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June 27, 2017

Ms. Lori Hamilton (MC 160)
Texas Commission on Environmental Quality
12100 Park 35 Circle
Building F, Room 3101
Austin, Texas 78753

VIA HAND DELIVERY

Re: Application for a water use permit for Lake Ringgold Reservoir
Pursuant to Water Code §§ 11.121 and 11.042
City of Wichita Falls (2813-7)

Dear Ms. Hamilton:

Please find enclosed one (1) original and six (6) copies of an application for a Texas water use permit filed on behalf of my client, the City of Wichita Falls (the "City"). The enclosed application requests authorization to construct the Lake Ringgold Reservoir, and to take, store, and divert state water, as specified in the application. This application is consistent with the presentation provided by the City and its consultants during the March 27, 2017 pre-application meeting with you and your staff.

Enclosed herein is my firm's check in the amount of $100.00, which is submitted as partial payment for the application fees. On behalf of the City, please consider me your contact for processing this application.

We look forward to working with you and your staff in processing this application. Should you have any questions regarding this matter, please do not hesitate to contact either me or Ashleigh Acevedo (512-322-5891) at your convenience.

Sincerely,
Brad Castleberry w/p ASV

Brad B. Castleberry

BBC/ald
ENCLOSURES

cc: Mr. Russell Schreiber
Ms. Simone Kiel
Ms. Ashleigh Acevedo

Texas Commission on Environmental Quality

City of Wichita Falls

Application for Water Use Permit for Lake Ringgold Reservoir

June 27, 2017

Submitted to:

Texas Commission on Environmental Quality
Water Supply Division, Water Rights Permitting (MC-160)
12100 Park 35 Circle
Austin, Texas 78753

Prepared for:

City of Wichita Falls, Texas
1300 7th Street
Wichita Falls, Texas 76307-7531

Prepared by:

Lloyd Gosselink Rochelle & Townsend, P.C.
816 Congress Avenue, Suite 1900
Austin, Texas 78701

Freese and Nichols, Inc.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109

City of Wichita Falls

Application for Water Use Permit for Lake Ringgold Reservoir

<u>Exhibits:</u>

Section 1

Application for Water Use Permit
for Lake Ringgold Reservoir

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
APPLICATION FOR PERMIT TO APPROPRIATE STATE WATER
(SECTION 11.121, 11.042, 11.085 **OR** 11.143, TEXAS WATER CODE)
TAC CHAPTERS 30, 50, 281, 287, 288, 295, 297 AND 299
Water Supply Division, Water Rights Permitting MC-160
P.O. Box 13087
Austin, Texas 78711-3087
Telephone (512) 239-4691, FAX (512) 239-4770
(if including a check, mail directly to P.O. Box 13088, Austin, TX 78711-3088)

Notice: This form will not be processed until all delinquent fees and/or penalties owed to the TCEQ or the Office of the Attorney General on behalf of the TCEQ are paid in accordance with the Delinquent Fee and Penalty Protocol.

1. Applicant Information.

A. Applicant Name(s): **City of Wichita Falls**

Mailing Address: 1300 7th Street, Wichita Falls, TX 76307-7531

Telephone Number: 940-761-7477 Fax Number: _________

Email Address: Russell.Schreiber@wichitafallstx.gov

B. Customer Reference Number (if issued): CN600129316

Note: If you do not have a Customer Reference Number, complete Section II of the Core Data Form (TCEQ-10400) and submit it with this application.

C. Fees and Penalties

Applicant owes fees or penalties?

☐ Yes ☑ No

If yes, provide the amount and the nature of the fee or penalty as well as any identifying number:

____

D. Lienholder Information

Provide this information on the holder of any liens on any land to which the water right would be appurtenant):

Not applicable

2. Dam (structure), Reservoir and Watercourse Data.

A. Type of Storage Reservoir (indicate by checking (√) all applicable)

☑ on-channel ☐ off-channel ☐ existing structure ☑ proposed structure* ☐ exempt structure**

*Applicant shall provide a copy of the notice that was mailed to each member of the governing body of each county and municipality in which the reservoir, or any part of the reservoir, will be located as well as copies of the certified mailing cards.

**TWC Section 11.143 for uses of water for other than domestic, livestock, or fish and wildlife from an existing, exempt reservoir with a capacity of 200 acre-feet or less. Please complete Paragraph 6 below if proceeding under TWC 11.143.

Date of Construction: to be constructed

B. Location of Structure No. 1. Lake Ringgold Dam

1) Watercourse: Little Wichita River

2) Location from County Seat: 13 miles in a northeasterly direction from Henrietta, Clay County, Texas.

Location from nearby town (if other than County Seat): ________ miles in a _________ direction from ____, a nearby town shown on county highway map.

3) Zip Code: 76261

4) The dam will be/is located in the Morse, W and Hall, IMW Original Survey No. 306 and 202, Abstract No. 306 and 202 in Clay County, Texas.

5) Station 50+00 on the centerline of the dam is S63° 18'19.82"E (bearing), 924.879 feet (distance) from the northeast corner of Bass, A Original Survey No. 11, Abstract No.11 , in Clay County, Texas, also being at Latitude 33.8962900 °N, Longitude -97.9929801°W.

C. Reservoir:

1) Acre-feet of water impounded by structure at normal maximum operating level: 275,000

2) Surface area in acres of reservoir at normal maximum operating level: 15,500

D. Drainage Area

The drainage area above the dam is 947,200 acres or 1,480 square miles.

E. Other

1) If this is a U.S. Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service (SCS)) floodwater-retarding structure, provide the Site No. Not applicable and watershed project name ____.

2) Do you request authorization to close the "ports" or "windows" in the service spillway?

☐ Yes ☐ No

3. Appropriation/Diversion Request (total amount of water needed, including maximum projected uses and accounting for evaporative losses for off-channel storage, if applicable).

A. Appropriated water will be used as follows:

	Purpose*	Place of Use	Acre-feet per year
1)	Municipal, Industrial, Agricultural and Mining	Red River Basin	65,000
2)			
3)			

*If agricultural use, list crops(s) to be irrigated: Landscape and other crops

B. Lands to be irrigated (if applicable):

1) Applicant proposes to irrigate a total of not applicable acres in any one year. This acreage is all of or

part of a larger tract(s) which is described in a supplement attached to this application and contains a total of ____________ acres in ______________________ County, Texas. A copy of the deed(s) describing the overall tract(s) with the recording information from the county records is attached.

2) Location of land to be irrigated: In the ____ Original Survey No. _______________, Abstract No. ______________.

C. Diversion Point No. 1 Lake Ringgold Dam.

1) Watercourse: Little Wichita River.

2) Location of point of diversion at on the perimeter of the proposed Lake Ringgold. Lake Ringgold location is in Clay County Texas as described in 2A.

3) Location from County Seat: 13 miles in a northeasterly direction from Henrietta, Clay County, Texas.

Location from nearby town (if other than County Seat): ________ miles in a ___________ direction from _________________________________, a nearby town shown on county highway map.

4) Zip Code: 76261

5) The diversion will be (check (√) all appropriate boxes and if applicable, indicate whether existing or proposed):

		Existing	Proposed
	Directly from stream		
	From an on-channel reservoir		X
	From stream to an off-channel reservoir		
	From a stream to an on-channel reservoir		
	From an off-channel reservoir		
	Other method (explain fully, use additional sheets if necessary)		

6) Rate of Diversion (Check (√) applicable provision):

_X_ 1. Diversion Facility:

A. 62,770 Maximum gpm (gallons per minute)

B. unknown Number of pumps

C. unknown Type of pump

D. unknown gpm, Pump capacity of each pump

E. Portable pump _________ Yes or X No.

___2. If by gravity:

A. ____ Headgate ______ Diversion Dam ______ Maximum gpm

B. ____ Other method (explain fully - use additional sheets if necessary)

____

____

7) The drainage area above the diversion point is 947,200 acres or 1,480 square miles.

D. Return Water or Return Flow

Applicant is requesting to reuse 100 percent of the return flows generated from the diversion and use of water from Lake Ringgold. Until such time as the facilities are developed to reuse this water, water which is diverted but not consumed as a result of the above stated use, will be returned from wastewater treatment facilities to the Red River Basin.

E. Surplus Water

Since the applicant is requesting to reuse 100 percent of the return flows generated from the diversion and use of water from Lake Ringgold, there will be no surplus water.

4. Discharge Point Information (if applicable, provide Latitude and Longitude coordinates in decimal degrees to at least six decimal places and indicate the method used to calculate the diversion point location).

Discharge Point No. or Name: not applicable ______________

A. Select the appropriate box for the source of water being discharged:

- ☐ Treated effluent
- ☐ Groundwater
- ☐ Other ________________________________

B. Location of discharge point will be/is at Latitude ______________° N, Longitude ______________°W, also bearing ______°______, ____________feet from the _________ corner of the _______________ Original Survey No. __________, Abstract No. _____, in ________________ ________________County, Texas.

What method was used to determine the Latitude and Longitude for the discharge point? (*i.e.*, GPS Unit, USGS 7.5 Topographic Map, etc.)

____

C. Location from County Seat: __________ miles in a ________direction from ___________________, ___________________ County, Texas.

Location from nearby town (if other than County Seat): ________ miles in a _________________ direction from _________________, a nearby town shown on county highway map.

D. Zip Code: _____________________

E. Water will be discharged into ______________________________________ stream/reservoir, (tributaries)____, ___________________ Basin.

F. Water will be discharged at a maximum rate of _________ cfs (__________ gpm).

G. The amount of water that will be discharged is ______________acre-feet per year.

H. The purpose of use for the water being discharged will be ______________________________.

I. Additional information required:

For groundwater

1) Provide water quality analysis and 24 hour pump test for the well if one has been conducted.
2) Locate and label the groundwater well(s) on a USGS 7.5 Minute Topographic Map
3) Provide a copy of the groundwater well permit if it is located in a Groundwater Conservation District.
4) What aquifer the water is being pumped from?

For treated effluent

1) What is the TPDES Permit Number? Provide a copy of the permit.
2) Provide the monthly discharge data for the past 5 years.
3) What % of treated water was groundwater, surface water?
4) If any original water is surface water, provide the base water right number.

5. General Information.

A. The proposed __X____ or existing ______ works will be (are) located on the land of the applicant, which will be acquired prior to construction, whose mailing address is 1300 7th Street, Wichita Falls, TX 76307-7531.

B. If an application for the appropriation is granted, either in whole or in part, construction works will begin within 2 years after such permit is issued. The proposed work will be completed within 7 years from the date the permit is issued.

C. A Water Conservation Plan is attached? X Yes _ No.

D. X Interbasin transfer is not requested.

__Applicant requests authorization to transfer ________________ acre-feet of water per year from the ______________________________ Basin to the ________________________ Basin of which _________ acre-feet of water will be used for ___________________________ purposes and _________ acre-feet of water will be used for ___________________________ purposes.

E. _X____ Bed and Banks request to transfer 65,000 acre-feet of water per year within the bed and banks of Lake Arrowhead, a reservoir on the Little Wichita River, tributary of the Red River, Red River Basin.

F. Is this project located within 200 river miles of the coast? ____ Yes X No ____Unknown

5. Maps, plats, plans, and drawings accompany this application as required by applicable TAC Sections.

X______ Yes ______ No. Attach additional sheets.

6. _______The dam(s) and reservoir(s) shown on the attached application was (were) constructed for domestic and livestock purposes and I/we elect to seek a permit under Section 11.143 of the Texas Water Code.

7. Provide information describing how this application addresses a water supply need in a manner that is consistent with the state water plan or the applicable approved regional water plan for any area in which the proposed appropriation is located or, in the alternative, describe conditions that warrant a waiver of this requirement.

The proposed Lake Ringgold project is included as a recommended strategy for the City of Wichita Falls in the approved 2016 Region B Water Plan and 2017 State Water Plan.

[signature]	
Applicant Name (Sign)	Applicant Name (Sign)
Darron Leiker	
Applicant Name (Printed)	Applicant Name (Printed)

SWORN TO AND SUBSCRIBED before me this 27th day of June, 20 17.

LINDA MERRILL
Notary Public, State of Texas
Comm. Expires 12-22-2018
Notary ID 482691-4

Linda Merrill

Notary Public for the State of Texas

Supplemental Dam/Reservoir Information Sheet

Structure No. 1. Lake Ringgold Dam

A. Type of Storage Reservoir (indicate by checking (√) all applicable)

☑ on-channel ☐ off-channel ☐ existing structure ☑ proposed structure* ☐ exempt structure**

*Applicant shall provide a copy of the notice that was mailed to each member of the governing body of each county and municipality in which the reservoir, or any part of the reservoir, will be located as well as copies of the certified mailing cards.

**TWC Section 11.143 for uses of water for other than domestic, livestock, or fish and wildlife from an existing, exempt reservoir with a capacity of 200 acre-feet or less. Please complete Paragraph 6 below if proceeding under TWC 11.143.

Date of Construction to be constructed

B. Location of Structure No. 1. Lake Ringgold Dam.

1) Watercourse: Little Wichita River

2) Location from County Seat: 13 miles in a northeasterly direction from Henrietta, Clay County, Texas.

Location from nearby town (if other than County Seat): ______ miles in a _____ direction from ________________________, a nearby town shown on county highway map.

3) Zip Code: 76261

4) The dam will be/is located in the Morse W and the Hall, IMW Original Survey No. 306 and 202, Abstract No. 306 and 202 in Clay County, Texas.

5) Station 50+00 on the centerline of the dam is S63° 18'19.82"E (bearing), 924.879 feet (distance) from the northeast corner of Bass, A Original Survey No. 11, Abstract No.11, in Clay County, Texas, also being at Latitude 33.8962900 °N, Longitude -97.9929801 ºW.

C. Reservoir:

1) Acre-feet of water impounded by structure at normal maximum operating level: 275,000

2) Surface area in acres of reservoir at normal maximum operating level: 15,500

D. The drainage area above the dam is 947,200 acres or 1,480 square miles.

E. Other:

1) If this is a U.S. Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service (SCS)) floodwater-retarding structure, provide the Site No. N/A and watershed project name ________________________

2) Do you request authorization to close the "ports" or "windows" in the service spillway?

☐ Yes ☐ No

Supplemental Discharge Point Information Sheet

Discharge Point No. or Name: 1 Perimeter of Lake Arrowhead

1) Select the appropriate box for the source of water being discharged:

    ☐ Treated effluent

    ☐ Groundwater

    X Other Proposed Lake Ringgold

2) Location of discharge point will be/is on the perimeter of the existing Lake Arrowhead. Lake Arrowhead is located in Clay County Texas.

3) Location from County Seat: 10.42 miles in a southwesterly direction from Henrietta,

    Clay County, Texas.

    Location from nearby town (if other than County Seat): ___________ miles in a __________________

    direction from _____________________, a nearby town shown on county highway map.

4) Zip Code: 76379

5) Water will be discharged into Little Wichita River/Lake Arrowhead stream/reservoir,

    (tributaries),

    Red River _______________ Basin.

6) Water will be discharged at a maximum rate of 139.86 cfs (62,770 gpm).

7) The amount of water that will be discharged is 65,000 acre-feet per year.

8) The purpose of use for the water being discharged will be Municipal, Industrial, Agricultural and Mining.

9) Additional information required:

For groundwater

1. Provide water quality analysis and 24 hour pump test for the well if one has been conducted.
2. Locate and label the groundwater well(s) on a USGS 7.5 Minute Topographic Map
3. Provide a copy of the groundwater well permit if it is located in a Groundwater Conservation District.
4. What aquifer the water is being pumped from?

For treated effluent

1. What is the TPDES Permit Number? Provide a copy of the permit.
2. Provide the monthly discharge data for the past 5 years.
3. What % of treated water was groundwater, surface water?
4. If any original water is surface water, provide the base water right number.

Supplemental Diversion Point Information Sheet

Diversion Point No. 2 Lake Arrowhead Existing Intake. (Provde a completed *Supplemental Diversion Point Information Sheet* for additional diversions)

1) Watercourse: Little Wichita River/Lake Arrowhead

2) Location of point of diversion at Latitude 33.763707°N, Longitude -98.370091 °W,

also, bearing S56° 21' 03.29" W°, 1293.53 feet (distance) from the Northeast corner of the

M. Haley Original Survey No. 188, Abstract No. 188, in

Clay County, Texas. **Provide Latitude and Longitude coordinates in decimal degrees, to at least six decimal places, and indicate the method used to calculate the diversion point location.**

3) Location from County Seat: 10.42 miles in a southwesterly direction from Henrietta,

Clay County, Texas.

Location from nearby town (if other than County Seat): ________ miles in a __________________

direction from __________________, a nearby town shown on county highway map.

4) Zip Code: 76379

5) The diversion will be (check (√) all appropriate boxes and if applicable, indicate whether existing or proposed):

		Existing	Proposed
	Directly from stream		
	From an on-channel reservoir	X	
	From stream to an off-channel reservoir		
	From a stream to an on-channel reservoir		
	From an off-channel reservoir		
	Other method (explain fully, use additional sheets if necessary)		

6) Rate of Diversion (Check (√) applicable provision):
_X_1. Diversion Facility:
A. 41,850 Maximum gpm (gallons per minute)
1) unknown Number of pumps
2) unknown Type of pump
3) unknown gpm, Pump capacity of each pump
4) Portable pump _______ Yes or X No

___2. If by gravity:
A._______ Headgate _____ Diversion Dam ______ Maximum gpm
B._______ Other method (explain fully - use additional sheets if necessary)

7) The drainage area above the diversion point is 526,080 acres or 822 square miles.

Supplemental Diversion Point Information Sheet

Diversion Point No. 3 Perimeter of Lake Arrowhead.

1) Watercourse: Little Wichita River/Lake Arrowhead

2) Location of point of diversion on the perimeter of the existing Lake Arrowhead. Lake Arrowhead is located in Clay County Texas.

3) Location from County Seat: 10.42 miles in a southwesterly direction from Henrietta, Clay County, Texas.

Location from nearby town (if other than County Seat): ________ miles in a __________________ direction from __________________, a nearby town shown on county highway map.

4) Zip Code: 76379

5) The diversion will be (check (√) all appropriate boxes and if applicable, indicate whether existing or proposed):

		Existing	Proposed
	Directly from stream		
	From an on-channel reservoir	X	
	From stream to an off-channel reservoir		
	From a stream to an on-channel reservoir		
	From an off-channel reservoir		
	Other method (explain fully, use additional sheets if necessary)		

6) Rate of Diversion (Check (√) applicable provision):

__X__1. Diversion Facility:

A.62,770 Maximum gpm (gallons per minute)

1) unknown Number of pumps
2) unknown Type of pump
3) unknown gpm, Pump capacity of each pump
4) Portable pump _______ Yes or X No

___2. If by gravity:

A._______ Headgate _____ Diversion Dam ______ Maximum gpm

B._______ Other method (explain fully - use additional sheets if necessary)

7) The drainage area above the diversion point is 526,080 acres or 822 square miles.

Supplemental Environmental Information Sheet

Water right projects have the potential to alter environmental conditions in the state's rivers and streams through flow modification, sediment load alteration, loss of wetlands, and removal of riparian vegetation. The Resource Protection Team assess the effects issuance or amendment of a water right may have on existing instream uses. Instream uses include, but are not limited to, water quality, fish and wildlife habitat, recreation, and freshwater inflows to bays and estuaries.

The following items are suggested guidelines for data to be submitted depending on the nature of the particular application. Please note that *not* all the information identified below is required for the water right application to be considered administratively complete. However, depending on the magnitude and scope of the proposed project, failure to provide requested information for technical review may result in delayed processing times or a recommendation of denial of the application.

ITEMS TO BE PROVIDED FOR ALL APPLICATIONS:

1. USGS 7.5 minute topographic map with all diversion points, discharge points, reservoirs, and/or land to be irrigated clearly indicated. <u>The USGS topographic map is included in Appendix L of the Supporting Report (Exhibit A).</u>

2. Photographs of the stream at the project area (i.e., diversion point/dam location) including upstream and downstream views. Photographs should be in color and reflect the existing conditions of the stream and the riparian vegetation. Each photograph should include a description of what is depicted as well as be referenced to the USGS topographic map indicating the location and direction of the shot. <u>Photographs are included in Appendix H of the Supporting Report (Exhibit A).</u>

3. Brief description of the affected stream or water body at the project location including:

   a) Average and maximum channel width and depth;
   b) Flow characteristics of the stream (i.e., is the stream perennial, intermittent with pools, or intermittent?);
   c) Description of land uses upstream within the watershed, if known.

   <u>Descriptions of the affected stream are included in the Supporting Report, Chapter 5 and Appendix J (Exhibit A).</u>
4. Any known recreation or other public uses of the affected stream or water body.
   <u>Instream uses of the Little Wichita River is discussed in Chapter 5 of the Supporting Report (Exhibit A).</u>

ADDITIONAL ITEMS TO BE PROVIDED IF AN EXISTING DAM AND RESERVOIR ARE SOUGHT TO BE PERMITTED:

1. Date dam constructed.

2. Will the reservoir be maintained at normal pool elevation with an alternate source of water? If so, identify the source of water. If groundwater will be used, see below.

3. Does the dam have an operational low flow outlet or other means to pass state water?

MINIMAL ADDITIONAL ITEMS TO BE PROVIDED IF A DAM AND RESERVOIR ARE PROPOSED TO BE CONSTRUCTED:

1. In addition to indicating the location of the project location on the USGS topographic map, please identify the area of lake inundation at normal pool level.

This is included in the application drawings, which are also included in Appendix B of the Supporting Report (Exhibit A).

2. Provide a brief description of the area to be affected by the proposed dam and reservoir.

   This is included in Chapter 5 of the Supporting Report (Exhibit A).

3. The local U.S. Army Corps of Engineers (USACE) district should be notified of the proposed project. If the USACE determines that a 404 permit is required, provide the project number and name of the USACE Project Manager.

   The Tulsa District of the USACE will be notified of the project. The USACE project number and contact will be provided when a USACE Project Manager is assigned.

4. Will the reservoir be maintained at normal pool elevation with an alternate source of water? No. If so, identify the source of water. If groundwater will be used, see below.

5. Will the dam have a low flow outlet or other means to pass state water?

   Yes. A low flow outlet structure will be provided. This structure may be combined with the intake structure for diversion or may be a separate structure. This is discussed in Chapter 2 and Appendix B of the Supporting Report (Exhibit A).

POSSIBLE ADDITIONAL ITEMS TO BE PROVIDED IF A DAM AND RESERVOIR ARE PROPOSED TO BE CONSTRUCTED:

1. A quantitative or qualitative evaluation of existing aquatic, riparian, wetland, and terrestrial habitats that will be subject to impact by the proposed reservoir project, preferably performed by a qualified third party. Acceptable evaluation procedures to be used may include, but are not limited to, USFWS's Habitat Evaluation Procedures or TPWD's Wildlife Habitat Appraisal Procedure. Any habitat evaluation should include an assessment of the effects of the project on habitats in the river segment downstream.

   A habitat evaluation study was conducted and is included in Appendix I of the Supporting Report (Exhibit A).

2. Description of the alternatives that were examined to meet the water needs that the proposed project is intended to fulfill. Were other site locations examined that may result in less environmental impact? How was the size of the proposed reservoir determined? Would a smaller reservoir be adequate to meet the projected water needs? Habitat mitigation shall be considered only after the complete sequencing (avoidance, minimization or modification, and compensation/replacement) process has been performed.

   Alternatives to the Lake Ringgold project are discussed in Chapter 3 of the Supporting Report (Exhibit A). Each of the alternatives considered but dismissed would have environmental impacts. These alternatives were dismissed due to development obstacles, cost feasibility and reliability of water supply. The size of the proposed Lake Ringgold was based on optimizing the project's benefits while minimizing potential impacts.

3. Should habitat losses be found to be unavoidable, a mitigation plan should be developed that will compensate for lost or altered ecosystem functions and values imposed by the proposed project. This plan should address both the direct and indirect impacts to aquatic, riparian, and terrestrial habitats, as well as short- and long-term effects that may result from the proposed project. Habitat mitigation plans shall be ensured through binding legal contracts or conservation easements and shall include goals and schedules for completion of those goals. Mitigation areas shall be managed in perpetuity by a party approved by the Commission to maintain the habitat functions and values that will be affected by the proposed project.
   A conceptual mitigation plan was developed and is included in Chapter 6 and Appendix K of the Supporting Report (Exhibit A).

ADDITIONAL ITEMS TO BE PROVIDED IF GROUNDWATER WILL BE USED:

Information regarding the groundwater wells to be used in this project and groundwater quality data from each well to be used. Well information should include the following:

a) Depth of well;
b) Name of aquifer from which water is withdrawn;
c) Pumping capacity of well.

Water chemistry information should include but not be limited to the following parameters:

a) Chlorides;
b) Sulfates;
c) Total Dissolved Solids (TDS);
d) pH;
e) Temperature.

If data for on-site wells are unavailable, historical data collected from similar sized wells drawing water from the same aquifer may be provided. However, please note that on-site data may still be required when it becomes available.

Alternatives Analysis Worksheet for Wetland Impacts

1. Alternatives
    1. How could you satisfy your needs in ways which do not affect wetlands? <u>Each of the alternatives considered and dismissed would have impacts to streams and/or wetlands.</u>
    2. How could the project be re-designed to fit the site without affecting wetlands? <u>The project cannot be redesigned to not impact wetlands.</u>
    3. How could the project be made smaller and still meet your needs? <u>While a smaller project could potentially meet the projected needs, it would not optimize the water supply for the project. A smaller footprint would have minimal reductions to wetland impacts since the wetlands are located along the stream corridor at lower elevations.</u>
    4. What other sites were considered? <u>See Chapter 3 of the Supporting Report (Exhibit A).</u>
        1. What geographic area was searched for alternative sites?
        2. How did you determine whether other non-wetland sites are available for development in the area?
    5. What are the consequences of not building the project? <u>If the project was not built, the City of Wichita Falls would not be able to meet its water needs, as demonstrated during the 2011-2015 drought.</u>

2. Comparison of alternatives. <u>The comparison of the alternatives to the Lake Ringgold project is discussed in Chapter 3 of the Supporting Report (Exhibit A).</u>
    1. How do the costs for the alternatives considered above?
    2. Are there logistic (location, access, transportation, etc.) factors that limit the alternatives considered?
    3. Are there technological limitations for the alternatives considered?
    4. Are there other reasons certain alternatives are not feasible?

3. If you have not chosen an alternative which would avoid wetland impacts, explain:
    1. Why your alternative was not selected?
    2. What you plan to do to minimize adverse effects on the wetlands impacted?

    The reasons the other alternatives were dismissed are discussed in Chapter 3 of the Supporting Report (Exhibit A). Each of these alternatives include infrastructure that would impact streams and/or wetlands.

4. Please provide a comparison of each criterion (from Part II) for each site evaluation in the alternatives analysis. The comparison of the alternatives to the Lake Ringgold project is discussed in Chapter 3 of the Supporting Report (Exhibit A).

PERMIT APPLICATION COMPLETION CHECKLIST FOR
HYDROLOGY, WATER CONSERVATION, AND DAM SAFETY

Name(s) of Applicant: **City of Wichita Falls**

Stream, Basin, and County: **Little Wichita River, Red River Basin, Clay County**

USGS 7.5 minute topographic map with all diversion points, discharge points, reservoirs, and/or land to be irrigated clearly indicated: **Diversion will be directly from the perimeter of the proposed new reservoir in Clay County, which is shown on the USGS topographic maps in the application drawings (Exhibit A).**

Latitude and Longitude of all diversion points and/or reservoirs, including how the coordinates were determined: **The latitude and longitude provided below is the location of the centerline of the proposed Lake Ringgold Dam at Station 50+00.**

Latitude: 33.8962900 °N, Longitude -97.9929801°W

Diversion amount: **65,0000 acre-feet per year**
Diversion rate: **62,770 gpm**

Monthly Diversion Distribution (the amount of the total water that you plan to divert each month):

J	F	M	A	M	J	J	A	S	O	N	D

Unknown

Reservoir capacity and surface area: **Capacity= 275,000 acre-feet, Area=15,500**

Drainage area: **1480 square miles**

Request to use the bed and banks of a watercourse and/or reservoir: **No.**

Other (copy of contract for water, alternate source of water, accounting plan, etc.) **Not applicable.**

<u>WATER CONSERVATION PLAN</u> **Attached (Exhibit C).**

1. Plan and appropriate data form

2. Please specify the <u>quantitative</u> goals as outlined on the data form

<u>DAM SAFETY</u>

If a reservoir is requested in the application, the following information should be submitted:

1. Surface area and capacity of the reservoir **Capacity= 275,000 acre-feet, Area=15,500**

2. Plans (with engineer's seal) for the reservoir if the dam is over 6 feet high **Attached (Exhibit A).**

3. Engineer's signed and sealed hazard classification **Included in *the Report Supporting an Application for a Texas Water Right for Lake Ringgold* (Exhibit A).**

4. Statement from engineer that the structure complies with the Chapter 299 Rules and supporting documentation **Included in *the Report Supporting an Application for a Texas Water Right for Lake Ringgold* (Exhibit A).**

Section 2

Supplemental Application for
Water Use Permit
for Lake Ringgold Reservoir

CITY OF WICHITA FALLS

Supplemental Application for Water Use Permit for the Lake Ringgold Reservoir pursuant to Texas Water Code § 11.121 and 11.042

June 2017

In addition to the TCEQ Application Form (Form 10214), a narrative description of the water use permit sought for the Lake Ringgold Reservoir with this application (the "Application") is found below. The following documents are also attached as Exhibits to this Application:

- A Report Supporting an Application for a Texas Water Right for Lake Ringgold
- B Authority to File Application
- C Water Conservation and Drought Contingency Plan
- D Application Fees

I. Background

The City of Wichita Falls (the "City") provides both wholesale and retail treated water supply to customers in a service area covering parts of Archer, Clay, Wichita, and Young Counties. Lake Ringgold will be located in Clay County, Texas, on the Little Wichita River approximately 0.5 miles upstream of its confluence with the Red River. As proposed, the City will construct the proposed Lake Ringgold Dam approximately 13 miles northeast of the City of Henrietta. The project will impound 275,000 acre-feet of water at the normal pool elevation of 844 feet above mean sea level and have a surface area of 15,500 acres. The project has a drainage area of 1,480 square miles. The City is requesting to withdraw up to 65,000 acre-feet per year from the reservoir.

The City's operation of Lake Ringgold, as described in greater detail in Section 2.6 of the *Report Supporting an Application for a Texas Water Right for Lake Ringgold* (the "Supporting Report"), included herein as **Exhibit A**, in coordination with upstream reservoirs in the Little Wichita River Basin when possible and the ability to overdraft Lake Ringgold provides the City the needed flexibility to optimize its water supplies to meet a growing demand.

Water from the proposed project will be used primarily as a municipal water supply for the City and serve as a supplement to existing supplies. Water not needed for municipal purposes will be used secondarily for agriculture, industrial, and mining purposes. Some water may be transmitted using the bed and banks of Lake Arrowhead for subsequent diversion, treatment, and use.

The City has long considered Lake Ringgold as an additional water supply. In response to the extreme drought experienced between 2011 and 2015 in Texas, generally, and the City, specifically—explained in more detail in Section 1.1 of the Supporting Report—the City has moved forward with pursuing the necessary authorizations to construct Lake Ringgold.

Particularly, with this Application, the City is seeking the following authorizations pursuant to Texas Water Code §§ 11.121 and 11.042:

1. Impoundment and storage of up to 275,000 acre-feet of water in the proposed Lake Ringgold.

2. Diversion and use of up to 65,000 acre-feet of water per year for municipal, industrial, agricultural, and mining purposes.

3. Diversion from a point on the perimeter of the proposed Lake Ringgold at a maximum diversion rate of 62,770 gallons per minute (gpm).

4. Reuse of 100 percent of the return flows generated from the diversion and use of water from Lake Ringgold.

5. Bed and banks permit to transport water diverted from Lake Ringgold within the bed and banks of Lake Arrowhead.

II. Application Information

Name of Applicant:	City of Wichita Falls, Texas
Address:	1300 7th Street, Wichita Falls, Texas 76307-7531
Principal Contact:	Brad Castleberry, Lloyd Gosselink Rochelle & Townsend, P.C.
Telephone:	(512) 322-5856
Fax:	(512) 472-0532

III. Authorization for Filing Application

On or about May 16, 2017, the City Council authorized the filing of this Application. A copy of the City Council resolution authorizing the filing and prosecution of the Application is included herein as **Exhibit B**.

IV. Source of Supply

The source of water associated with this Application is the Little Wichita River.

V. Amount and Purpose of Diversion and Use

The City seeks a permit to appropriate state water under Texas Water Code § 11.121 to divert and use up to 65,000 acre-feet of water per year, as described in further detail in Section 2.6 of the Supporting Report. The City provides wholesale and retail water service not only to customers within the City's limits, but also to cities and other political subdivisions within the surrounding counties. In the wake of the City's most recent extreme drought during which the City was compelled to take emergency action to provide water for municipal use (Section 1.1 of the Supporting Report) and as demand on the City continues to increase (Section 1.3 of the supporting report), the City is now pursuing construction of Lake Ringgold. Diversions from

Lake Ringgold will supplement the City's existing municipal supplies to ensure that municipal users have a reliable water supply in the long term (Sections 1.2 and 3.3 and Appendix C of the Supporting Report). To best manage its municipal supplies, the City seeks flexibility with its diversions from Lake Ringgold and the ability to overdraft Lake Ringgold (Section 2.6 of the Supporting Report).

VI. Diversion Information

The City seeks to divert from any point on the perimeter of the proposed Lake Ringgold at a maximum diversion rate of 62,770 gpm. A USGS topographic map is included in Appendix L of the Supporting Report. Application drawings, including a vicinity and location map, are included in Appendix B of the Supporting Report. Photographs of the project site are included in Appendix H of the Supporting Report.

VII. Water Conservation and Drought Contingency

Pursuant to Texas Water Code § 11.134(b)(4), 30 Texas Administrative Code ("TAC") § 295.9, and Chapter 288 of 30 TAC and in response to the 2011 drought, the City updated and adopted its Water Conservation and Drought Contingency Plan (the "Plan") in 2014. In 2015, the City Council approved an ordinance to amend the Plan. A copy of the Plan, as amended, is included herein as **Exhibit C** and summarized in greater detail in Section 1.2.5 of the Supporting Report.

VIII. Administrative Requirements and Fees

The Application provides relevant information to address the administrative requirements of 30 TAC § 295, Subchapter A and the requirements of Texas Water Code Chapter 11, specifically § 11.134(b)(1). In accordance with 30 TAC § 295.131 and other TCEQ rules relating to fees, the City is submitting a partial payment of $100.00 with this Application, which is attached as **Exhibit D**. With the filing of this Application, the City requests a determination of any additional fees that may be required. Upon receipt of such determination, the City will forward such fees to the TCEQ.

IX. Notice

Pursuant to Section 11.121 of the Texas Water Code and 30 TAC § 295.152, an application for a permit pursuant to Texas Water Code § 11.121 requires mailed notice to (1) each claimant or appropriator of water from the source of water supply, (2) all navigation districts, and (3) others who in the judgment of the TCEQ might be affected.

In addition to these notice requirements, Texas Water Code 11.124(f) requires that the application contain evidence of mailed notice of the application to each member of the governing body of each county and municipality in which the reservoir, or any part of the reservoir, will be located. A copy of this application will promptly be sent to the City of Henrietta clerk and the Clay County clerk, and notice will be mailed to the Henrietta Mayor, each member of the

Henrietta City Council, the Clay County Judge, and each Clay County Commissioner. Evidence of mailed notice of the application will be provided at that time.

X. Additional Findings Pursuant to Texas Water Code § 11.0134

Under Section 11.134 of the Texas Water Code, certain additional conditions must be met if the TCEQ is to grant an application for a water right:

A. Beneficial Use

The proposed appropriation is intended for municipal, industrial, agricultural, and mining use. Texas Water Code §11.134(b)(3)(A) requires that proposed appropriations of water be intended for a beneficial use. The "beneficial use" of water is defined in Texas Water Code §11.002(4) and 30 TAC §297.1(8) as the use of water "which is economically necessary for a purpose authorized by [Chapter 11 of the Texas Water Code]." A "municipal" purpose of use, relevant for purposes of this Application, is "the use of potable water within a community or municipality and its environs for domestic, recreational, commercial, or industrial purposes or for the water of golf course, parks and parkways, other public recreational spaces; or the use of reclaimed water in lieu of potable water for the preceding purposes; or the use of return flows authorized pursuant to Texas Water Code, § 11.042, in lieu of potable water for the preceding purposes. . . ." 30 TAC § 297.1(33). An "agricultural" purpose of use is identified in Texas Water Code §11.023 as a purpose for which water may be diverted and beneficially used and is defined in 30 TAC §297.1(2) to include "any use or activity involving agriculture, including irrigation." "Irrigation" is defined under 30 TAC §297.1(26) to include "the use of water for the irrigation of crops, trees, and pasture land, including, but not limited to, golf courses and parks which do not receive water through a municipal distribution system." An "industrial" purpose of use includes the "use of water in processes designed to convert materials of a lower order of value into forms having greater usability and commercial value, including the development of power by means other than hydroelectric, but does not include agricultural use." 30 TAC §297.1(24) Additionally, a "mining" purpose of use is "the use of water for mining processes including hydraulic use, drilling ,washing sand and gravel, and oil filed repressuring." 30 TAC §297.1(31).

The primary use planned is for municipal supply in the City's service area, within which demand on the City is increasing. Sections 1.2 through 1.4 and Appendix C of the Supporting Report show the projected population and water needs for the City's Service Area, including the current ability of existing supplies to meet demand. Additionally, Section 2.6 of the Supporting Report describes how the City plans to make full use of supplies from Lake Ringgold in coordination with its existing supplies.

Finally, Section 1.1 of the Supporting Report details the City's successful water conservation measures taken during the 2011-2015 and drought, and Section 1.2.5 of the Supporting Report details the City's water conservation and drought contingency program. The City's compliance with this program will further ensure the City's use of water is put to beneficial use by avoiding waste and guaranteeing water conservation.

B. Public Welfare

Construction of and diversion from Lake Ringgold will allow the City to provide water for beneficial use, as defined by the Texas Water Code. Such action is not detrimental to the public welfare, a requirement under Texas Water Code § 11.134(b)(3)(C). Indeed, the proposed reservoir and will benefit the public welfare as it provides the City with greater water security and reliability and allows the City more flexibility in utilizing existing water supplies. Furthermore, the City's commitment to use conservation methods to avoid waste and to ensure water is used efficiently will further ensure that the City's use of water is not detrimental to public welfare.

C. Consistency with State and Regional Water Plans

The City is located within the Region B Regional Water Planning Area ("Region B"). According to the State Water Plan, *Water for Texas 2017*, the population in Region B is expected to increase by eleven percent (11%) from 2020 to 2070, but the City alone is expected to grow by twelve percent (12%).[1] Although per capita water use is expected to decrease due to water savings from more efficient plumbing fixtures as required by the State Plumbing Code, there is projected to be an increase in the current demand for water for municipal uses over the same time period for Region B.[2] Both the State Water Plan and the Region B Plan recognize and recommend the construction of the Lake Ringgold Reservoir as a water management strategy for Region B.[3] Moreover, the site is recognized as a site of unique value and is currently protected by Texas Water Code § 16.051.[4] The Region B Plan is approved in accordance with Texas Water Code § 11.134(c).

D. Groundwater Assessment

No adverse impact to groundwater resources will result from the Application. Section 5.5 of the Supporting Report explains that groundwater resources in the Clay County are limited, and Lake Ringgold is not within a recharge zone of any aquifer—major or minor. Therefore, no significant, direct negative impact on groundwater sources is expected. As detailed in the alternatives section of the Supporting Report, Chapter 3, allowing the City to construct Lake Ringgold and utilize this water as requested in the Application will reduce the need to utilize other sources of water, particularly groundwater from beyond Clay County. In effect, granting

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[1] Texas Water Development Board, *Water for Texas 2017*, pg. 50 (2016), available at http://www.twdb.texas.gov/waterplanning/swp/2017/doc/SWP17-Water-for-Texas.pdf [hereinafter *Water for Texas 2017*]; 2016 Region B Water PlanI, pg. 2-3 (Dec. 2015), available at http://www.twdb.texas.gov/waterplanning/rwp/plans/2016/B/Region_B_2016_RWP.pdf [hereinafter *2016 Region B Water Plan*].

[2] *2016 Region B Water Plan*, at 2-6.

[3] *Water for Texas 2017*, at 94-95; Texas Water Development Board, *Water for Texas 2017, List of Recommended Water Management Strategy Projects* (Feb. 9, 2017), available at http://www.twdb.texas.gov/waterplanning/swp/2017/index.asp; *2016 Region B Water Plan*, at 1-27, 5-7, 5-32, 5-47, 6-11, and 9-4.

[4] *Water for Texas 2017*, at 26.

the Application may actually have a positive effect on groundwater resources by reducing groundwater consumption, including consumption from private wells when extreme conservation measures are in place.

E. Impacts on Other Water Rights Holders or the Environment

Section 4.4 and Appendix F of the Supporting Report detail the no injury analysis that was performed to determine the effects of the requested water right on other water rights pursuant to Texas Water Code § 11.134(b)(3)(B). The analysis reflected only a small change (less than 0.1 acre-feet per year) in the mean shortage for three of the thousands of water rights in the Little Wichita watershed and no changes in either period or volume reliability. Such changes are within the margin of error and are negligible, thus no injury will result to existing permanent water rights.

The City also performed numerous environmental reviews pursuant to Texas Water Code § 11.134(b)(3)(D), which requires an evaluation of the proposed appropriation on instream uses, water quality, fish and wildlife, groundwater, and fish and wildlife habitat. The information needed for the TCEQ to assess these impacts is provided in Chapter 5 and Appendices F, I, and J of the Supporting Report.

F. Availability of Unappropriated Water

Unappropriated water is available in the Little Wichita River. Chapter 4 and Appendix F of the Supporting Report describe the analyses that demonstrate the availability of unappropriated water pursuant to Texas Water Code § 11.134(b)(2).

XI. Requirements for Bed and Banks Authorization

In accordance with Texas Water Code § 11.042 relating to bed and banks authorizations, Chapter 7 of the Supporting Report details necessary additional information relating to water quality and carriage losses associated with the City's request to use the bed and banks of Lake Arrowhead. Particularly, because Lake Ringgold and Lake Arrowhead will be located within the same watershed, water quality is expected to be similar, and Lake Ringgold water may even improve the quality of Lake Arrowhead water. Additionally, because of a short residence time in Lake Arrowhead, carriage losses are expected to be minimal.

Exhibit A

Report Supporting an Application for a Texas Water Right for Lake Ringgold

Innovative approaches
Practical results
Outstanding service

REPORT SUPPORTING AN APPLICATION FOR A TEXAS WATER RIGHT FOR LAKE RINGGOLD

Prepared for:

City of Wichita Falls, Texas

May 2017

Prepared by:

FREESE AND NICHOLS, INC.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109
817-735-7300

STATE OF TEXAS
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93615
LICENSED
PROFESSIONAL ENGINEER

6-8-17

Simone F. Kiel, P.E.

STATE OF TEXAS
JOHN LEE RUTLEDGE
65045
REGISTERED
PROFESSIONAL ENGINEER

6-8-17

John L. Rutledge, P.E.

Michael P. Votaw, PWS, Wildlife Biologist

Report Supporting an Application for a Texas Water Right for Lake Ringgold

Prepared for:

CITY OF WICHITA FALLS, TEXAS

Freese and Nichols, Inc.
Texas Registered Engineering Firm
F-2144

Freese and Nichols, Inc.
4055 International Plaza
Suite 200
Fort Worth, TX 76109
(817) 735-7300

ENGINEER'S CERTIFICATION

I certify that the preliminary design for the structure of the dam and spillway for Lake Ringgold was prepared under my direction and complies with the Texas Administrative Code, Title 30, Part 1, Chapter 299 rules and supporting documentation. According to the criteria given in Chapter 299, the dam would be classified as a large, high hazard structure.

STATE OF TEXAS
JOHN LEE RUTLEDGE
65045
REGISTERED
PROFESSIONAL ENGINEER

6-8-17

Freese and Nichols, Inc.
Texas Registered Engineering Firm
F-2144

John L. Rutledge, P.E.

Freese and Nichols, Inc.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109

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REPORT SUPPORTING AN APPLICATION FOR A TEXAS WATER RIGHT FOR LAKE RINGGOLD

PREFACE

This report supports the water right application by the City of Wichita Falls for the Lake Ringgold Reservoir. As proposed, Wichita Falls would construct a dam on the Little Wichita River, approximately 13 miles northeast of Henrietta, Texas. The lake would have a surface area of 15,500 acres and storage capacity of 275,000 acre-feet.

The application requests the right to

- Impound and store 275,000 acre-feet of state water in the proposed Lake Ringgold;
- Use and diversion of 65,000 acre-feet per year for municipal, industrial, mining and agricultural use;
- Divert from the perimeter of the lake at a maximum rate of 62,770 gpm;
- Use of return flows generated from the diversion and use of water from Lake Ringgold; and
- Use of the bed and banks of Lake Arrowhead for transport of diverted water from Lake Ringgold.

This report provides supporting information and technical analysis necessary to review the water right application. The main report presents the purpose and need for the project, alternatives considered and dismissed, hydrological review and analysis, and environmental studies and review. Required supporting documents can be found in the appendices, which include:

• Application drawings	Appendix B
• Water Availability Modeling	Appendix F
• Accounting Plan	Appendix G
• Mitigation Plan	Appendix K
• USGS Topographic Map	Appendix L

Other appendices provide technical analyses that support the discussion in the main report.

REPORT SUPPORTING AN APPLICATION FOR A TEXAS WATER RIGHT FOR LAKE RINGGOLD

May 2017

1. BACKGROUND AND NEED FOR THE PROJECT

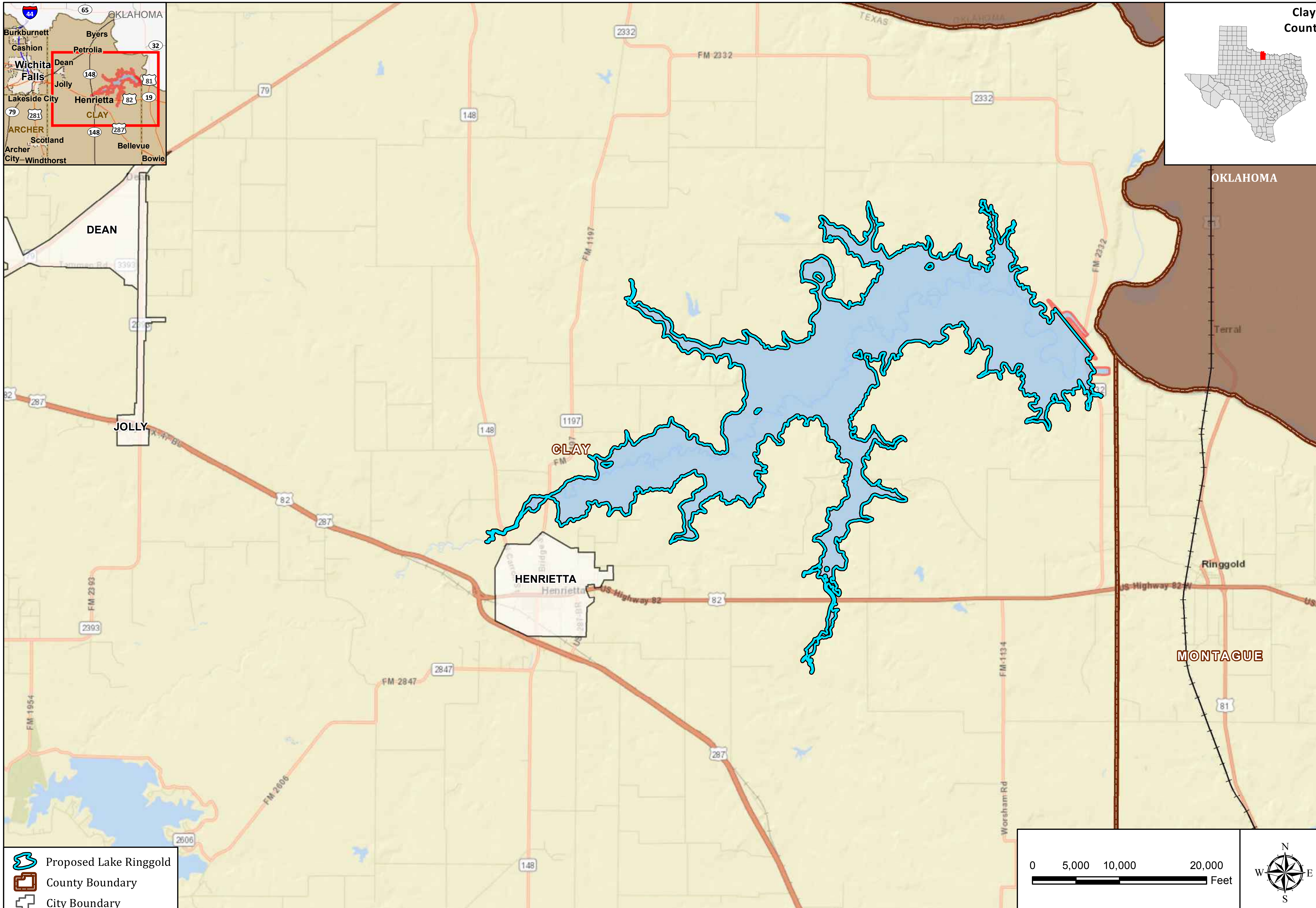
Lake Ringgold is a proposed 15,500-acre reservoir located in Clay County, Texas northeast of the town of Henrietta. The proposed dam would be located on the Little Wichita River, approximately 0.5 miles upstream of its confluence with the Red River, and would impound 275,000 acre-feet of water at the normal pool elevation of 844 feet-msl. The proposed site for Lake Ringgold is shown in Figure 1-1. The Lake Ringgold water supply project has been studied numerous times, with the earliest studies in 1958 and the most recent in 2014 as part of the City's *Long-Range Water Supply Plan* (FNI, 2015). Water from this lake would be beneficially used for municipal water supply.

The critical drought that the City of Wichita Falls (the City) experienced between 2011 and 2015 has emphasized the need for additional water supplies. The *2016 Region B Regional Water Plan* (BAM/FNI/APAI, 2016) for the Wichita Falls area indicates the City will need additional water supplies by 2020, and this project is recommended for implementation by 2040 to meet the City's long-term projected needs.

1.1 2011 Drought

In 2011, the state of Texas experienced the beginning of an extreme drought, and the Wichita Falls area was especially hard hit. High temperatures and little rainfall contributed to rapidly falling lake levels at each of the City's water sources. From 2011 to May 2015, the drought and water levels in the City's three surface water sources declined to unprecedented levels. In response, the City initiated its drought plan, including adding a fifth drought stage, and substantially reduced its water use. Even with extreme drought measures, such as no outside watering, the lakes continued to decline.

While the City continued to reduce its demands, diversions from Lake Kemp was limited to only municipal and manufacturing use. No releases were made from Lake Kemp for irrigation use. Despite the limited demands, evaporative losses continued to deplete water supplies and concentrate salts so that the total dissolved solids (TDS) in Lake Kemp exceeded 5,000 mg/L. These high TDS levels limited the City's ability to treat water from this source. In direct response to the drought, the City implemented a temporary



CITY OF WICHITA FALLS

Proposed Lake Ringgold

LOCATION MAP

FN PROJECT NO.	WCH15215
DATE CREATED	4/17/2017
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas North Central
FILE NAME	Fig1-1_LocationMap
PREPARED BY	HHM

FREESE NICHOLS
FREESE AND NICHOLS
4055 International Plaza Suite 200
Fort Worth, Texas 76109-4895
(817) 735-7300

1-1

FIGURE

Path:H:\ENVIRONMENTAL\Final_Exhibits\Reports\WRPA\Fig1-1_LocationMap.mxd direct potable reuse project to utilize treated wastewater effluent, using the existing reverse osmosis facility normally used to treat Lake Kemp water. The temporary direct reuse project allowed the City to reduce diversions from Lakes Kickapoo and Arrowhead, but it also negated its ability to treat water from Lake Kemp. In May 2015, 15 to 25 inches of rain fell across the Wichita River and Little Wichita River watersheds. By June 2015, Lakes Arrowhead and Kickapoo were full and Lake Kemp was at 87 percent of its storage capacity. Historical water levels for Lakes Kickapoo, Arrowhead, and Kemp are shown in Figure 1-2 to Figure 1-4 (TWDB, 2015a, 2015b, 2015c).

Even though the lakes refilled in 2015, the City recognized that extreme drought management and the direct potable reuse project were not a permanent solution for long-term water needs. The City needed to develop a reliable long-term supply that could supplement its existing sources. In 2014, the City contracted with Freese and Nichols to develop a long-range water supply plan (FNI, 2015). This plan considered over 20 potential new water sources. Of these options, it was recommended that the City continue with its water conservation efforts, develop an indirect reuse project and develop Lake Ringgold. The plan was subsequently updated to reflect the end of the drought and confirm the available supplies from the City's existing water sources (FNI, 2016). This update confirmed the need for Lake Ringgold.

1.2 City of Wichita Falls Existing Water Supply Sources

The City of Wichita Falls owns and operates Lake Kickapoo and Lake Arrowhead on the Little Wichita River and co-owns the Lake Kemp-Diversion system on the Wichita River.

The following sections present a brief description of each of the City's water sources followed by supply evaluations. Figure 1-5 shows the locations of the City's surface water sources and raw water transmission system to the City. Table 1.1 shows the water rights for each of the City's existing sources.

Table 1.1: City of Wichita Falls' Water Rights

Reservoir	Water Right No.	Priority Date	Water Right Amount (acre-feet/year)					
			Mun	Ind	Irr	Mining	Rec	Total
Kemp/ Diversion	5123[1]	10/2/20	25,150	40,000	120,000[2]	2,000	5,850	193,000
Kickapoo	5144	6/21/44	40,000					40,000
Arrowhead	5150	6/20/62	45,000					45,000

1. Certificate of Adjudication 5123 is held jointly by the City of Wichita Falls and Wichita County Water Improvement District.
2. CA 5123 includes the ability to divert 16,660 acre-feet per year of the permitted 120,000 acre-feet per year directly from the Wichita River for irrigation.

Figure 1-2
Lake Arrowhead Historical Storage

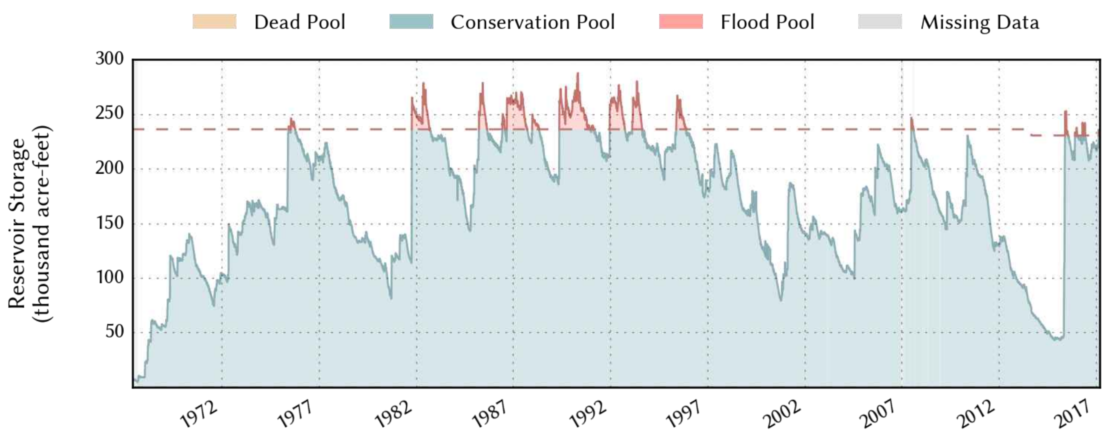


Figure 1-3
Lake Kickapoo Historical Storage

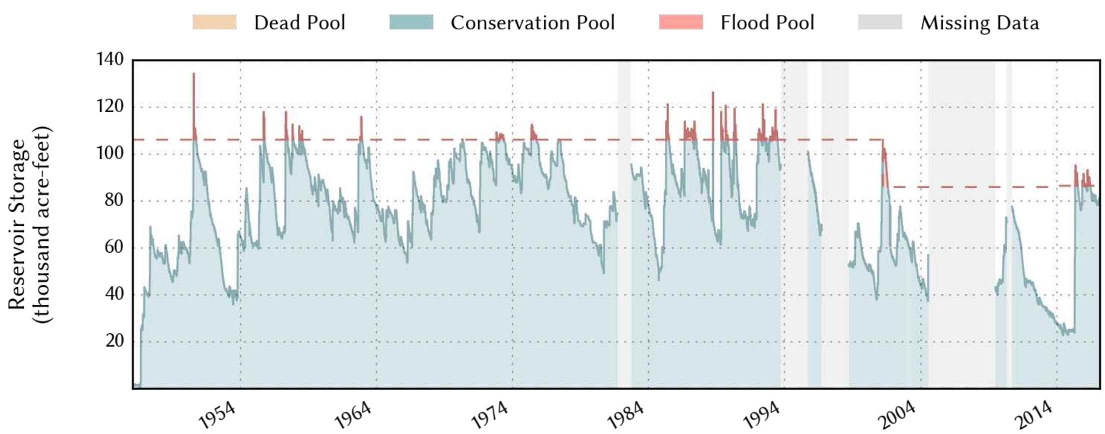


Figure 1-4
Lake Kemp Historical Storage

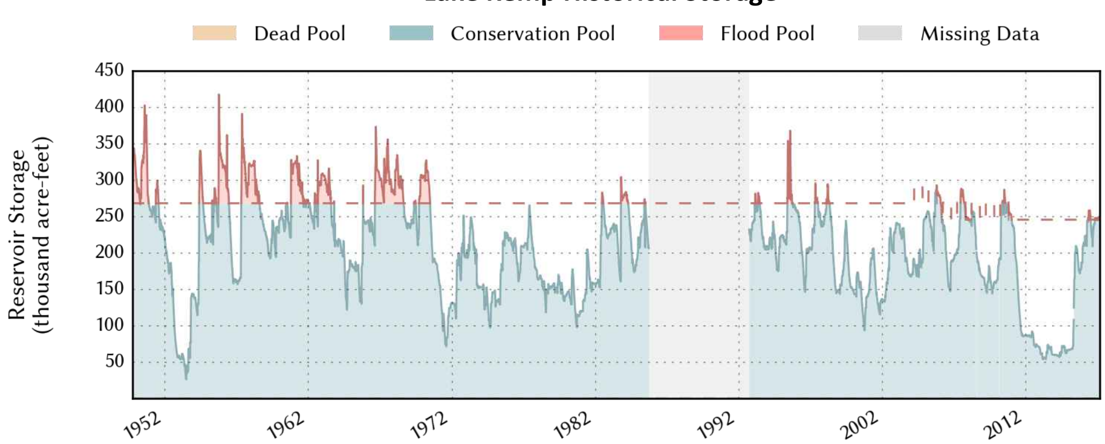
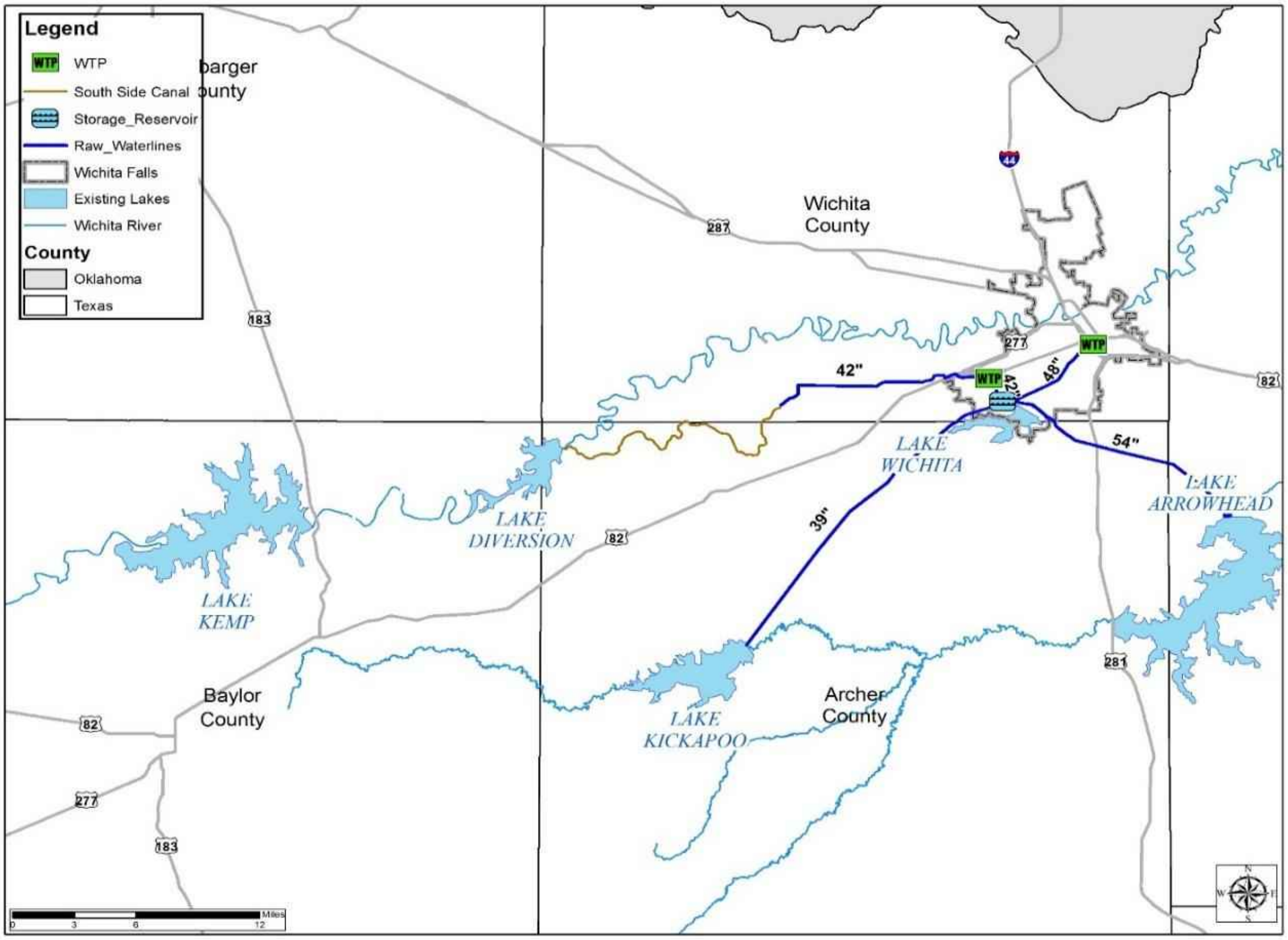


Figure 1-5 Wichita Falls Existing Raw Water Supply Sources



1.2.1 Lakes Kickapoo and Arrowhead

Lakes Kickapoo and Arrowhead are located in the Little Wichita River Basin, upstream of the proposed Lake Ringgold. Water from these lakes is transported to the City's water treatment plants for treatment and distribution. Some raw water is sold directly to wholesale customers. Water from both lakes is of good quality and can be treated with conventional treatment.

Lake Kickapoo was built by the City in 1946 for municipal water supply. The reservoir is located on the North Fork of the Little Wichita River in Archer County. The diversion rights from the lake (Certificate of Adjudication 02-5144) total 40,000 acre-feet per year with a priority date of June 21, 1944. The current storage capacity of the lake is estimated at 86,345 acre-feet (TWDB, 2013a). In addition to the water that is transported to the City for treatment, raw water is sold from the lake to the City of Archer City, the City of Olney and the Wichita Valley Water Supply Corporation.

Lake Arrowhead was built in 1966 by the City for municipal, industrial and recreational use. The lake is located on Little Wichita River in Clay County, about 12 miles southeast of the City. The diversion rights from Lake Arrowhead (Certificate of Adjudication 02-5150) total 45,000 acre-feet per year with a priority date of June 20, 1962; however, the maximum diversion from both Lakes Arrowhead and Kickapoo cannot exceed 65,000 acre-feet per year. The storage capacity of Lake Arrowhead is currently estimated at 230,359 acre-feet (TWDB, 2013b). In addition to the City, direct customers from Lake Arrowhead include three systems operated by the Red River Authority (Lake Arrowhead Area, Arrowhead Ranch Estates Area, and Lake Arrowhead State Park) and Windthorst Water Supply Corporation (WSC). Also, water is periodically released downstream to the City of Henrietta in fulfillment of its senior water right.

1.2.2 Kemp – Diversion System

Lake Kemp is located on the Wichita River, immediately upstream of State Highway 183 in Baylor County. The lake is authorized to store 318,000 acre-feet of water. Lake Diversion was constructed approximately 20 miles downstream of Lake Kemp for secondary storage with an authorized capacity of 45,000 acre-feet. The reservoir lies in both Archer and Baylor Counties.

Lake Diversion is operated in conjunction with Lake Kemp to provide water supply for municipal, industrial, irrigation, mining and recreational purposes. The City and Wichita County Water Control and Improvement District (WCID) No. 2 own the water rights in Lake Kemp and Lake Diversion. Water released from Lake Kemp travels to Lake Diversion for distribution. Irrigation and municipal water is diverted into canal systems that distribute water to customers in Archer, Clay and Wichita Counties. Municipal water is diverted from the canal system to a pipe for transmission to the City. American Electric Power has a contract to divert up to 20,000 acre-feet per year for the Oklaunion Power Plant in Wilbarger County. This water is diverted directly from Lake Diversion. Water from Lake Diversion also is used to provide water to the Dundee Fish Hatchery during the spring spawning season. However, due to the drought and low water elevations, the Fish Hatchery was temporarily closed, and has now resumed operations.

Both Lakes Kemp and Diversion are authorized by Certificate of Adjudication 02-5123. Authorized diversion and storage rights from the reservoir system have a priority date of October 2, 1920.

Historically, most of the water use from Lake Kemp has been limited to irrigation and industrial purposes because of the high salinity levels in Lake Kemp. In 2008, the City completed a reverse osmosis system at the Cypress Water Treatment Plant (WTP) and infrastructure to more fully utilize water from Lake Kemp for municipal purposes. However, during periods with low inflows, the quality of the water diminishes as salts become concentrated due to evaporation. As previously discussed, the TDS concentration in Lake Kemp exceeded 5,000 mg/l during the drought. This limited the City's ability to treat and use Lake Kemp water.

1.2.3 Supply Availability

During the 2011-2015 drought, it became apparent that the Little Wichita and Wichita River Basins were experiencing a new drought of record. While the City was in the midst of the drought, the impacts of the drought on supplies to the City were estimated using several techniques. These estimates are the basis of the 2016 Region B Water Plan evaluation and the 2015 Long Range Water Supply Plan.

By June 2015, both Lakes Kickapoo and Arrowhead were full, and Lake Kemp was near full. For this water right application, the current water supplies to Wichita Falls were updated to reflect hydrology through June 2015. Based on the operations of Lakes Kickapoo and Arrowhead and water quality concerns in Lake Kemp, the available supply of the lakes assume a 20 percent reserve capacity. During the most recent drought, the minimum combined storage of Lakes Arrowhead and Kickapoo hovered near 20 percent for most of 2014 into early 2015, despite some inflows to the lakes and extreme drought management restrictions. The drought had significant economic impacts to the City as some businesses closed or relocated. Also, as previously discussed, the low water levels in Lake Kemp resulted in high salinity levels that posed treatability concerns. The 20 percent reserve capacity provides a reasonable estimate of the minimum useable quantity of water available to the City.

The supply available from Lake Kemp is based on the municipal portion of the Lake Kemp water right and then is adjusted for treatment losses through the City's reverse osmosis treatment system. Details of the analysis of the current supplies is included in Appendix C. Table 1.2 presents a summary of the supply currently available to the City.

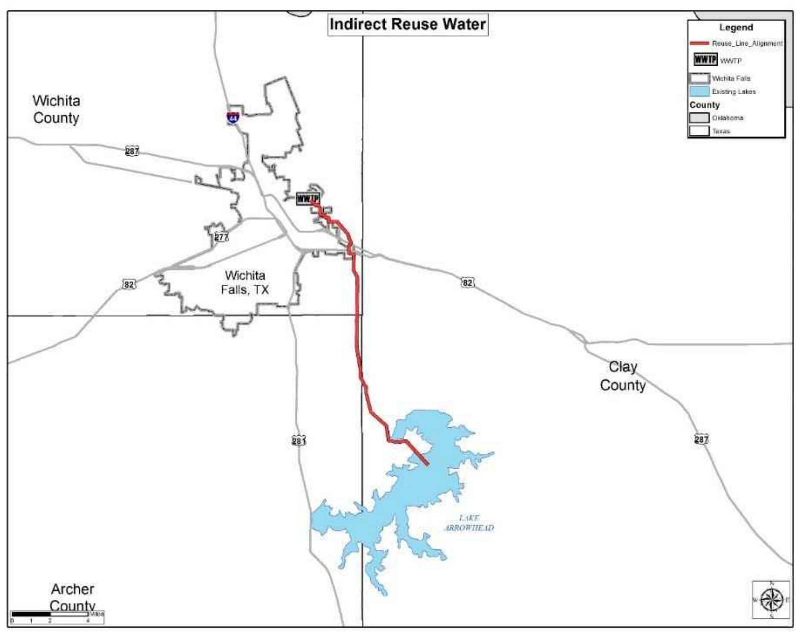
Table 1.2: Available Supply for Wichita Falls from Lakes Arrowhead, Kemp and Kickapoo
-Values in Acre-Feet/Year-

	Minimum Storage[1] (ac-ft)	2020	2030	2040	2050	2060	2070
Kickapoo	17,435	5,600	5,220	4,960	4,700	4,440	3,700
Arrowhead	46,260	12,200	11,400	11,060	10,720	10,380	8,200
Wichita System Subtotal	--	*17,800*	*16,620*	*16,020*	*15,420*	*14,820*	*11,900*
Kemp Total	44,607	29,000	26,100	23,200	20,300	17,400	14,500
Kemp Municipal (treated supply)[2]	--	*2,948*	*2,652*	*2,357*	*2,063*	*1,768*	*1,474*
Total Current Supply Available to Wichita Falls	**--**	***20,748***	***19,272***	***18,377***	***17,483***	***16,588***	***13,374***

1 Available supplies assume a 20% minimum reserve capacity in each reservoir. These values represent the minimum storage reported from the water availability analysis.
2 Supplies available to the City considering water rights, other users in the reservoir, and reduction due treatment.

1.2.4 Lake Arrowhead Indirect Reuse

The City currently generates approximately 8 MGD of treated wastewater from the River Road Wastewater Treatment Plant (WWTP). The City is developing an indirect reuse project that would discharge the River Road WWTP treated effluent to Lake Arrowhead. A permit to discharge the wastewater to Lake Arrowhead has been granted by TCEQ, and the City is in the process of obtaining a bed and banks water right permit for use of Lake Arrowhead.



The indirect reuse project would provide additional water supply to the City. The City is in the process of constructing a pipeline from the River Road WWTP to Lake Arrowhead to convey the treated wastewater. However, during drought the amount of available reuse water may be less as drought management strategies reduce the amount of water being used by the City. For purposes of the reliable supply analysis, it is assumed that the current 8 MGD (8,968 acre-feet per year) would be discharged to Lake Arrowhead for water supply.

The indirect reuse project is expected to be on line by 2018 and is included in the analysis of current supplies.

1.2.5 Additional Water Conservation

In recent years, Wichita Falls has made significant efforts to promote conservation and efficiency. In 2014, the City prepared an updated Water Conservation and Drought Contingency Plan. A copy of this plan is included with this application. This plan includes the following elements:

- Specification of Water Conservation Goals
  - Keep municipal per capita consumption at or below 165 gpcd by 2015.
  - Keep municipal per capita consumption at or below 160 gpcd by 2020.
  - Keep municipal per capita consumption at or below 155 gpcd by 2030.
- Public Awareness and Education Program
  - Education programs for school aged children in the City and other districts.
  - Informational sentences on each water bill sent by the City.
  - Preparation of video tapes, slides, short programs for community presentations at clubs, on TV and radio, news articles, etc.
- Conservation-oriented rate structure.
- Universal Metering and Meter Repair and Replacement Program
- Leak Detection and Maintenance Program
- Record Management Program that allows for the identification of residential, commercial, industrial, and public users. The City identifies and tracks the different categories of water consumption.
- Following cessation of the drought contingency plan, Wichita Falls adopted the Revised 2015 Post Drought Ordinance. A copy of the signed ordinance is included with this application and includes the following permanent water conservation measures: Permanent conservation measures:
  - Spray irrigation use prohibited from 10 am. to 7 p.m. unless using a hand-held hose equipped with a positive shut-off nozzle, soaker hose, bucket, watering can, bubbler or drip irrigation system.
  - Prohibition on water waste and operation of broken irrigation system which may include leaks or broken or misaligned heads.
  - Washing a car at any location other than a commercial car wash, car dealership, detail shop or automotive shop is prohibited, unless the hose has a positive shutoff nozzle attached.

- No water shall be served at a restaurant, bar or club unless the customer requests water.
- All new ice machines that are installed muse be single-pass water cooled.
- Hotels/Motels/Short Term Lodging must offer a towel and linen reuse water conservation option with maintain in each applicable room informational signage and a offer the opportunity for guest participation.

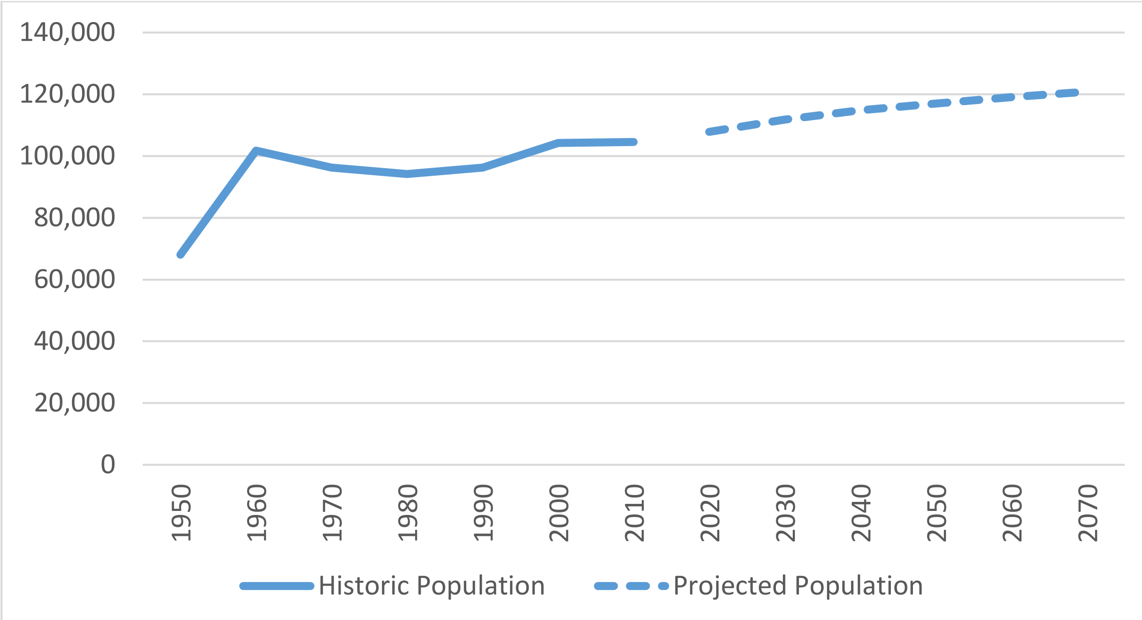
The City has reviewed all of its retail and wholesale water customer contracts and has ensured that all contracts have additional conservation requirements, as required pursuant to 30 TAC, Chapter 288. If the City's retail/wholesale customer intends to sell the water to another water retailer, then the contract for resale must also include water conservation requirements.

Based on these conservation measures the City is expected to reduce future water demands by approximately 2 MGD (2,242 acre-feet per year). These reductions are above the water savings associated with the passive implementation of water efficient plumbing fixtures that are included in the demands on Table 1.4. These reductions are expected to occur over time. In the short-term, in response to the severe drought from 2011 - 2015, the City was able to significantly reduce water demands by implementing drought contingency measures. However, this level of reduction is not sustainable and does not promote economic growth. The 2 MGD water use reduction anticipated in the City's *Long-Range Water Supply Plan* represents aggressive conservation savings above the goals included in the City's 2014 conservation plan.

1.3 Projected Population and Water Demand

Population projections presented here were developed by the Texas Water Development Board (TWDB) for the 2016 regional water plans and approved by the Region B Water Planning Group (BAM/FNI/APAI, 2016). Figure 1-6 shows the historic and projected population for the City. Table 1.3 shows the population for the City and all the customers it serves. While some of this population may be served by water supplies other than those provided by the City, the total population for each customer was included in Table 1.3. The service area for the City is shown in Figure 1-7.

Figure 1-6
Wichita Falls Historical and Projected Population



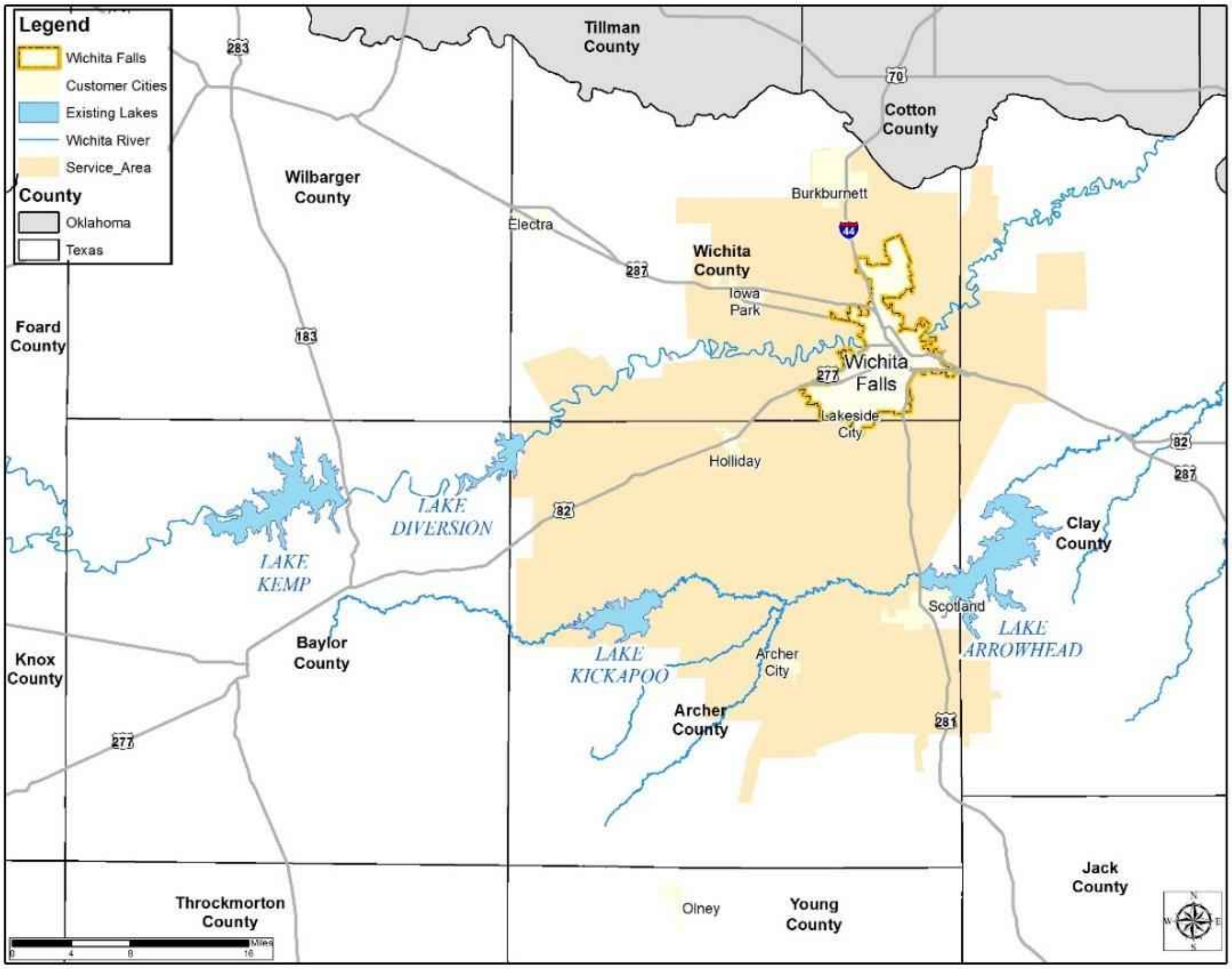
Source: 2016 Region B Water Plan

Table 1.3: Projected Wichita Falls Customer Population

Customer	Recipient	Population					
		2020	2030	2040	2050	2060	2070
Wichita Falls	Wichita Falls	107,835	111,767	114,848	117,013	119,080	120,838
Archer City	Archer City	1,834	1,834	1,834	1,834	1,834	1,834
Archer Co. MUD #1	Archer County - Other	424	255	208	208	208	208
Holliday	Holliday	1,982	2,257	2,330	2,330	2,330	2,330
Lakeside City	Lakeside City	1,021	1,050	1,058	1,058	1,058	1,058
Scotland	Scotland	613	751	788	788	788	788
Windthorst WSC	Windthorst WSC	1,295	1,351	1,364	1,364	1,364	1,364
Dean Dale WSC	Clay County	2,262	2,333	2,333	2,333	2,333	2,333
Red River Auth.	Clay County Other	4,688	4,835	4,835	4,835	4,835	4,835
Burkburnett	Burkburnett	11,151	11,557	11,876	12,100	12,314	12,495
Dean Dale WSC	Wichita County	1,121	1,161	1,193	1,216	1,237	1,256
Friberg-Cooper WSC	Wichita County-Other	2,691	2,791	2,868	2,921	2,974	3,018
Iowa Park	Iowa Park	6,555	6,794	6,981	7,113	7,238	7,345
Electra	Electra	2,879	2,984	3,066	3,124	3,179	3,226
Pleasant Valley	Pleasant Valley	part of Wichita County Other population (see Friberg-Cooper WSC)					
Sheppard A.F.B.	Wichita Falls	part of Wichita Falls population					
Wichita Valley WSC	Wichita Valley WSC	5,868	6,106	6,234	6,302	6,367	6,422
Olney	Olney	3,370	3,485	3,568	3,655	3,740	3,822

Source: 2016 Region B Water Plan

Figure 1-7
Wichita Falls Service Area Map



The projected water demands on the City take into consideration dry year water use and an expected level of future water efficiency based on the replacement of high water use plumbing fixtures. The demands for the City's retail customers also include a 20 percent safety factor, which represents the demand level at which the City would need to develop additional supplies. The demands by the City's wholesale customers are based on the contractual obligation with the City. Table 1.4 shows the projected demand on Wichita Falls in acre-feet per year. These demands are approximately 32,000 to 33,500 acre-feet per year.

Table 1.4: Projected Wichita Falls Demand (acre-feet/year)

Customer	Recipient	Contract Type	Contract	Demands (acre-feet/year)					
			MGD	2020	2030	2040	2050	2060	2070
Wichita Falls[1]	Wichita Falls		No contract limit	20,828	20,969	21,053	21,182	21,506	21,821
Archer City	Archer City	Max Day	0.6	336	336	336	336	336	336
Archer Co. MUD #1	Archer County - Other	Max Day	0.15	84	84	84	84	84	84
Holliday	Holliday		No contract limit	342	377	382	378	377	377
Lakeside City	Lakeside City	Avg. Annual	0.16	179	179	179	179	179	179
Scotland	Scotland	Avg. Annual	0.18	202	202	202	202	202	202
Windthorst WSC	Windthorst WSC	Max Day	0.75	420	420	420	420	420	420
Dean Dale WSC	Clay County	Max Day	0.825	308	307	305	303	301	300
Red River Authority/ TPWD	Clay County Other	Avg. Annual	0.37	415	415	415	415	415	415
Burkburnett	Burkburnett	Avg. Annual	1.67	1,872	1,872	1,872	1,872	1,872	1,872
Dean Dale WSC	Wichita County			154	155	157	159	161	162
Friberg-Cooper WSC	Wichita County - Other	Avg. Annual	0.15	168	168	168	168	168	168
Iowa Park	Iowa Park	Max Day	2.5	1,401	1,401	1,401	1,401	1,401	1,401
Electra	Electra	Max Day	1.5	841	841	841	841	841	841
Wichita Valley WSC	Wichita Valley WSC	Max Day	1.205	675	675	675	675	675	675
Pleasant Valley	Pleasant Valley	Avg. Annual	0.1	112	112	112	112	112	112
Wichita Valley WSC	Wichita Valley WSC	Avg. Annual	1.01	1,132	1,132	1,132	1,132	1,132	1,132
Olney	Olney	Max Day	1	561	561	561	561	561	561
Manufacturing	Wichita County		No contract limit	1,975	2,069	2,186	2,277	2,277	2,277
Steam Electric Power	Wichita County			360	360	360	360	360	360
TOTAL				**32,365**	**32,635**	**32,840**	**33,057**	**33,380**	**33,694**

1. Water demands for Sheppard AFB are included with the City of Wichita Falls' demands.
Source: 2016 Region B Water Plan

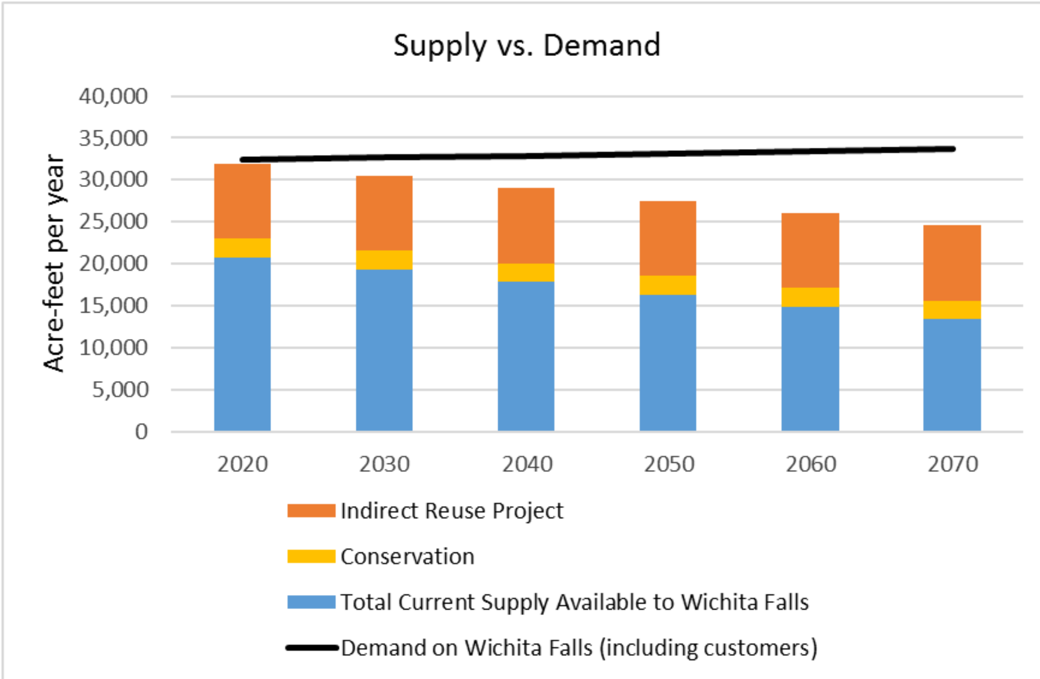
1.4 Comparison of Supply and Demand

Water needs are identified by finding the difference between the reliable supplies for the City and the projected demands. In addition to these supplies, for the purposes of this application, the indirect reuse project is expected to be in operation prior to 2020 and provide an additional 8,968 acre-feet of supply per year. Also, it is assumed that the City will continue to see long-term conservation savings associated with its active conservation program. The additional conservation savings, over and above what is already included in the projections, are estimated at 2,242 acre-feet per year (2 MG). This is consistent with the conservations savings reported in the City's *Long-Range Water Supply Plan* and *2016 Region B Water Plan*. Table 1.5 and Figure 1-8 show the supply and demand comparison for the City.

Table 1.5: Wichita Falls Needs Analysis
-Values are in Acre-feet per Year-

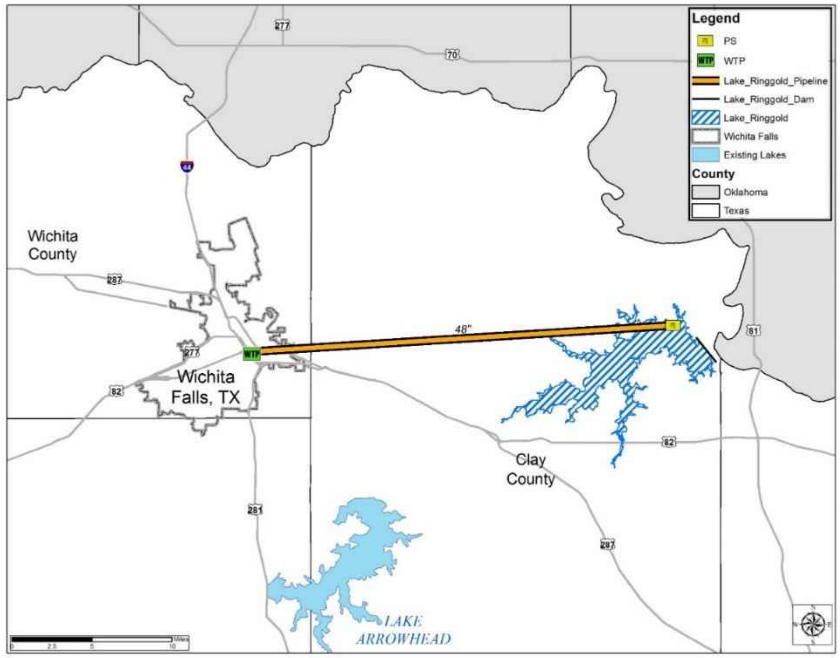
	2020	2030	2040	2050	2060	2070
Supply						
Kickapoo	5,600	5,220	4,840	4,460	4,080	3,700
Arrowhead	12,200	11,400	10,600	9,800	9,000	8,200
Wichita System Subtotal	*17,800*	*16,620*	*15,440*	*14,260*	*13,080*	*11,900*
Kemp Municipal (treated supply)	2,948	2,652	2,357	2,063	1,768	1,474
Total Current Supply Available to Wichita Falls	***20,748***	***19,272***	***17,797***	***16,323***	***14,848***	***13,374***
Demand on Wichita Falls (including customers)	32,365	32,635	32,840	33,057	33,380	33,694
Need/Surplus	11,618	13,363	15,043	16,735	18,532	20,320
Short Term Strategies Implemented						
Conservation	2,242	2,242	2,242	2,242	2,242	2,242
Indirect Reuse Project	8,968	8,968	8,968	8,968	8,968	8,968
Need/Surplus	408	2,153	3,833	5,525	7,322	9,110

Figure 1-8
Supply versus Demand (acre-feet per year)



2. DESCRIPTION OF THE PROPOSED PROJECT

2.1 Overall Project Description



Lake Ringgold is a proposed 15,500-acre reservoir located in Clay County, Texas. The proposed dam would be located on the Little Wichita River, approximately 0.5 miles upstream of its confluence with the Red River, and would impound 275,000 acre-feet of water at the normal pool elevation of 844 feet-msl.

The proposed project would include construction of the Lake Ringgold dam, intake pump station and a transmission system to move the water to the City. The location of the pump station and pipeline has not been determined. The alignment shown in Section 2.1 is for costing purposes only. One option would be to pump diverted water from Lake Ringgold to Lake Arrowhead, and then utilize existing and/or future transmission facilities to move the water to the City. The water would be treated at an existing water treatment plant.

2.2 Dam and Reservoir

Previous studies for the Lake Ringgold site identified the proposed dam location based on local topography, proximity to the City, water quality and yield. Preliminary design evaluations for the dam and spillway were conducted as part of a 1981 study (FNI, 1981). For this application, those findings were reviewed and updated based on current topographic and geographic data, available aerial imagery and updated analyses. The application drawings, which include the plan and profile of the embankment and spillways, are included in Appendix B. Also, a supplemental geotechnical investigation was conducted in 2012 to confirm the findings in the 1981 report and provide additional information along the dam alignment near the river bed, abutments, and proposed spillway locations. The geotechnical investigation is summarized in Appendix D.

Lake Ringgold Dam is proposed to be a zoned earthen embankment with an uncontrolled concrete spillway. The dam would be approximately 9,485 feet in length with a maximum height of approximately 85.0 feet. The dam would have a 20-foot wide crest at elevation 875.0 feet-msl. The principal spillway, located on the left end of the dam, would have a crest elevation of 844 feet-msl, equivalent to the normal pool, and a crest width of 350 feet. Water would discharge via the proposed concrete spillway and chute into a stilling basin, which will then flow through a concrete channel to the existing downstream channel. The emergency spillway would be located on the right abutment and would consist of a 500-foot wide earthen channel with a crest elevation of 856 feet-msl. The emergency spillway would discharge directly to the Red River, located downstream.

The downstream side of the embankment would have a 3.5-horizontal to 1-vertical (3.5H:1V) slope. The upstream side of the embankment would have a 3H:1V slope with a 50-foot wide upstream berm located at elevation 810 feet-msl. The upstream berm is recommended to provide an acceptable factor of safety against possible rapid drawdown conditions. The preliminary geotechnical investigation confirmed that subsurface conditions at the site consist of clayey and sandy materials underlain by mudstone. It was determined that borrow material for the embankment may be obtained from the reservoir area and excavation of the principal spillway channel and emergency spillway.

A compacted fill embankment that consists of lean clays and a 3-foot wide slurry trench would provide the primary barriers to seepage through the embankment and foundation. The slurry trench would extend a minimum of three feet into the mudstone. Based on borings drilled along the dam alignment in the area of the slurry trench, the maximum depth of the slurry trench would extend about 37 feet below the ground surface, although greater depths may become necessary during construction. A chimney drain and downstream finger drains would collect and dispose of seepage through the dam, reduce the possibility of material piping and prevent excessive uplift pressure at the toe.

A low flow outlet will be provided in the final design of the dam to pass inflows to senior downstream water right holders. This outlet may be combined with the proposed diversion structure. The location of the low flow outlet and the diversion structure have not been finalized.

2.3 Service Spillway and Emergency Spillway

The 100-year and 500-year frequency storms were analyzed for Lake Ringgold Dam to size the principal spillway and determine the crest elevation for the emergency spillway. The principal spillway is a concrete ogee-crested structure. The design was developed to minimize the number of impacted structures within the town of Henrietta while also minimizing the required spillway width. Based on this analysis, a spillway width of 350 feet, with a crest elevation of 844 feet-msl was chosen for the principal spillway configuration. For preliminary design, a constant discharge coefficient of 3.8, a typical value for an ogee spillway, was used.

The conceptual design for the emergency spillway consists of an earthen broad-crested spillway with 3H:1V side slopes. The crest of the emergency spillway was set slightly higher than the 100-year flood elevation in Lake Ringgold. With a crest elevation of 856 feet-msl, the emergency spillway would be 500 feet wide. The discharge rating curve for the emergency spillway was developed using the USACE hydraulic model, HEC-RAS. Cross sections representing the proposed spillway configuration were modeled. Varying discharges were modeled through the cross sections and the elevation and discharge relationship for the most upstream cross section was used to develop the rating curve.

The discharge rating curves for the principal spillway, emergency spillway and combined discharge are shown on Table 2.1.

Table 2.1:
Discharge Rating Curve for Lake Ringgold Dam

Elevation (ft-msl)	Principal Spillway (cfs)	Emergency Spillway (cfs)	Combined Discharge (cfs)
844[1]	0	0	0
846	3,762	0	3,762
848	10,640	0	10,640
850	19,547	0	19,547
852	30,094	0	30,094
854	42,058	0	42,058
856[2]	55,287	0	55,287
858	69,670	3,193	72,863
860	85,120	8,405	93,525
862	101,569	17,989	119,558
864	118,959	28,785	147,744
866	137,242	39,582	176,823
868	156,375	50,586	206,962
870	176,324	67,337	243,661
872	197,056	84,087	281,143
874	218,541	101,057	319,598
875[3]	229,559	111,628	341,187

1. Principal spillway elevation
2. Emergency spillway elevation
3. Top of dam

The proposed Lake Ringgold Dam would be classified by TCEQ as a large size, high hazard dam, and would be required to safely pass the full critical Probable Maximum Flood (PMF). With the current proposed spillway configuration, the critical PMF at Lake Ringgold Dam would result in a peak water surface elevation in the lake of 871.2 feet-msl. With a minimum required freeboard of 2.3 feet, the minimum top of dam elevation is 874.5 feet-msl. Including an additional half foot of freeboard, the proposed top of dam elevation is 875.0 feet-msl, which means that the Lake Ringgold Dam can safely pass the PMF without overtopping the embankment. The design storm analyses are included in Appendix E.

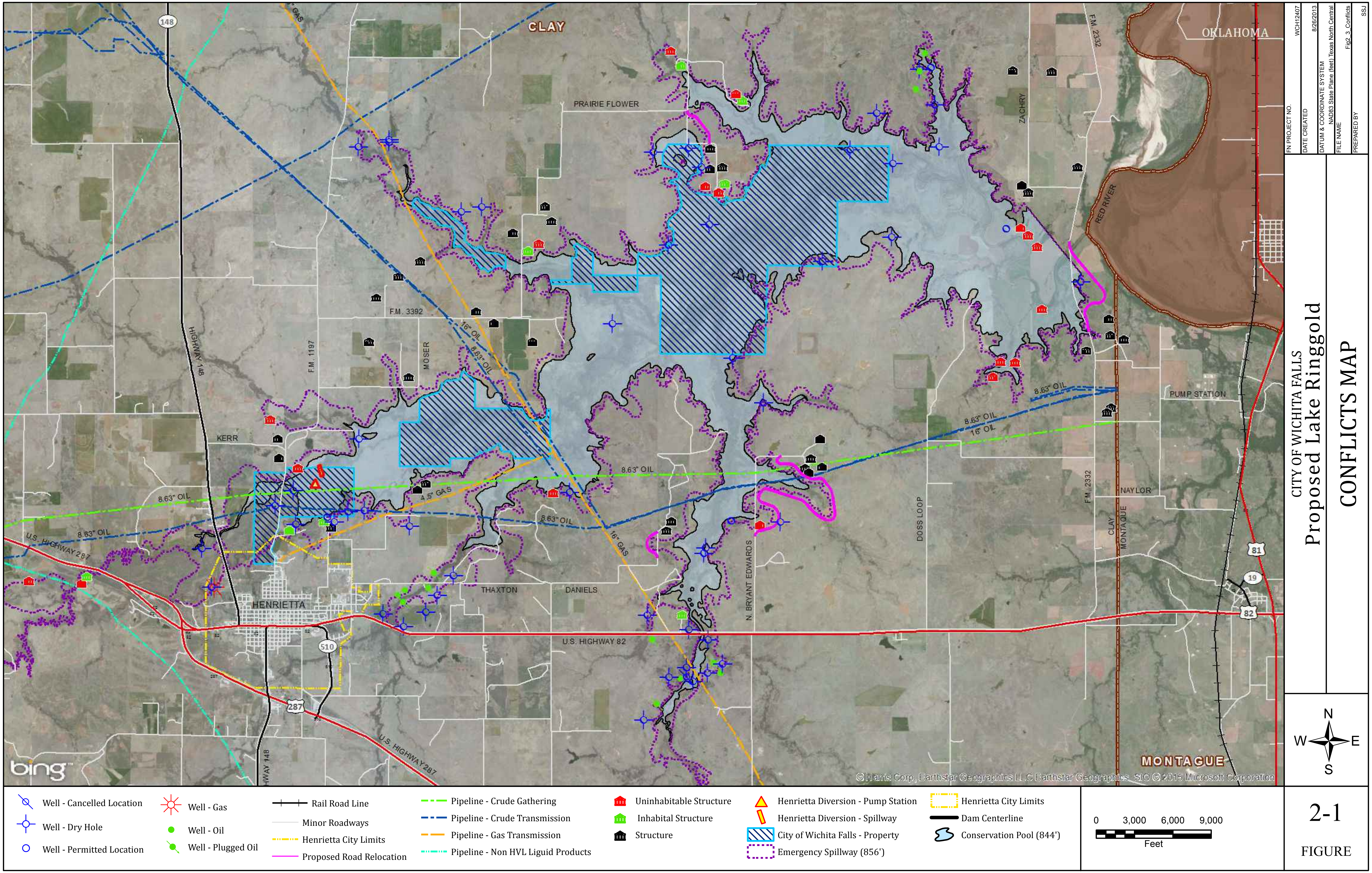
2.4 Diversion Structure

The water right application requests diversion from any location along the perimeter of Lake Ringgold. The primary location and conceptual design of the diversion for the City has not been determined at this time. The City will design the intake structure to avoid entrainment and impingement of aquatic species. There are no proposed power facilities that will use this water source and no proposed structures that would trigger Section 316B requirements.

2.5 Potential Conflicts

The proposed conservation pool for Lake Ringgold would inundate approximately 15,500 acres and isolate approximately 630 acres on islands within the reservoir, for a total of 16,130 acres. At the emergency spillway elevation of 856 feet-msl, the total acreage within this elevation contour would be approximately 23,940 acres (including any isolated islands). For purposes of potential conflicts, the emergency spillway elevation of 856 feet-msl is considered. Most of this acreage is rural undeveloped land or used for agricultural purposes. Potentially, there are several surface and subsurface infrastructure conflicts that would need to be considered during construction of the project. These conflicts shown on Figure 2-1 were identified using available aerial photos, roadside inspection and available geodatabases. There may be additional conflicts that were not identified during this initial investigation.

Based on the preliminary study, there are four crude oil pipelines and two natural gas pipelines that cross the reservoir site. Farm to Market Road 2332 currently crosses the proposed dam site and would need to be re-routed. Also, several other local roads may require re-routing to provide access to existing residences and lands around the proposed reservoir. Within the lake footprint, one residence and ten other structures (such as barns or storage sheds) would be impacted by the reservoir. The City of Henrietta's diversion facilities on the Little Wichita River would also be inundated. The Henrietta facilities include the diversion structure, pump station and associated structures. These facilities would be



Path:H:\ENVIRONMENTAL\FINAL_EXHIBITS\August_2013\Fig2_3_Conflicts.mxd protected or moved. Within the acreage associated with the emergency spillway elevation, six additional residences and 17 additional structures may be impacted. Further site-specific investigations will be needed to confirm the elevations of these structures and appropriate resolution.

2.6 Proposed Project Operation

The proposed lake would be operated for municipal water supply for the City. The City has existing sources of water supplies in the Little Wichita and Wichita River Basins. Lakes Kickapoo and Arrowhead, which are upstream of the proposed project in the Little Wichita River watershed, are primarily used for municipal supplies. Water supplies in the Little Wichita River watershed are of good quality and represent the least expensive sources of water available to the city. Lakes Kemp and Diversion in the Wichita River watershed also provide water to the City's reverse osmosis treatment facility at the Cypress WTP. The City is also implementing an indirect reuse project, in which treated return flows will be transported to Lake Arrowhead. With multiple sources of water available to the City (Lakes Kickapoo, Arrowhead, and Kemp, and reuse supplies), Lake Ringgold would be operated in consideration of demand levels and supplies from the City's other sources to provide good quality water at the lowest cost.

The request for 65,000 acre-feet per year provides the City with the flexibility to take water from the most downstream reservoir in the Little Wichita River Basin when available and cut back on diversions at other times. During wetter periods, taking more than the firm yield of Lake Ringgold would provide empty storage to capture spills from upstream reservoirs. As the storage in Lake Ringgold decreases, diversions from Lake Ringgold would be cut back and the City would utilize water from its other sources. The ability to overdraft Lake Ringgold will allow the City to optimize its supplies from the Little Wichita River Basin now and in the future.

2.7 Estimated Project Costs

The initial project would likely develop the lake and transmission capacity to move up to 43 MGD of supply to the City. Additional transmission capacity would be developed at a later time. Of the 24,000 acres of land needed for the reservoir site and flood easement, the City currently owns approximately 6,662 acres. Along with purchasing the remaining lands for the site and constructing the dam and spillway, additional facilities needed for the project include a 43 MGD lake intake structure and pump station facilities, and approximately 30 miles of 48" transmission line. As shown in Table 2.2, the total capital cost is $322,520,000 with an annual cost of $3.64 per thousand gallons during debt service, reducing to $1.52 per thousand gallons after debt service. All costs are in September 2014 dollars.

Table 2.2:
Construction Cost Estimate for Lake Ringgold
(September 2014 Dollars)

Construction Costs	
Ringgold Reservoir & Dam	$67,150,000
48-inch Raw Water Pipeline	$37,950,000
Road Crossings	$7,650,000
43 MGD Pump Station with Intake Structure	$12,840,000
Reservoir Conflicts	$7,690,000
Total Construction Costs:	**$133,280,000**
Other Project Cost:	
Construction Contingencies @ 20%	$26,660,000
Engineering, Legal & Financial @ 20%	$26,660,000
Land and Pipeline Easements	$36,670,000
Environmental Studies, Mitigation & Permitting	$75,930,000
Interest During Construction (5 Years)	$23,320,000
Total Other Project Costs:	**$189,240,000**
Total Capital Cost:	**$322,520,000**
Annual Costs:	
Debt Service (30 yrs. @ 4%)	$18,650,000
Operation and Maintenance @ 3%	$4,800,000
Power Costs	$1,070,000
Water Treatment Costs	$7,470,000
Total Annual Costs:	**$31,990,000**
During Amortization (with debt service)	
Cost of Water ($Per 1,000 Gallons)	**$3.64**
After Amortization (after debt service)	
Cost of Water ($Per 1,000 Gallons)	**$1.52**

3. ALTERNATIVES TO THE PROPOSED PROJECT

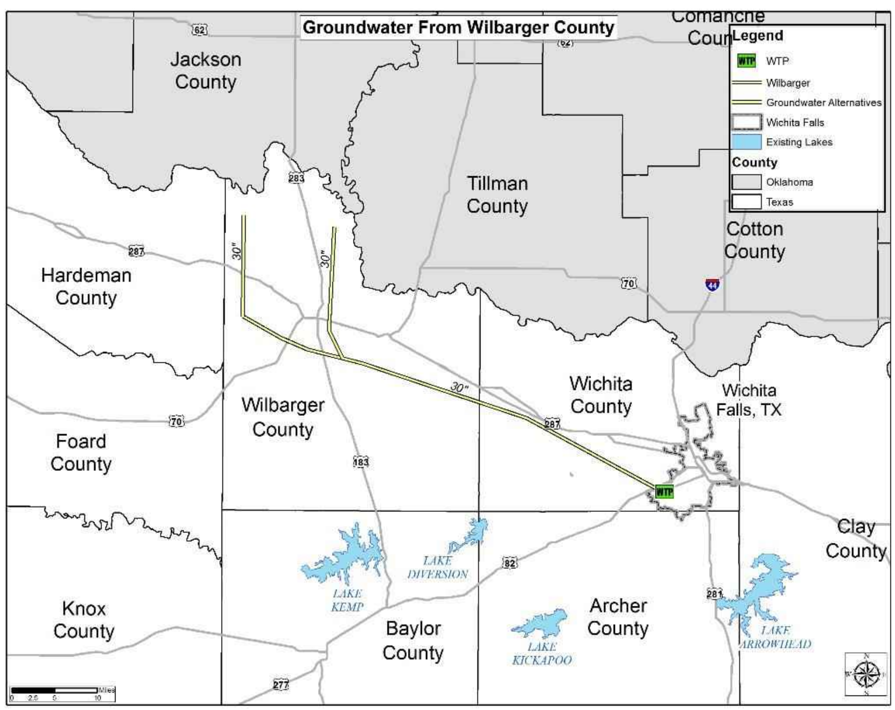
3.1 Alternative Water Management Strategies for Wichita Falls

In 2014, the City developed a *Long-Range Water Supply Plan* to address the immediate and long-term water needs of the City (FNI, 2015). Both short-term and long-term strategies were identified and evaluated. Lake Ringgold is considered a long-term strategy, and as such, the alternative strategies discussed below only include long-term strategies as a means of comparison. Long-term strategies are those that can meet the projected water needs in 2040 and beyond. They typically represent a substantial capital investment and many have the potential to meet most or all of the City's projected water shortage.

Four long term strategies are identified as alternatives to the proposed Lake Ringgold Project. The *Long-Range Water Supply Plan* developed for the City also considered the development of groundwater in Denton County. However, based on current usage and Modeled Available Groundwater estimates, it is highly unlikely that new groundwater of any significant quantity could be permitted in Denton County. Therefore, this strategy is not discussed.

3.1.1 Groundwater from Wilbarger County

This strategy includes the construction and development of 25 groundwater supply wells in the Seymour Aquifer along the Red River in the northwestern portion of Wilbarger County. The wells would be spaced approximately 1,000 feet apart with collection lines from each well being pumped into storage facilities and conveyed by gravity flow through a 75-mile 30-inch diameter pipeline to the existing Cypress WTP for enhanced treatment. Pressure reducing stations would be installed on the pipeline route to reduce the conveyance pressure on the pipeline.



Water Quantity, Quality, and Reliability

It is anticipated that 25 wells with a pumping capacity of approximately 200 GPM (0.25 MGD) and spaced approximately 1,000 feet apart could potentially be developed to provide the City with an additional water supply of 5,600 acre-feet per year.

Based on historical information, it is anticipated the water in Wilbarger County will not meet drinking water standards for TDS, Chlorides, Sulfates, and Iron. There may also be elevated nitrates. However, this water can be adequately treated at the Cypress WTP, which has advanced treatment capabilities. The Cypress WTP may need to be expanded to treat both water from Lake Kemp and groundwater from Wilbarger County

Based on past historical information and data, this supply has been moderately reliable over the long term; however, as these wells are continually pumped during an extended drought, the water table will need to be monitored and re-evaluated on an annual basis. The Seymour Aquifer is a shallow aquifer that can be significantly affected by drought, reducing its reliability at times when most needed. Also, it may be difficult to identify sufficient groundwater resources to produce 5,600 acre-feet per year. Current groundwater sources are heavily used by both municipal and agricultural water users. Based on the Modeled Available Groundwater estimates, nearly all the groundwater in Wilbarger County is currently used by existing users. There are no known willing sellers of groundwater in Wilbarger County to the City.

Regulatory Requirements

There are no special regulatory requirements for this strategy other than approval from TCEQ for the design of the wells and the treatment of the finished water prior to distribution. To date, there is no Groundwater Conservation District in Wilbarger County.

Impacts

Development of additional groundwater water supplies in this area may have a minimal impact on the environment as the various well locations are developed and storage facilities are constructed along with the well collection lines and transmission line from the well site to the Cypress WTP.

As the water supply wells are developed and required easements are obtained, there will be a minimal impact on the agricultural and rural lands due to construction. Furthermore, as additional water is continually taken from the aquifer, the agricultural lands could experience a reduction in the water levels in the Wilbarger County area.

Potential Cost

To provide for an additional 5,600 acre-feet per year of finished water it is estimated the total capital cost would be $107,540,000 with an annual cost during debt service of $6.53 per thousand gallons and $3.12 per thousand gallons after debt service.

Time to implement

The identification, analysis, and acquisition of sufficient groundwater supplies could take five years or longer. The estimated time to complete the required permitting, design and construction work being approximately five years, if sufficient supplies could be identified and acquired.

Development Obstacles

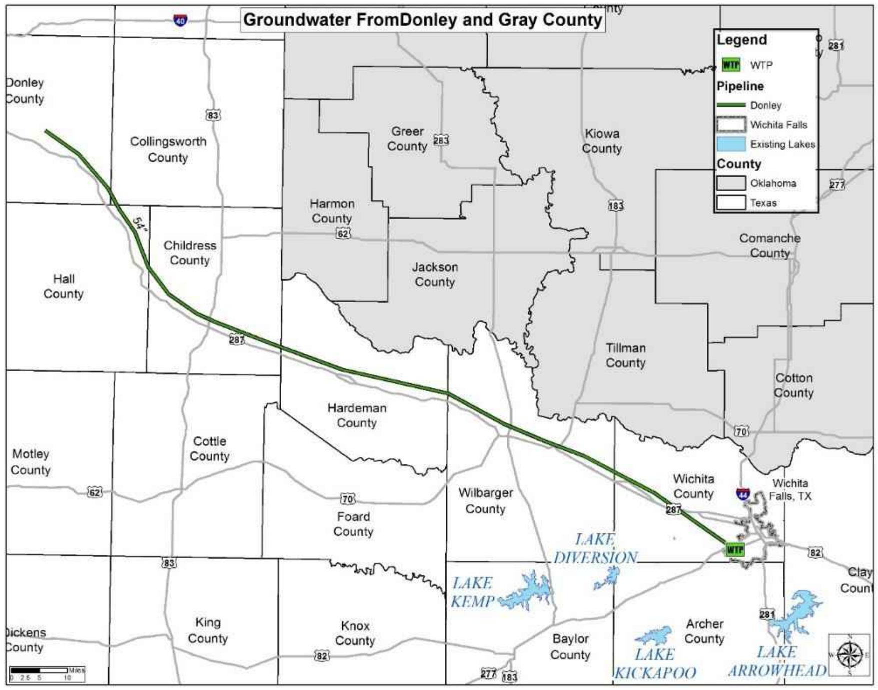
The City would need to negotiate agreements with willing sellers for the groundwater rights and then would need to pursue a routing study to determine the best route for the transmission line along with acquiring all the necessary easements for the conveyance facilities. There is considerable competition for groundwater in Wilbarger County, and the ability to negotiate with multiple landowners in the same area may be limited.

Supply Independence and Competition for Water

Being a groundwater supply source, this strategy is independent of the City's current surface water supplies. And though not directly subject to evaporation losses, it is anticipated that if the aquifer is continuously pumped, the water levels will decline during extreme drought conditions, potentially to a level that significantly impacts production and water quality.

Currently this groundwater source is being heavily utilized for agricultural irrigation purposes throughout the Wilbarger County area. The City would be competing for the groundwater with the agricultural community.

3.1.2 Groundwater from Donley and/or Gray County



This strategy includes the construction and development of 40 groundwater supply wells in the Ogallala Aquifer in the eastern portions of Donley and Gray County. It is anticipated that 40 wells each pumping at approximately 260 GPM (0.40 MGD) could potentially be developed to provide the City with an additional water supply of 16,800 acre-feet per year.

This strategy assumes that the City could acquire sufficient groundwater rights to provide the 16,800 acre-feet per year for at least 100 years. The wells would be spaced approximately 1,000 feet apart with collection lines from the well system pumped into storage facilities then gravity flow directly into existing storage and pumping facilities in the City. A 185-mile 54-inch pipeline would be constructed from the well field to the City. Because of the elevation difference, no transmission pump stations are needed. To maintain acceptable pressures in the pipeline, eight pressure reducing values are included.

Water Quantity, Quality and Reliability

It is anticipated that 40 wells with a pumping capacity of approximately 260 GPM (0.40 MGD) and spaced approximately 1,000 feet apart could potentially be developed so as to provide the City with an additional water supply of 16,800 acre-feet per year. Based on historical information on the Ogallala in these two counties, the water quality will meet all state and regulatory standards and will only require disinfection prior to entering the distribution system.

The Ogallala in Donley County begins to thin out towards the southeast. The saturated thickness is greater to the north and in Gray County. Historically the groundwater supply in this area has been developed for irrigation and as a public water supply for many smaller entities. Though the water levels have declined over the last ten years, it is anticipated that wells in this area of the Ogallala can be developed for a long term supplemental water source for the City.

Regulatory Requirements

Both Donley County and Gray County are located within the Panhandle Groundwater Conservation District (PGCD). The District has management and regulatory authority over the groundwater in both counties, and development of wells in either Donley County or Gray County will require approval from the District. The PGCD manages its groundwater sources based on 50% of storage remaining in 50 years. This would need to be considered in evaluating the long-term reliability of the well field.

Impacts

Development of a groundwater supply for the City could have a moderate impact on the environment as the various well locations are developed, storage facilities are constructed and the conveyance system from Donley and Gray Counties into the City is constructed. Environmental impacts can be minimized during design. The agricultural and rural impacts of this project will be moderately high, in that large tracts of land would be utilized for the well field and storage facilities in addition to land acquisition for pipeline easements.

Development of groundwater supplies in the Donley and Gray County area could have a moderate impact on entities within that general area. It would, however, provide the City with an additional source of supply without impacting the City's surface water sources.

Potential Cost

The total capital cost to provide for 16,800 acre-feet per year supplemental water supply from the Ogallala in Donley and Gray Counties is $628,360,000. The annual cost during debt service is $10.83 per thousand gallons and the average annual cost after debt service is $4.20 per thousand gallons.

Time to implement

It is estimated that this project will take approximately 10 years for permitting, land/easement acquisition, design, and construction.

Development Obstacles

In addition to regulatory requirements, it will be necessary to contract with willing sellers of the land to be developed or contract to purchase the water from the landowners. Furthermore, routing of the conveyance facilities and purchase of right of way and easements will be a challenge. Depending on the location of the well field areas, additional studies may be required to validate the long-term supply availability of the groundwater.

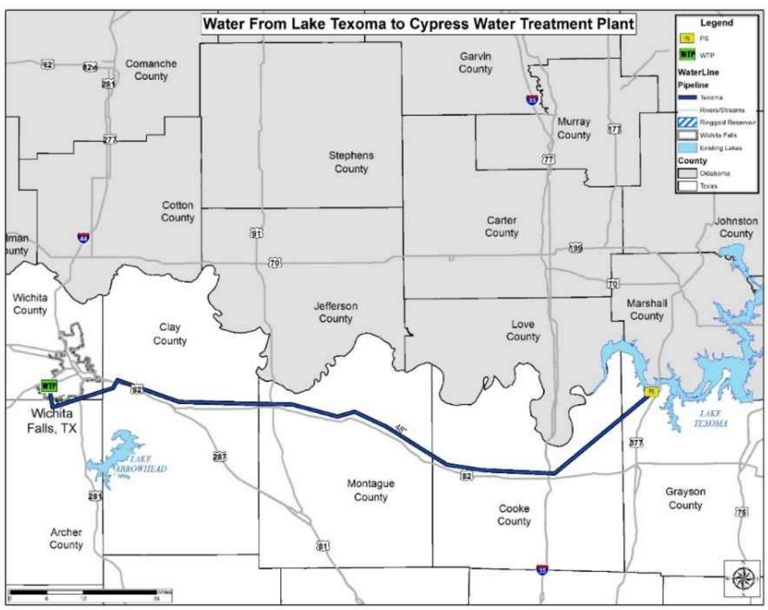
Supply Independence and Competition for Water

This would be the first groundwater supply source that has ever been developed by the City. With the City being totally dependent on surface water, a groundwater source not impacted by drought would be a good additional source of supply for the City.

As the drought continues in Texas, more entities may give serious consideration to the development of groundwater supplies from the Ogallala in Donley and Gray County. It can be expected that the competition for this water will increase over the years and that the PGCD management rules and regulations could begin to limit the development of addition groundwater supplies that can be taken outside of the District.

3.1.3 Lake Texoma Water

This strategy assumes that the City enters into an agreement with an existing water right holder to purchase water from Lake Texoma and transport the water to the City. Raw water is transported to the City and treated at the Cypress WTP. This strategy includes an intake structure at Lake Texoma, 120-mile pipeline and three booster pump stations. The raw water would be treated at the Cypress WTP using the existing conventional treatment facilities and expanding the existing reverse osmosis treatment from 10 MGD to 20 MGD. The brine would be discharged to the Wichita River under the City's existing permit. This strategy includes upsizing the pipeline near the Ringgold Reservoir site to allow transport of Ringgold lake water to the City, if the Ringgold project is developed.



Storage in Lake Texoma is allocated to both Texas and Oklahoma. Texas has permitted nearly all of its share of the lake's storage. Existing water rights holders that may be willing to sell water to the City include the City of Denison and the Greater Texoma Utility Authority. The Red River Authority also owns water rights in Lake Texoma, but the available quantity is less than the amount needed by the City.

Water Quantity, Quality, and Reliability

Previous discussions with existing water rights holders indicate that there is water available for the City. For purposes of this evaluation, it is assumed that 16,800 acre-feet per year (15 MGD) of water could be secured from Texas water rights holders for at least 50 years. This water supply is expected to be reliable.

Located on the Red River, the water in Lake Texoma has elevated TDS and sulfates. Lake Texoma water would need to be treated to reduce the salts or blended with higher water quality supplies. Since the brackish water is lake water, pretreatment would likely be required before advanced treatment could be used. If advanced treatment is used, the salt levels would likely require approximately 40 to 50% of the total supply to be treated using RO and then blended with the remaining supplies or other City supplies. It is unlikely that this quantity of brackish water (16,800 acre-feet) could be blended only with the City's other supplies to meet the drinking water standards.

Zebra mussels are also present in Lake Texoma. While this does not pose a water quality issue, it does create potential maintenance concerns for the intake and transmission system, especially if the water is treated in the City.

The reliability is expected to be high. There is some uncertainty regarding reaching agreements with existing water right holders, the contract amounts and terms of the contract. Also, currently Oklahoma is using only a small portion of its allotment. If Oklahoma began using more water from Lake Texoma, then there will be additional competition for this water during drought.

Regulatory Requirements

There is no interbasin transfer required since the use will occur in the Red River Basin. There will be regulatory requirements associated with the treatment and disposal of the reject water although the City may be able to use the Cypress WTP existing discharge permit of 6 MGD. Presently, it may be difficult to obtain a new wastewater discharge permit for brine disposal to the Red River. The City would need to obtain a Section 404 permit for the intake structure and possibly the pipeline.

Impacts

There should be minimal environmental impact from the construction of the pipeline. As mentioned above, there could be potential impacts from zebra mussels, and it is likely that any raw water transported from Lake Texoma would have a requirement to stay in a closed system (*i.e.*, could not be blended in another lake). The 120-mile pipeline will cross agricultural and rural lands and require a large number of easements. The assumed pipeline route shown on the map follows roads to minimize the potential impacts to agricultural and rural users.

Potential Cost

The cost includes 90 miles of 48-inch pipeline and 33 miles of 54-inch pipeline. It was assumed that a 10 MGD expansion of the Cypress reverse osmosis treatment facilities would be needed. The capital cost is $401,230,000. The annual cost with debt service is $7.66 per thousand gallons and the average annual cost after debt service is $3.42 per thousand gallons.

Time to implement

Assuming that a brine discharge permit does not need to be obtained and the water treatment plant improvements consist of only an expansion of the existing reverse osmosis facilities at Cypress WTP, the permitting, design and construction is estimated to take approximately 11 years.

Development Obstacles

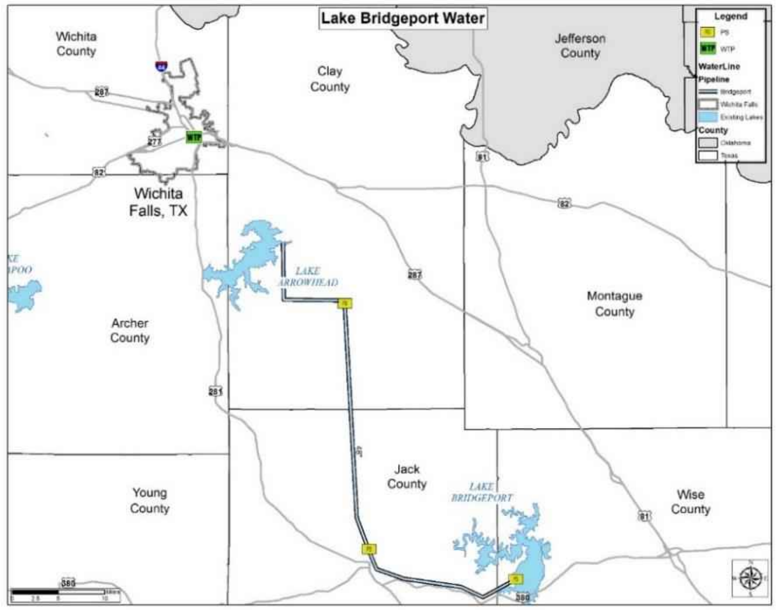
The City would need to purchase the supply from another provider. As noted earlier, the presence of zebra mussels in Lake Texoma could pose maintenance issues for transmission and treatment facilities.

Supply Independence and Competition for Water

Lake Texoma has a large contributing drainage area of approximately 33,800 square miles. Lake Texoma is not likely to be impacted in the same manner as the City's current supplies during a drought, which provides some level of independence from current supplies.

All or nearly all the current water conservation pool allotted to Texas is under contract with the USACE and permitted by a Texas water right. Texas water right holders have not fully utilized their full authorized diversion amounts to date, but they are expecting to use more Texoma water over the next 50 years. Much of the unused water in Lake Texoma is held by Oklahoma. It is unknown when Oklahoma will make use of this water.

3.1.4 Lake Bridgeport Water



This strategy assumes that the City enters into an agreement with Tarrant Regional Water District (TRWD) to purchase water from Lake Bridgeport and transport the water to Lake Arrowhead. This would require the construction of one 15 MGD intake pump station and two 15 MGD booster pump stations with storage facilities and approximately 75 miles of 48-inch diameter pipe to convey the raw water from Lake Bridgeport into Lake Arrowhead. The existing Lake Arrowhead pump station would then be utilized to pump the water into the City's existing secondary reservoir and conveyed to the Cypress WTP and Jasper WTP.

Water Quantity, Quality, and Reliability

Previous discussions with TRWD indicate that there would be available water for the City as a supplemental source of up to approximately 16,800 acre-feet during most years of normal rainfall.

It is anticipated that the water quality from Lake Bridgeport would be comparable in water quality and compatible with the Lake Arrowhead water so that it can be treated conventionally through the existing City facilities at Cypress WTP and Jasper WTP.

Reliability is expected to be high with the exception of during drought years. TRWD will set a minimum lake level for Bridgeport, whereby at or below that level, the City would not be able to take water from the lake. So, it is anticipated that this strategy would not benefit the City during drought conditions. This source is considered unreliable unless the City can reach an agreement with TRWD to use water under drought conditions.

Regulatory Requirements

Lake Bridgeport is in the Trinity River Basin, and this alternative would require an interbasin transfer of water into the Red River Basin. The City might need to obtain a 404 permit for the intake structure and the pipeline.

Impacts

The environmental impacts for this strategy should be minimal and those impacts will be related to the construction of the pipeline and the various pump stations in addition to miscellaneous creek crossings.

The 75-mile pipeline will cross agricultural and rural lands and require a large number of easements. The pipeline route is now shown to follow roads and minimize the potential impacts to agricultural and rural users.

Potential Cost

The total capital cost to provide for a limited supplemental supply from Lake Bridgeport is $235,200,000. The annual cost with debt service is $5.06 per thousand gallons and the average annual cost after debt service is $2.58 per thousand gallons.

Time to Implement

It is estimated that it could take up to ten years to negotiate a water contract, acquire easements, design the facilities, and build the pump stations and transmission line.

Development Obstacles

The City would need to negotiate a water supply purchase contract from TRWD. In addition a detailed route study would need to be completed and all easements and pump station sites would need to be acquired.

Supply Independence and Competition for Water

With Lake Bridgeport being in a different river basin, it provides for some supply independence, but like the City's lakes, Lake Bridgeport has also experienced some low lake levels and is impacted by drought conditions.

Lake Bridgeport is owned and heavily utilized by TRWD as a water supply for numerous entities in and around the Wise, Jack, and Parker County area. Therefore, the City would have very limited access to the water during drought conditions.

3.2 Comparison of Alternatives

The five alternative strategies, along with Lake Ringgold, were compared in the table below.

Table 3.1:
Summary Strategy Costs

Strategy	Strategy Amount (ac-ft/yr)	Annual Cost before amortization	Annual Cost after amortization	Cost per 1,000 Gallons before amortization	Cost per 1,000 Gallons after amortization
Ringgold	27,000	$31,990,000	$13,340,000	$3.64	$1.52
GW Wilbarger Co	5,600	$11,910,000	$5,690,000	$6.53	$3.12
GW Donley & Gray Co	16,800	$59,310,000	$22,970,000	$10.83	$4.20
Texoma	16,800	$41,920,000	$18,720,000	$7.66	$3.42
Bridgeport	16,800	$27,730,000	$14,130,000	$5.06	$2.58

Groundwater from Donley and/or Gray Counties was the most costly at $10.83 per thousand gallons. For times when the City did not need the full 16,800 acre-feet, the unit cost of water would be much higher due to debt service. Considering the cost and potential operational issues associated with a 185-mile pipeline, this strategy is not a practical alternative. The inability to contract for water from Lake Bridgeport during drought makes this strategy not a practical alternative to Lake Ringgold.

There are considerable uncertainties with the development of groundwater from Wilbarger County. While this strategy was evaluated for 5,600 acre-feet per year, the Seymour Aquifer along the Red River is quite shallow and has limited pumping capacity. Most of the aquifer with the greatest saturated thickness is already being used by others, including the City of Vernon. This uncertainty of supply and the potential reduced reliability during drought makes this alternative less practical than Lake Ringgold.

The purchase of water from Lake Texoma would require agreements with existing users, which would have a termination date. The City would need to invest in a 120-mile pipeline for a water supply that may not be available long term. This uncertainty, along with the maintenance and operational issues associated with a 120-mile pipeline and costs for this infrastructure make the Lake Texoma alternative less practical than Lake Ringgold.

3.3 Recommended Water Management Strategies for Wichita Falls

Based on the strategy evaluations, the long-term strategy that provides the greatest potential for reliable water supply at a reasonable cost to the City is Lake Ringgold.

4. WATER SUPPLY AVAILABLE FROM LAKE RINGGOLD

The Little Wichita watershed above the proposed Lake Ringgold site contains three major reservoirs: Lake Olney/Cooper built in 1935 and expanded in 1954, Lake Kickapoo built in 1946 and Lake Arrowhead built in 1966. There are three active and one former USGS stream gage stations in the watershed. The total drainage area for the proposed Lake Ringgold is 1,480 square miles.

4.1 Existing Water Rights in Little Wichita Watershed

The City owns Certificate of Adjudication (CA) 02-5150, which authorizes Lake Arrowhead, and CA 02-5144, which authorizes Lake Kickapoo.

There are twelve other water rights in the watershed, authorizing a total storage of 9,278 acre-feet and the diversion of 7,876 acre-feet per year. Table 4.1 is a summary of these water rights, grouped by the six water rights between Lake Kickapoo and Lake Arrowhead and the six water rights between Lake Arrowhead and the Lake Ringgold Dam site. There are no water rights above Lake Kickapoo. The largest municipal rights belong to the Cities of Olney, Archer City, and Henrietta, with smaller rights belonging to Windthorst Water Supply Corporation and the City of Megargel. Currently, the City of Olney, Archer City and Windthorst WSC each have water supply contracts with the City. A detailed listing of all the water rights in the Little Wichita Watershed are included in Appendix F.

Table 4.1:
Summary of Other Water Rights in the Little Wichita Watershed

Type of Use	Between Kickapoo and Arrowhead		Between Arrowhead and Ringgold Dam Site	
	Diversion (acre-feet per year)	Storage (acre-feet)	Diversion (acre-feet per year)	Storage (acre-feet)
Irrigation	65	0	3,865	380
Recreation	0	0	0	44
Municipal	2,236	7,960	1,559	743
Mining	0	0	1	0
Industrial	150	151	0	0
Total	**2,451**	**8,111**	**5,425**	**1,167**

4.2 Yield of the Project

The firm yield of Lake Ringgold was calculated with a modified version of the TCEQ Red River WAM Run 3 and an Excel based model with extended hydrology through June 2015. The firm yield of a reservoir is defined as the maximum amount of water that can be taken from a reservoir under historical hydrological conditions without having a shortage. In a firm yield analysis, the storage in the reservoir is near zero at the end of the worst drought encountered in the simulation.

The WAM modeling setup for Lake Ringgold uses the approach developed for the Reservoir Site Protection Study (TWDB, 2008) and modified for the Lake Ringgold Feasibility Study (FNI, 2013). A description of the modeling may be found in Appendix F. The Excel-based model was developed for the *Long-Range Water Supply Plan*, and is the model used to assess current supplies from the City's existing sources.

Based on these analyses, the firm yield for Lake Ringgold using the Red River WAM is 28,090 acre-feet per year. With the Excel model and the extended hydrology through June 2015, the firm yield of Lake Ringgold is 23,450 acre-feet per year.

4.3 Impacts of the Project on Other Water Rights

A no injury analysis was performed using the modified version of the TCEQ Red River WAM Run 3 with and without Lake Ringgold. This analysis shows very small changes (less than 0.1 acre-feet per year) in the mean shortage for three water rights and no changes in either Period or Volume Reliability. These impacts are well within the margin of error in the model and are negligible. Thus the modeling shows no injury to existing permanent water rights. A detailed table comparing the reliability of all the water rights in the Red River WAM is included in Appendix F.

4.4 Accounting Plan

The permit application requests the diversion of 65,000 acre-feet per year and the use of the bed and banks of Lake Arrowhead to convey Lake Ringgold water to the City and its customers. The permit also requests the use of future return flows generated from the beneficial use of this water. The location and amount of these return flows will be identified later. There are no environmental flows specified for this application.

The City has developed a draft accounting plan for its existing water sources in the Little Wichita River Basin (Lake Kickapoo, Lake Arrowhead and Indirect Reuse to Lake Arrowhead). The City has used this accounting plan as the basis to account for diversions associated with Lake Ringgold. The draft accounting plan is included in Appendix G.

5. ENVIRONMENTAL REVIEW OF THE PROJECT AREA

The following sections discuss environmental issues that must be addressed for an application for a water right permit as prescribed by the Texas Water Code (TWC) and associated regulations (TWC §§11.085, 11.147, 11.1491, 11.150, 11.152, and 30 TAC 297.53 thru 297.56). The information will form the basis for TCEQ's environmental review of the proposed Lake Ringgold Reservoir project. In the following sections, the term "project area" refers to the area of the conservation pool and the footprint of the dam and spillways, which totals approximately 16,174 acres.

5.1 Little Wichita River

The Little Wichita River flows from its headwaters in Archer County, TX to the confluence with the Red River in Clay County, TX. The segment of the Little Wichita River that would be impounded by construction of the proposed reservoir is within the TCEQ classified stream Segment No. 0211, which is identified as the Little Wichita River from Lake Arrowhead dam to the confluence with the Red River. The channel in this section of the river is approximately 25 feet wide at its upper banks, based on field visits. The Little Wichita River is classified by TCEQ as a perennial stream from its confluence with the Red River upstream to Lake Arrowhead Dam, with a high aquatic life use designation. However, there are periods during the dry summer months when there is little to no flow in the river (TCEQ, 2012). The riparian areas adjacent to the river are dominated by cedar elm and pecan trees with lesser amounts of honey locust, green ash, box elder, switchgrass and others. The adjacent uplands in the watershed are dominated by shrublands with herbaceous grasses. Much of the watershed is in agricultural use. The City of Henrietta is located near the upper end of the proposed reservoir, near the Little Wichita River. Photos of the proposed dam site and Little Wichita River are included in Appendix H.

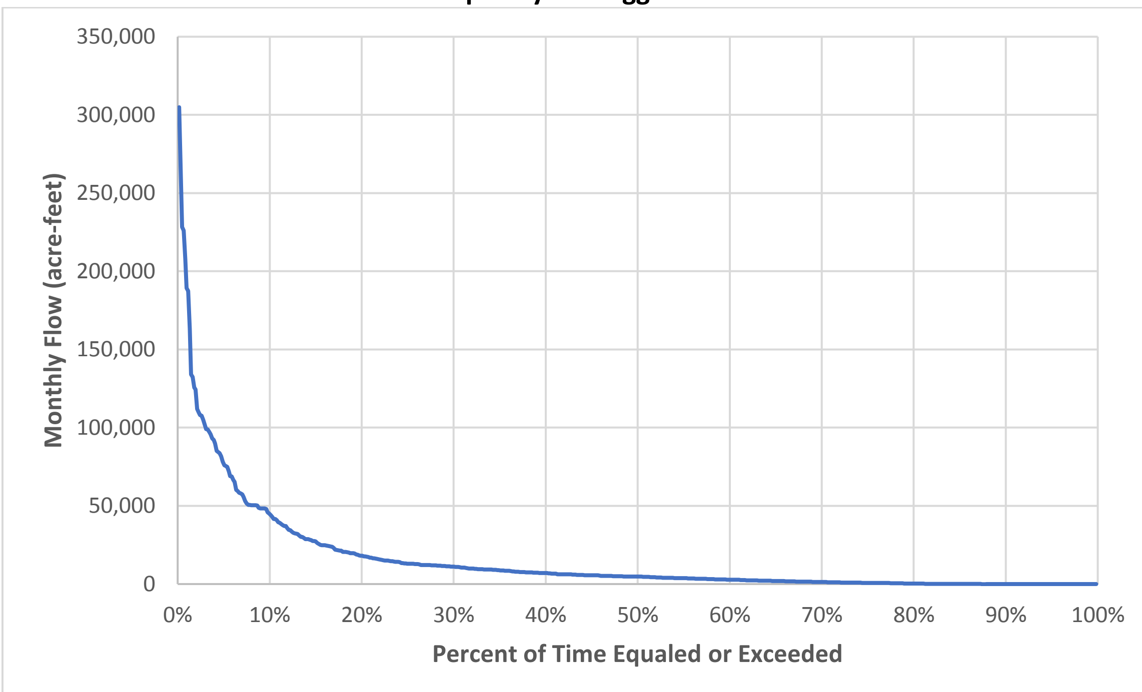
5.1.1 Instream Uses

The TCEQ defines instream use as "the beneficial use of instream flows for such purposes including, but not limited to, navigation, recreation, hydropower, fisheries, game preserves, stock raising, park purposes, aesthetics, water quality protection, aquatic and riparian wildlife habitat, freshwater inflows for bays and estuaries, and any other instream use recognized by law." 30 TAC §297.1. The Commission is required to evaluate the effects of a proposed water right on instream uses in accordance with TWC §11.147 and 30 TAC §297.56.

Flows in the Little Wichita River can vary from little to no flow in the summer to over 4,000 cfs during large rain events. The frequency curve for naturalized flows at the Ringgold dam site is shown on Figure 5-1.

This plot shows the percentage of time that the flow at Ringgold is likely to equal or exceed the flow in acre-feet per month on y-axis. As shown on the graph, the flows are relatively low most of the time. About half the time, the flow at the Ringgold dam site is below 4,700 acre-feet per month.

Figure 5-1
Flow Frequency at Ringgold Dam Site



The proposed dam for the reservoir would be located on the Little Wichita River about a half mile from the confluence with the Red River. Approximately 1,500 feet of channel downstream of the dam would be modified and/or improved to prevent erosion below the dam structure and to relocate a farm-to-market road, reducing the actual length of unmodified channel in the Little Wichita River. Any modified section of the Little Wichita would be considered under the impacts of the project and mitigated appropriately. As such, potential impacts on instream uses for the Little Wichita downstream of the project would be limited to a half mile segment or less, and this segment is heavily influenced by backwater from the Red River.

The designated uses published in the 2014 TCEQ Surface Water Quality Standards (TSWQS) for the Little Wichita River downstream of Lake Arrowhead include primary contact recreation, aquatic life and public water supply. Other observed or expected instream uses include domestic and livestock use. The proposed project would affect instream uses within the footprint of the reservoir by changing the Little Wichita River from a lotic aquatic system to a primarily lentic aquatic system. As a reservoir, water would continue to flow through the lake but the velocity and characteristics of the flow would be different. Water would also be passed through the reservoir for senior downstream water rights. It is anticipated that Lake Ringgold would continue to provide for the designated instream uses: recreation, aquatic life and public water supply.

Potential impacts to instream uses were also evaluated for the Red River given its proximity to the proposed project. The designated uses published by TCEQ for the Red River above Lake Texoma include primary contact recreation and aquatic life. The Little Wichita only contributes 17 percent of the flow in the Texas portion of the Red River at the Red River near Terral, Oklahoma (USGS stream gage 07315500). As such, the impacts on the Red River are expected to be small.

To estimate the impact of the proposed Lake Ringgold on instream flows, an analysis was performed evaluating the impact on regulated flows from the modified Red River WAM at the Terral gage, with and without the project. However, the flows at the Terral gage in the WAM include only the portion of the flows originating in Texas. In order to evaluate the impact fully the historical flows originating in Oklahoma were added to regulated flows. These historical flows were obtained from the original flow naturalization workbooks for the Red River WAM. Table 5.1 shows the impact of the proposed Lake Ringgold on regulated flow frequencies, including historical Oklahoma flows. Figure 5-2 compares the flow exceedance frequencies with and without the project. Figure 5-3 shows the same information except that the maximum value on the y-axis has been reduced in order to show the impacts on lower flows.

Table 5.1: **Impact of Lake Ringgold on Regulated Flows in the Red River**
-Values in Acre-feet per Month-

Exceedance Frequency	CP U10000 (Red River near Terral, OK)			
	Without Ringgold	With Ringgold	Difference	Percent Difference
50% (median)	38,584	37,286	1,297	3%
60%	26,076	25,361	715	3%
70%	19,611	19,156	455	2%
80%	14,286	14,286	0	0%
90%	9,151	8,950	201	2%
95%	6,491	6,491	0	0%
99%	3,847	3,847	0	0%
Minimum	3,226	3,226	0	0%

1. Flows reported in Table 5.1 and impacts shown are the sum of the regulated flows from the Red River WAM, which only has flows originating in Texas, and the historical flows at the gage originating in Oklahoma.

Figure 5-2 Comparison of Flows With and Without Lake Ringgold – Red River near Terral, OK

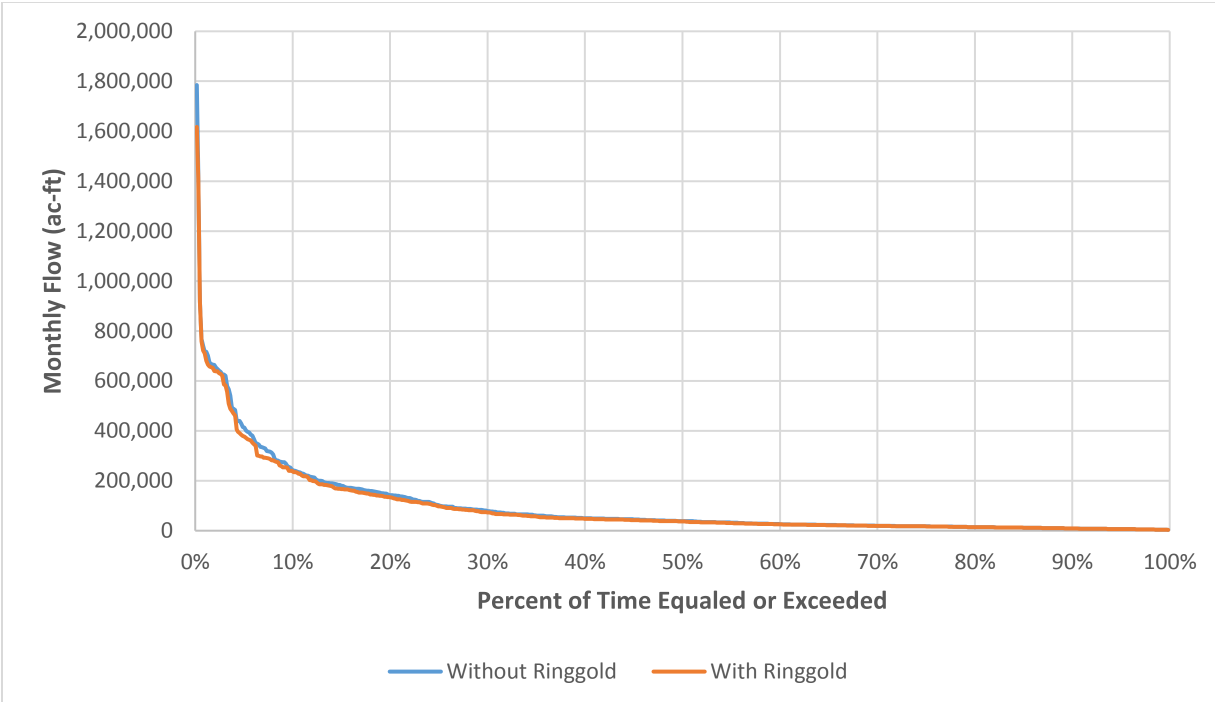
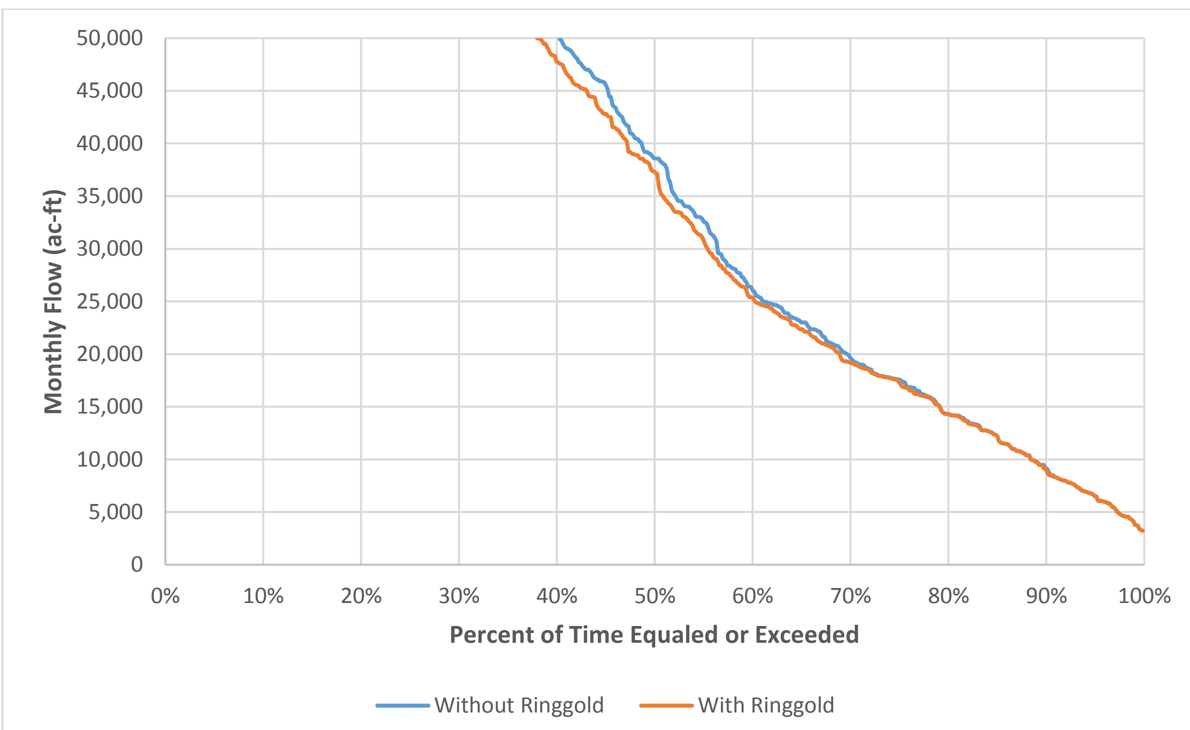


Figure 5-3 Comparison of Lower Flows With and Without Lake Ringgold – Red River near Terral, OK



Senate Bill 3, passed by the Texas Legislature in 2007, defines a process for developing environmental flow standards. The process involves a science team that performs the flow assessment, a stakeholder group that makes recommendations based on the assessment, and rule making by TCEQ to implement incorporation of the environmental standards in permits. Development of environmental flow standards for the Red River Basin is not currently scheduled. This means there are no existing environmental flow standards under the Texas Instream Flow Program for the Lake Ringgold project. There are also no current requirements to pass inflows for environmental purposes from the Little Wichita River to the Red River, which lies partially within Oklahoma. There are, however, occasions when flow will need to be passed for downstream senior rights.

The segment of the Little Wichita River that would not be directly impacted by the construction of the dam and spillways is about one half of a mile. This segment is affected by ebb and flow of the Red River. Due to the limited channel length and influence of the Red River, no instream flow releases are proposed from Lake Ringgold.

5.2 Fish and Wildlife Habitat

This section discusses the assessment of potential project impacts on fish and wildlife habitats in accordance with TWC §11.152 and 30 TAC §297.53. Terrestrial habitats and wildlife are discussed separately from aquatic habitats and fish.

5.2.1 Terrestrial Vegetation

The proposed reservoir site is located in the Central Great Plains (Broken Red Plains) ecoregion. Based on field observations, the predominant cover type in the footprint of the proposed reservoir is grassland/old field, consisting of a mix of native grasses and/or introduced Bermudagrass pasture lands. The riparian woodland/bottomland hardwood forest cover type is also common, being located along the Little Wichita River and its tributaries. Dominant trees in this cover type include cedar elm and pecan along with western soapberry, sugarberry, and green ash. Mesquite and post oak dominated shrublands are also common. The vegetative cover types for the reservoir site is shown in Figure 5-4 and summarized in Table 5.2. An assessment of the habitat value was conducted using the USFWS Habitat Evaluation Procedures (HEP). The definitions of terrestrial cover types and habitat assessments are located in Appendix I.

Table 5.2: Terrestrial Cover Types and Acreages Identified within the Conservation Pool of the Proposed Lake Ringgold Reservoir

Terrestrial Cover Types	Acres	Habitat Value (HUs)
UPLANDS		
Cropland	589	NA[2]
Grassland / Old Field	5,162	2,684
Riparian Woodland / Bottomland Hardwood[1]	4,020	1,327
Shrubland	2,243	897
Shrub Savanna	1,402	799
Tree Savanna	791	403
Upland Deciduous Forest	1,195	275
TOTAL	**15,402**	

1. This cover type includes both upland and wetland riparian forested areas. The acreage shown in this table includes only the upland areas. The wetland areas are shown as Forested Wetlands in Table 5.4.
2. NA – not applicable. Habitat units were not calculated for cropland.

5.2.2 Wildlife Species

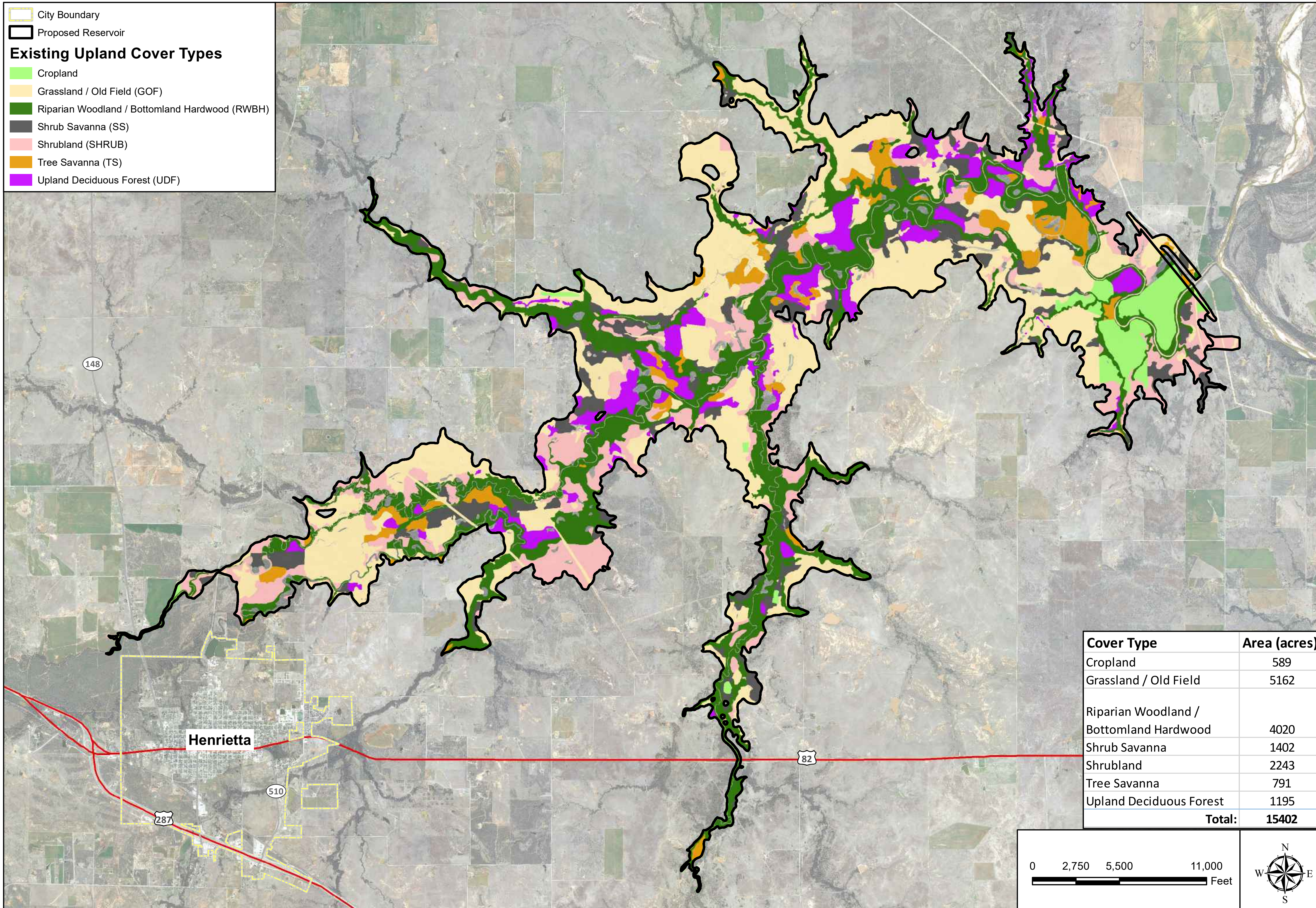
Mammals expected to occur in the area include white-tailed deer, coyote, armadillo, raccoon, skunks, jack rabbits, and various rodents, such as deer mice and hispid cotton rats. Migratory and non-migratory birds expected to occur include northern bobwhite, wild turkey, vultures, crows, hawks and falcons, and a variety of songbirds. Reptiles and amphibians in the area include a variety of snakes, frogs and toads. Wildlife species observed during field investigations are located in the Habitat Procedures (HEP) Report in Appendix I.

Construction of the reservoir would likely displace many of these terrestrial species to surrounding areas that are not inundated. However, the proposed reservoir would provide a more reliable water source for these species as well as increase habitat for other species, such as waterfowl, wading birds, shore birds, beaver, and mink.

UPLAND COVER TYPE MAP

CITY OF WICHITA FALLS

Proposed Lake Ringgold



Cover Type	Area (acres)
Cropland	589
Grassland / Old Field	5162
Riparian Woodland / Bottomland Hardwood	4020
Shrub Savanna	1402
Shrubland	2243
Tree Savanna	791
Upland Deciduous Forest	1195
Total:	**15402**

FN PROJECT NO. WCH15215

DATE CREATED 4/14/2017

DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central

FILE NAME 2_Uplands_11x17

PREPARED BY HHM

FREESE NICHOLS

FREESE AND NICHOLS
4055 International Plaza Suite 200
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(817) 735-7300

FIGURE 5-4

Path: H:\ENVIRONMENTAL\Final_Exhibits\Reports\WRPA\2_Uplands_11x17.mxd

5.2.3 Aquatic Habitat

Aquatic habitat types include rivers, streams, wetlands, and open waters (ponds, stock tanks, etc.). For the purposes of this report and water right application, aquatic habitat types were classified based on USACE definitions of waters of the U.S. A combination of desktop analyses supplemented with field verification was used to identify streams, wetlands, and open waters within the footprint of the proposed reservoir. The types of data utilized as part of the desktop analysis include recent and historic aerial photographs, USGS topographic maps, the USGS National Hydrography Dataset (NHD), and U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) data. It should be noted that a jurisdictional determination (JD) has not been conducted within the proposed project area, but would be required by the USACE as part of the Section 404 permitting process. As such, the types and amounts of aquatic habitat features within this application may vary from those within the Section 404 permit application. These changes are not expected to be significant.

Streams and Open Waters

A stream study was conducted at the Lake Ringgold site to assess the stream type and length of streams that would be impacted by construction and inundation of the reservoir. A summary of the study methods and results is presented in Appendix J.

The stream study was conducted from September 2016 through March 2017, with participation of TCEQ staff. Data from the NHD were reviewed and evaluated using both desktop analyses and field verification. The field study verified approximately 42 percent of the reservoir site. The remaining area was evaluated using desktop analysis and knowledge gained from the field work.

Within the project area, named streams include the Little Wichita River, the Dry Fork Little Wichita River, the East Fork Little Wichita River, Long Creek, and Turkey Creek. The remainder of the streams are unnamed tributaries of the Little Wichita River and/or other named streams within the footprint of the proposed reservoir. Based on this study, there are approximately 651,741 linear feet of streams and 100 acres of open waters (small ponds, stock tanks, ox bow lakes, etc.) within the footprint of the proposed project area. The stream length also includes the approximate 1,500 feet of the Little Wichita River that would be impacted by construction. The locations of these features are displayed on Figure 5-5 and summarized in Table 5.3.

Table 5.3: Approximate Amounts and Types of Potential Streams and Open Waters within the Proposed Lake Ringgold Reservoir

Potential Waters of the U.S.	Acres	Linear Feet
STREAMS		
Perennial	--	166,777
Intermittent	--	180,656
Ephemeral	--	304,308
OPEN WATERS		
Ponds, stock tanks, etc.	100	--
TOTAL	**100**	**651,741**

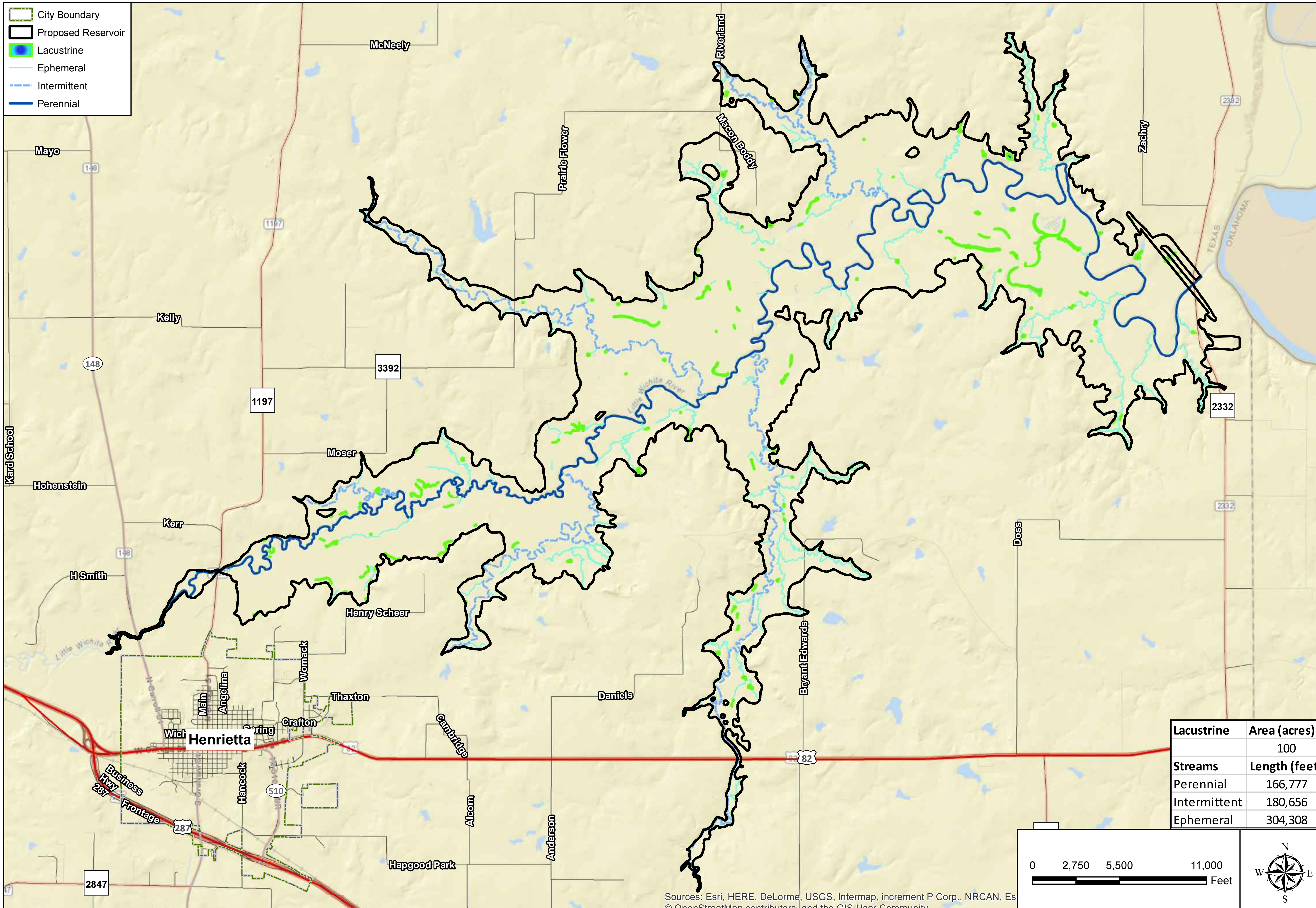
Wetlands

For regulatory purposes, wetlands are defined as "*those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas*" (33 CFR 328.3 (c)(4)). The classification of wetland type, *e.g.*, forested, shrub, or emergent wetland, is based on Cowardin's (1979) Classification of Wetlands and Deepwater Habitats of the United States in accordance with TCEQ regulations (30 TAC §297.53). The functional value of the wetlands was assessed using the USFWS HEP protocol. This protocol uses the wildlife function as an indicator of the functional value of the wetlands. Definitions of wetland cover types and the HEP assessment are discussed in Appendix I.

To identify potential wetlands within the proposed reservoir site, a desktop analysis was performed utilizing the USFWS NWI data as well as recent and historic aerial photography. Once identified, limited ground verification was performed to complement the desktop analysis. Based on this evaluation, approximately 278 acres of forested wetlands, 102 acres of emergent/herbaceous wetlands, and 38 acres of shrub wetlands were identified within the proposed project area. The locations of these potential wetlands are displayed on Figure 5.6 and are summarized in Table 5-4.

Table 5.4: Types and Amounts of Potential Wetlands Identified within the Proposed Lake Ringgold Reservoir

Potential Waters of the U.S.	Acres	Habitat Value (HUs)
WETLANDS		
Forested	278	92
Emergent / Herbaceous	102	35
Shrub	38	16
TOTAL	**418**	**143**



Lacustrine	Area (acres)
	100
Streams	**Length (feet)**
Perennial	166,777
Intermittent	180,656
Ephemeral	304,308

CITY OF WICHITA FALLS

Proposed Lake Ringgold

STREAMS & OPEN WATER

FN PROJECT NO. WCH15215

DATE CREATED 6/1/2017

DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central

FILE NAME 5_Ponds_Streams_11x17

PREPARED BY HHM

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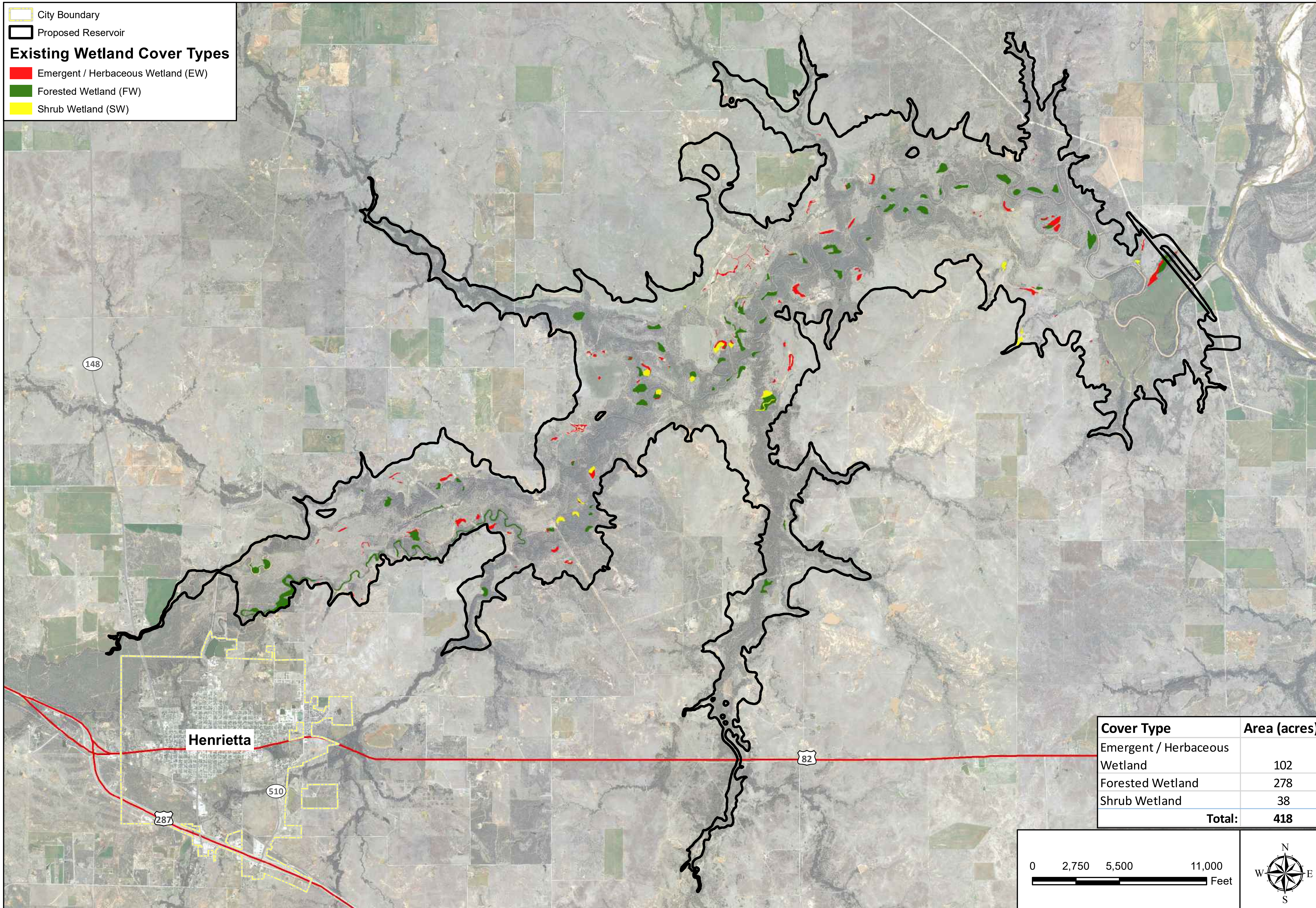
FIGURE

5-5

Path: H:\ENVIRONMENTAL\Final_Exhibits\Reports\WRPA\5_Ponds_Streams_11x17.mxd



Cover Type	Area (acres)
Emergent / Herbaceous Wetland	102
Forested Wetland	278
Shrub Wetland	38
Total:	418

FN PROJECT NO.	WCH15215
DATE CREATED	4/14/2017
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas North Central
FILE NAME	1_Wetlands_11x17
PREPARED BY	HHM

CITY OF WICHITA FALLS

Proposed Lake Ringgold

WETLAND COVER TYPE MAP

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FIGURE 5-6

5.2.4 Aquatic Species

The 2014 TCEQ Stream Standards report a high aquatic life use for the Little Wichita River. However, there are little available data on the aquatic life for this stream. In a 1998 study performed by the Red River Authority, fish were sampled in the Little Wichita River at Hwy 79 near Archer City upstream of Lake Arrowhead (RRA, 1998). It is anticipated that the Little Wichita River downstream of Lake Arrowhead would have similar fish species such as *Lepomis cyanellus* (green sunfish), *Gambusia affinis* (mosquitofish), *Cyprinella lutrensis* (red shiner), *Ameiurus natalis* (yellow bullhead), *Lepomis megaloti*s (longear sunfish) and *Campostoma anomalum* (central stoneroller). Each of these species, with the possible exception of the central stoneroller, is adaptable to a lake environment. The Rapid Bioassessment score for this sampling was Intermediate. As discussed in Section 5.3, recent water quality sampling indicates that the stream segment is impaired for chloride, depressed dissolved oxygen, sulfate, and total dissolved solids.

5.2.5 Endangered and Threatened Species

The Endangered Species Act (ESA) was passed by Congress in 1973. The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend. The USFWS has primary responsibility for administering the ESA for terrestrial and freshwater organisms. Section 7 of the ESA requires Federal agencies to use their legal authorities to promote the conservation purposes of the ESA and to consult with the USFWS to ensure that the effects of their actions to authorize, fund, or carry out are not likely to jeopardize the continued existence of listed species (USFWS, 1973).

Laws and regulations pertaining to state-listed endangered or threatened animal species are contained in Chapter 68 of the Texas Parks and Wildlife (TPW) Code and 31 TAC §§65.171 - 65.177. Laws and regulations pertaining to state-listed endangered or threatened plant species are contained in Chapter 88 of the TPW Code and 31 TAC §§69.01 - 69.9.

To identify state and federally listed threatened or endangered species, the online county lists maintained and published by the USFWS and TPWD were referenced for Clay County, Texas. Once species were identified, their likelihood of occurrence was evaluated using habitat and range descriptions provided by the USFWS, TPWD, or other relevant scientific literature sources. This information was then compared to the location of the proposed reservoir site and the habitats (cover types) that currently exist within its footprint. Other factors taken into consideration as part of this assessment included species dispersal potential (*i.e.*, mobility), whether the species would be considered a permanent resident or stopover species (*i.e.*, migratory), and the anticipated response a species may have following construction of a reservoir (*i.e.*, positive or negative response).

Federally Listed Threatened and Endangered Species

Table 5.5 lists the current federally-listed species and includes a brief description of their likely ranges, preferred habitats, and likely impacts on the species from the reservoir project.

Table 5.5: Federally-listed Threatened and Endangered Species

Common Name	Scientific Name	Listing Status	Discussion
Least Tern	*Sterna antillarum*	E	Low to no potential to negatively impact due to lack of preferred habitat within proposed project area. Species is primarily associated with the habitat along the Red River, which is not located within the project area. Nesting habitat of the Interior Least Tern includes bare or sparsely vegetated sand, shell, and gravel beaches, sandbars, islands, and salt flats associated with rivers and reservoirs. In Texas, Interior Least Terns are found at three reservoirs along the Rio Grande River, on the Canadian River in the northern Panhandle, on the Prairie Dog Town Fork of the Red River in the eastern Panhandle, and along the Red River (Texas/Oklahoma boundary) into Arkansas (TPWDb). Reservoir could provide habitat along the shoreline. Reduced flows to the Red River are not expected to impact downstream habitats.
Whooping Crane	*Grus americana*	E	Low to no potential to negatively impact due to the migratory nature of this species. Whooping cranes winter on the Aransas National Wildlife Refuge's 22,500 acres of salt flats and marshes. They summer and nest in poorly drained wetlands in Canada's Northwest Territories at Wood Buffalo National Park (TPWDf). Although unlikely, the reservoir could provide stop-over/resting areas for migrating whooping cranes (*i.e.*, Recent occurrence at Granger Lake).
Piping Plover	*Charadrius melodus*	T	Low to no potential to negatively impact due to the migratory nature of this species and lack of preferred habitat within proposed project area. Species is primarily associated with sandy beaches and lakeshores. Wintering range consists of beaches along the Texas coast. Summer ranges include sandy beaches along the Great Lakes, the Atlantic coast, as well as river systems in the northern Great Plains. Reservoir could provide stop-over/resting areas along the shoreline.
Red Knot	*Calidris canutus rufa*	T	Low to no potential to negatively impact due to the migratory nature of this species and the lack of preferred habitat within proposed project area. Species migrates long distances between nesting areas in mid- and high arctic latitudes and southern nonbreeding habitats as far north as the coastal US and southward to southern South America. Migration stops are mainly along the Atlantic coast of South America and the Atlantic and Gulf of Mexico coasts of North America. Although unlikely, the reservoir could provide stop-over/resting areas for migrating red knots.

(T) – Threatened
(E) – Endangered

State Listed Threatened and Endangered Species

Table 5.6 contains the common and scientific names of the current state-listed species included in this assessment, the current listing status for each species, as well as a brief description of their likely ranges, preferred habitats, and likely impacts on these species from the project.

Table 5.6: State Listed Threatened / Endangered Species (Clay County, Texas) and Potential Impact

Common Name	Scientific Name	TPWD Listing Status	Discussion
American Peregrine Falcon	*Falco peregrinus Anatum*	T	Low potential to negatively impact due to unlikely presence of the species. Species is a resident of the Trans-Pecos region, including the Chisos, Davis, and Guadalupe mountain ranges, except during migration (TPWDa). Peregrine falcons prefer to nest on very tall sheer cliff faces with a commanding view, a nearby water source and a good prey base. The breeding population in Texas is located in the remote wild canyons of the Rio Grande up into pine-oak woodlands in the Big Bend and Guadalupe Mountains national parks (Arnold, 2001b). No cliffs are located within the proposed reservoir site.
Bald Eagle	*Haliaeetus leucocephalus*	T	Bald Eagles breed in Texas from near sea level to about 1100 m (3600 ft.); (Oberholser, 1974) in and around large aquatic environments (ocean coasts, reservoirs, large lakes and rivers, marshes and swamps). Reservoir construction has the potential to positively impact by providing more habitat for hunting prey (*i.e.,* lake/reservoir area).
Whooping Crane	*Grus americana*	E	See federal description.
Peregrine Falcon	*Falco peregrinus*	T	See description for *American Peregrine Falcon*
Interior Least Tern	*Sterna antillarum*	E	See federal description.
Red Wolf	*Canis rufus*	E	No potential to impact. This species has been extirpated.
Gray Wolf	*Canis lupus*	E	No potential to impact. This species has been extirpated.
Texas Kangaroo Rat	*Dipodomys elator*	T	Moderate potential to negatively impact as this species is likely present within the proposed project area. This species occurs in north-central Texas from Cottle and Motley counties in the west to Montague County in the east. It lives on clay soils supporting sparse, short grasses and small, scattered mesquite bushes. Highly nocturnal, these kangaroo rats do not become active until complete darkness and reportedly cease activity on moonlit nights (Davis and Schmidly 1997).

Table 5.6 Continued

Common Name	Scientific Name	TPWD Listing Status	Discussion
Texas Horned Lizard	*Phrynosoma cornutum*	T	Moderate potential to negatively impact as this species is likely present within the proposed project area. Texas horned lizards occur in a variety of habitats (Donaldson et al. 1994). They inhabit areas from open desert to grasslands and shrublands, from sea level to nearly 6,000 feet in elevation, and on soils varying from pure sands and sandy loams to coarse gravels, conglomerates, and desert pavements (Price 1990). They are typically found in arid and semiarid habitats that contain bunch grasses, cacti, yucca, mesquite, and acacias.

(T) – Threatened
(E) – Endangered

The results of this assessment indicate that the proposed Lake Ringgold project has low to no potential to negatively impact any federally-listed threatened or endangered species. The least tern and whooping crane are federally-listed as endangered for Clay County, Texas. The piping plover and the red knot are federally-listed as threatened for Clay County, Texas. The least tern is primarily associated with the habitat along the Red River where areas of bare or sparsely vegetated sand and sandbars can be used as habitat. While some reductions of flow from the Little Wichita River into the Red River are expected to occur following construction of the proposed reservoir, downstream impacts to least tern habitat along the Red River are not expected to occur because changes to sand bars and sand features should be minimal downstream of the confluence. The whooping crane is a migratory species across portions of Texas as it makes its way from its nesting habitat in the Northwest Territories of Canada to winter in the Aransas National Wildlife Refuge. Similarly, the piping plover is a migratory species across Texas as it travels from breeding areas along shorelines of the Great Lakes and the northern Great Plains to the Texas Gulf Coast. The red knot is another Texas migrant, making long distance flyovers from the Texas Gulf Coast to its breeding grounds in the Arctic Circle. No impacts to these species are expected to occur as a result of constructing the proposed reservoir. This is primarily due to the strong migratory nature of this species and the lack of habitat within the region.

Only two of the nine state-listed species were identified as having a moderate potential to be impacted as a result of this analysis. Those species include the Texas horned lizard and the Texas kangaroo rat. The moderate potential for these species to be impacted comes as a result of their known ranges and habitats being within the region coupled with their non-migratory and lower mobility characteristics. However, once the dam is constructed and the proposed reservoir begins to fill, these species would likely relocate to areas outside of the reservoir's footprint. It should be noted that no surveys have been conducted to determine if these species or their preferred habitats are present within the footprint of the proposed reservoir.

5.3 Water Quality

The TWC and associated regulations (TWC §11.150 and 30 TAC §297.54) require TCEQ to evaluate the effects of proposed water right permits on water quality. The proposed reservoir would be in the same drainage basin as Lake Arrowhead and Lake Kickapoo, so it is anticipated that the water quality would be very similar to the existing reservoirs. Lake Ringgold would impound water that currently flows within the TCEQ classified stream Segment No. 0211, which is identified as the Little Wichita River from the Lake Arrowhead dam to the confluence with the Red River. TCEQ stream standards for this segment are shown in Table 5.7. (TCEQ, 2014)

Table 5.7: Water Quality Standards for Segment 0211,
Little Wichita River downstream of Lake Arrowhead

Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Dissolved Oxygen (mg/L)	pH Range (SU)	Temperature (°F)	E. coli (per 100 mL)
450	250	500	3.0[i]	6.5-9.0	91	126

i. The 24-hour minimum dissolved oxygen criterion in Segment 0211 is 2.0 mg/L.

The 2014 Draft Texas 303(d) List identifies Segment No. 0211 (Little Wichita River, downstream of Lake Arrowhead) as not attaining the stream standards for chloride, dissolved oxygen, sulfate, and total dissolved solids (TCEQ, 2015). The segment is currently classified as "5b" for chloride, sulfates and total dissolved solids, indicating a review of the standards for one or more parameters will be conducted before a management strategy is selected. The segment is classified as "5c" for depressed dissolved oxygen, indicating additional data or information will be collected and/or evaluated before a management strategy is selected. A change in the stream standard could result in the removal or delisting of this segment from the 303(d) list.

Historical water quality data for the Little Wichita River is available from 1968 through 2016, with consistent monitoring beginning in 2000 (TCEQ, 2017). The sampling locations on the Little Wichita River include TCEQ Surface Water Quality Monitoring Station 13633, near Henrietta, and Station 10140, at FM 2332. FM 2332 crosses the Little Wichita River just upstream of the confluence with the Red River. Due to potential backwater effects, water quality measurements at this location can be influenced by the quality within the Red River, and is not included in the assessment of water quality for Lake Ringgold. The average annual concentrations for total dissolved solids, chlorides, and sulfates in the Little Wichita River, near Henrietta, are shown in Table 5.8. The water quality measurements are lower than the 2014 TCEQ standards for the Little Wichita River (see Table 5.8). The construction of Lake Ringgold is not expected to significantly change the existing quality of the stream. The predicted mean concentrations in the reservoir are expected to be somewhat lower than the mean stream concentrations because most of the inflow to a reservoir occurs from high flow events, which generally have lower than average concentrations of chloride, sulfate, and TDS.

Table 5.8: Average Annual Water Quality Measurements in the Little Wichita River near Henrietta

Year	Dissolved Solids (mg/l)	Chloride (mg/l)	Sulfate (mg/l)
Water Quality Standard	*500*	*450*	*250*
2000	7	205	22
2001	46	72	7
2002	87	50	9
2003	56	87	12
2004	26	74	11
2005	16	34	5
2006	41	34	7
2007	145	14	5
2008	NA	NA	NA
2009	NA	NA	NA
2010	NA	NA	NA
2011	79	15	5
2012	190	42	5
2013	55	118	11
2014	37	127	11
2015	88	23	5
2016	54	43	8

NA – Not available

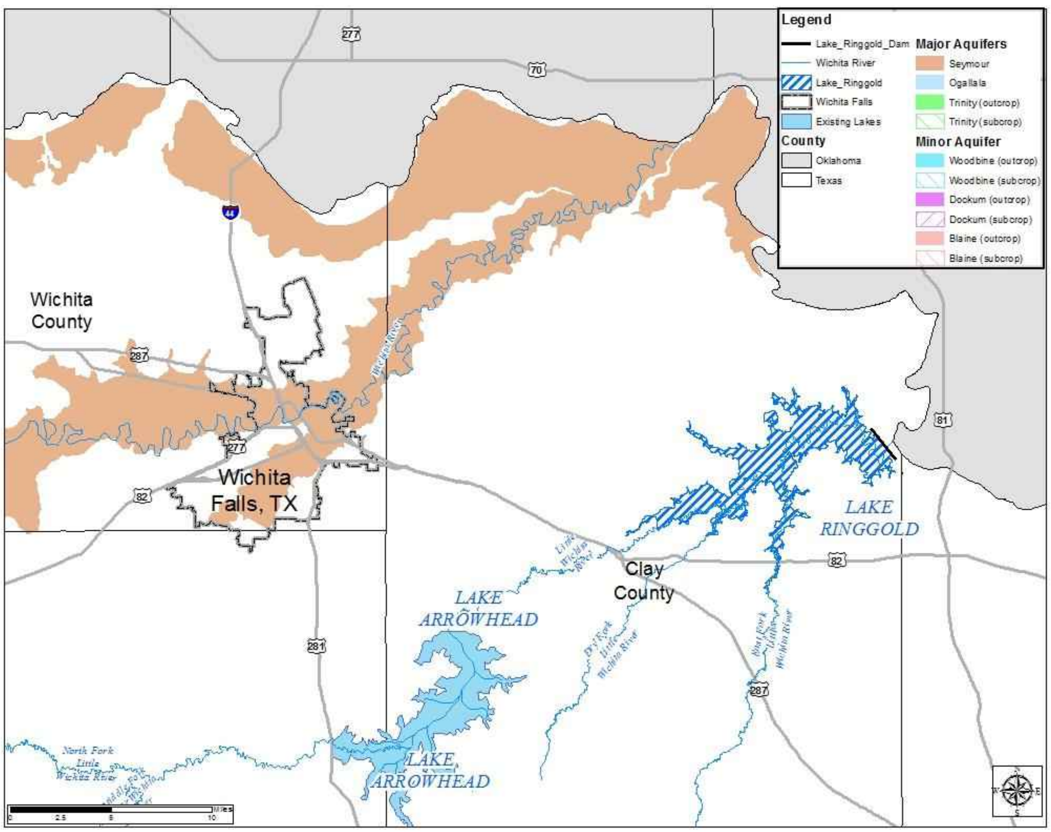
5.4 Bays and Estuaries

The Little Wichita River is a tributary of the Red River and eventually flows into the Atchafalaya River and the Gulf of Mexico in Louisiana. The proposed Lake Ringgold is located greater than 200 miles from the coast and therefore permit conditions to maintain beneficial inflows to an affected bay and estuary system are not required. Any impacts due to Lake Ringgold on coastal Louisiana and the Gulf of Mexico would be so small as to be insignificant.

5.5 Groundwater Resources

Groundwater resources in Clay County are limited. Clay County has no groundwater conservation district and is not within a priority groundwater management area designated under TWC Chapter 35. The Seymour Aquifer is present in the far north-western portion of Clay County. The remainder of the county has no well-defined aquifers as shown in Figure 5-7. The proposed Lake Ringgold project is not located over the recharge zone for any major or minor aquifer in Texas, and is not expected to have any significant direct impact on groundwater resources.

Figure 5-7
Groundwater Resources and Lake Ringgold



5.6 Flooding

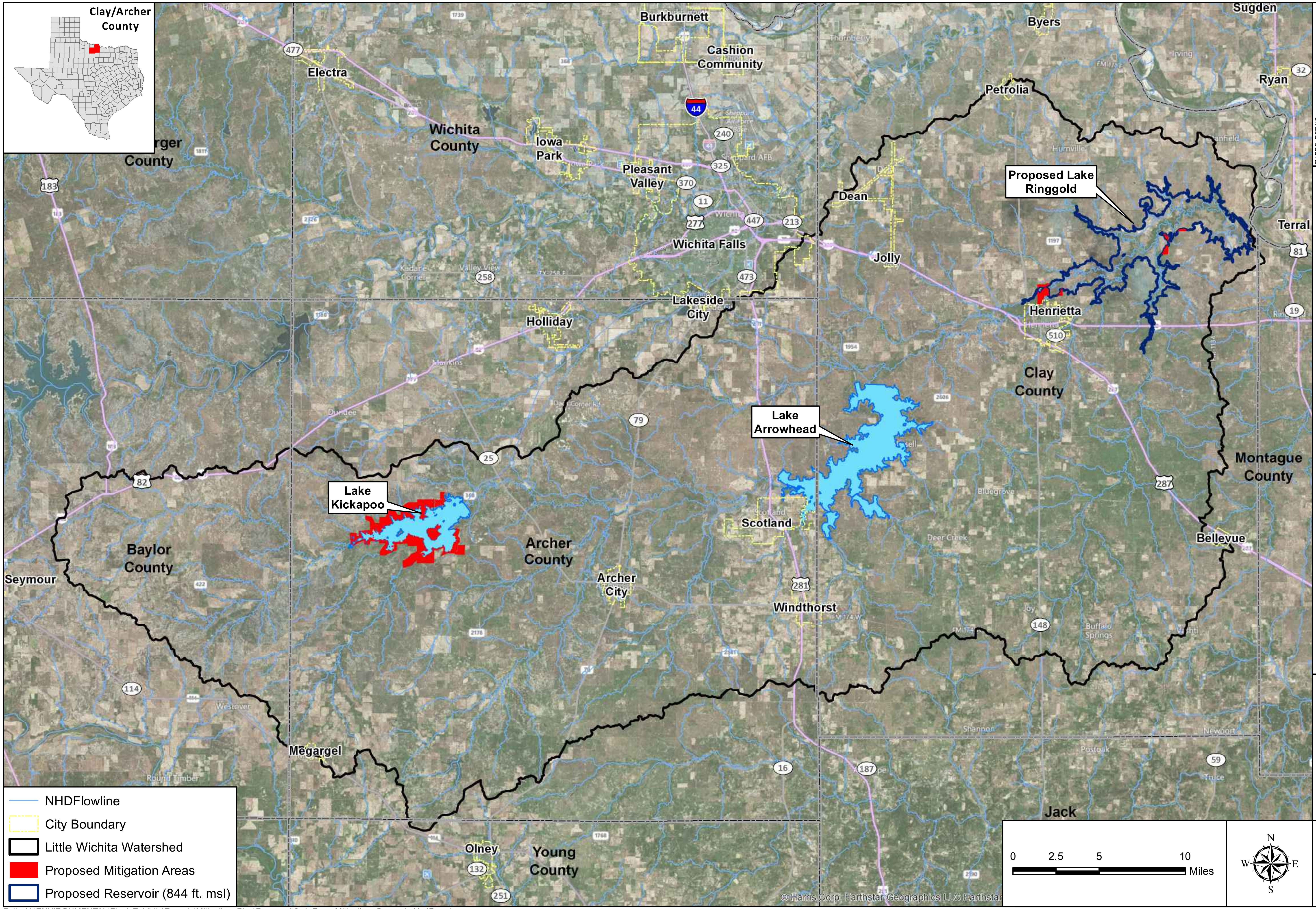
Lake Ringgold will have minimal impacts on flooding on the Little Wichita River, specifically in the town of Henrietta, located upstream of the proposed lake. Impacts were assessed for the 100- and 500-year frequency floods, and the principal and emergency spillway were designed to minimize the impact that would occur in Henrietta. The flooding impacts near Henrietta and along the Little Wichita River will be examined in greater detail during project development.

6. PROPOSED MITIGATION

In accordance with 30 TAC, §297.53, the effects, if any, of the proposed project on fish and wildlife habitat, including streams and wetlands shall be assessed, and unavoidable adverse impacts shall be mitigated to an acceptable level approved by the TCEQ.

The potential impacts of the project to wetlands and terrestrial habitats were assessed using the USFWS's HEP Procedures. The HEP methodology is recommended by the TCEQ as an acceptable tool for evaluating project impacts to wildlife habitat, including wetlands, and developing mitigation recommendations. Potential impacts to streams were determined utilizing a stream assessment to identify stream lengths by type (*i.e.*, perennial, intermittent, and ephemeral) within the footprint of the proposed project. Details of these studies are included in Appendices I and J.

To mitigate for the identified impacts, a conceptual mitigation plan was developed and is included in Appendix K. The conceptual mitigation proposal is multi-faceted and includes both off-site and on-site mitigation strategies. This conceptual mitigation plan also utilizes a watershed approach to mitigate for uplands, wetlands, open water, and streams within the Little Wichita River watershed (Figure 6-1), where the potential impacts would occur.



FN PROJECT NO. WCH15215
DATE CREATED 5/22/2017
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central
FILE NAME 6_1_Prop_Mitigation_Concept_11x17
PREPARED BY HHM

CITY OF WICHITA FALLS

Proposed Lake Ringgold

PROPOSED MITIGATION CONCEPT

FREESE NICHOLS
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6-1

FIGURE

7. OTHER INFORMATION FOR TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

7.1 Information Required for Authorizations to Use Bed and Banks

The City's application seeks to authorize the use of the bed and banks of Lake Arrowhead to deliver water pumped from Lake Ringgold to the City. The water would be delivered by pipeline to a discharge location on the perimeter of Lake Arrowhead. The water would be transported by the bed and banks of Lake Arrowhead to a diversion location on the perimeter of Lake Arrowhead. This diversion location would include the City's existing intake structure and potential future intake structures. The water would be diverted from Lake Arrowhead within days of discharge, with little to no residence time in the lake.

7.1.1 Water Quality

The quality of water from Lake Ringgold is expected to be similar to the quality in Lake Arrowhead. The water quality within the Little Wichita River watershed is discussed in Section 5.3 of this report. There are no anticipated negative impacts to the water quality in Lake Arrowhead from the discharge of Lake Ringgold water. With the proposed future discharges of wastewater reuse water to Lake Arrowhead (which may have slightly lower water quality), the discharge of water from Lake Ringgold may improve the water quality in Lake Arrowhead.

7.1.2 Carriage Losses

Carriage and/or evaporation losses associated with the transport of Lake Ringgold water is expected to be negligible because there will be little to no residence time in Lake Arrowhead. The operation of this conveyance proposes to divert Lake Ringgold water immediately after the discharge of the water to Lake Arrowhead. Therefore, no carriage losses are assumed.

APPENDIX A

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Appendix A
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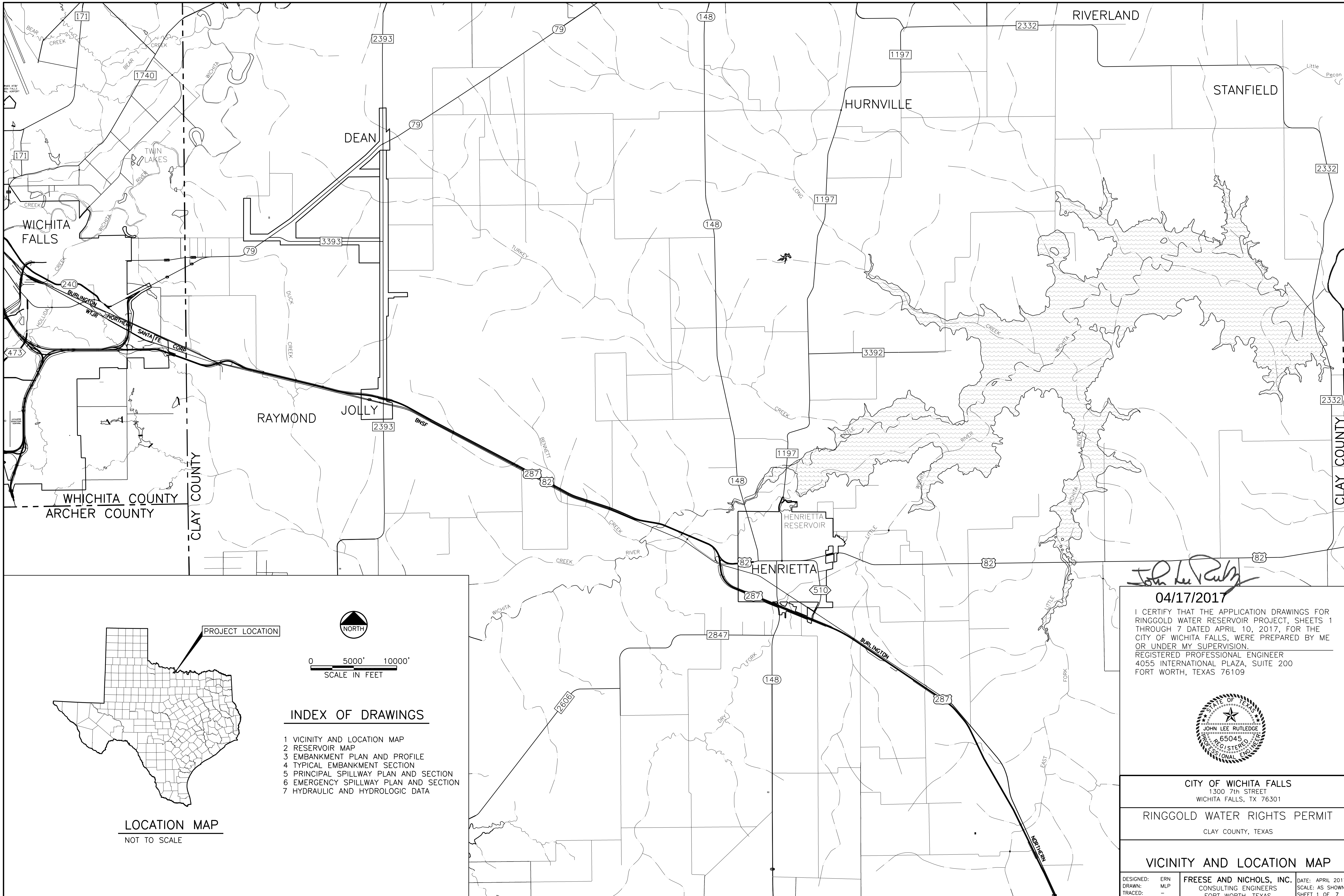
APPENDIX B

APPLICATION DRAWINGS



INDEX OF DRAWINGS

1 VICINITY AND LOCATION MAP
2 RESERVOIR MAP
3 EMBANKMENT PLAN AND PROFILE
4 TYPICAL EMBANKMENT SECTION
5 PRINCIPAL SPILLWAY PLAN AND SECTION
6 EMERGENCY SPILLWAY PLAN AND SECTION
7 HYDRAULIC AND HYDROLOGIC DATA

John Lee Rutledge
04/17/2017

I CERTIFY THAT THE APPLICATION DRAWINGS FOR RINGGOLD WATER RESERVOIR PROJECT, SHEETS 1 THROUGH 7 DATED APRIL 10, 2017, FOR THE CITY OF WICHITA FALLS, WERE PREPARED BY ME OR UNDER MY SUPERVISION.

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STATE OF TEXAS
JOHN LEE RUTLEDGE
65045
REGISTERED PROFESSIONAL ENGINEER

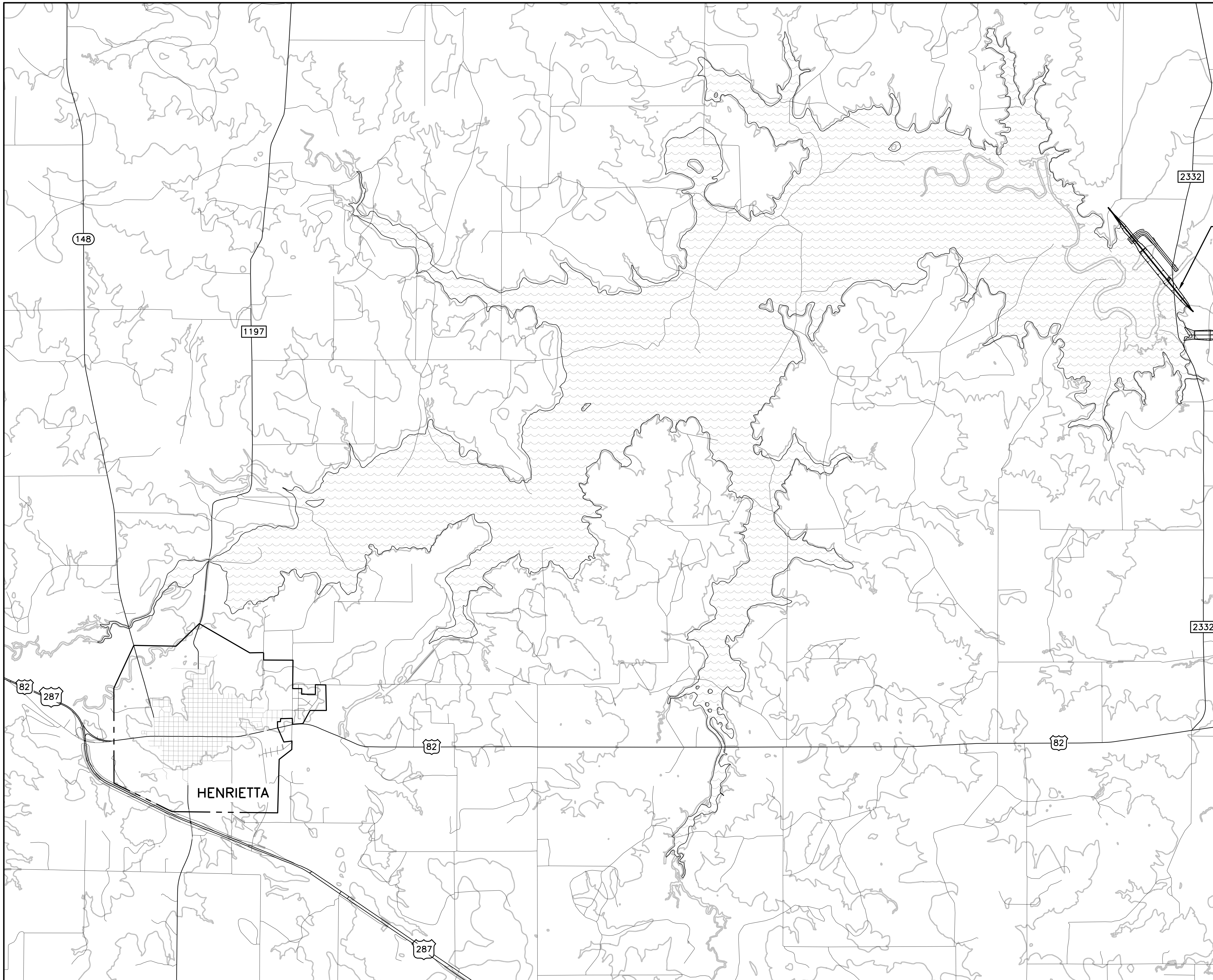
CITY OF WICHITA FALLS
1300 7th STREET
WICHITA FALLS, TX 76301

RINGGOLD WATER RIGHTS PERMIT

CLAY COUNTY, TEXAS

VICINITY AND LOCATION MAP

DESIGNED:	ERN	FREESE AND NICHOLS, INC.	DATE: APRIL 2017
DRAWN:	MLP	CONSULTING ENGINEERS	SCALE: AS SHOWN
TRACED:	–	FORT WORTH, TEXAS	SHEET 1 OF 7
CHECKED:	SK		



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RESERVOIR MAP

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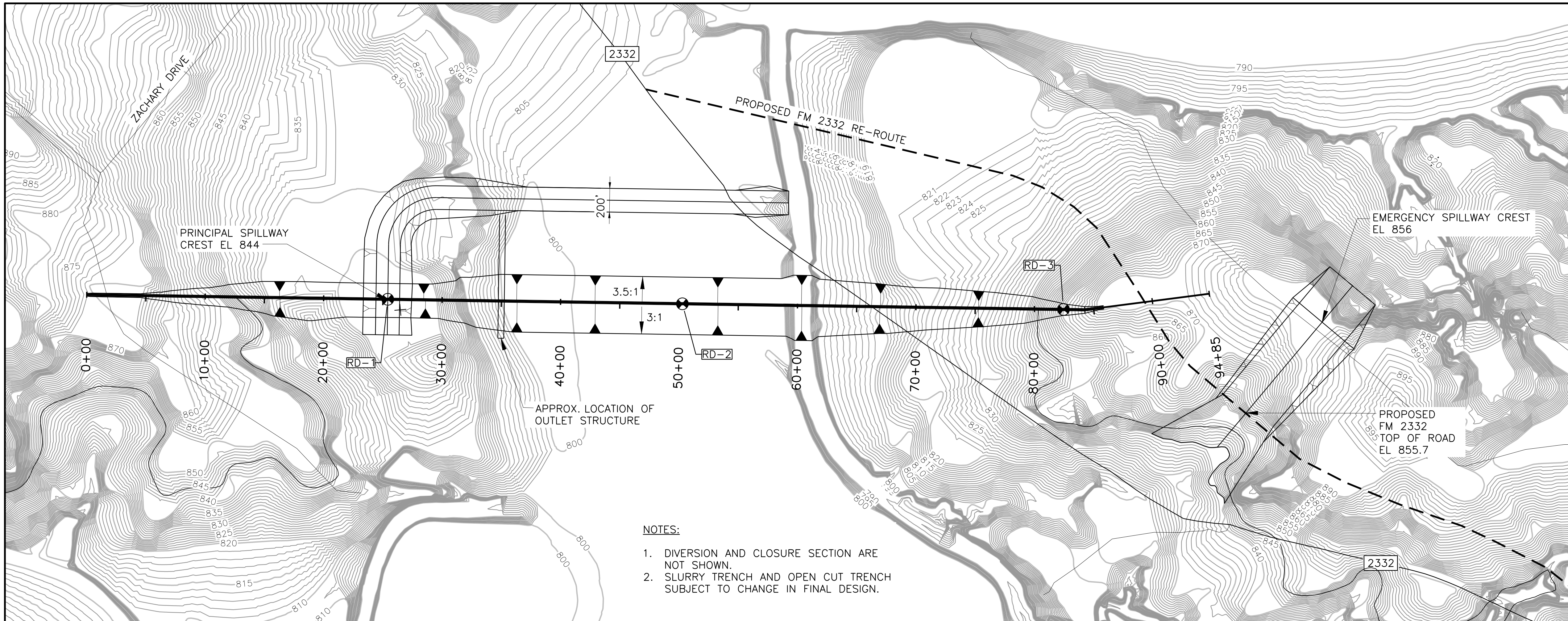
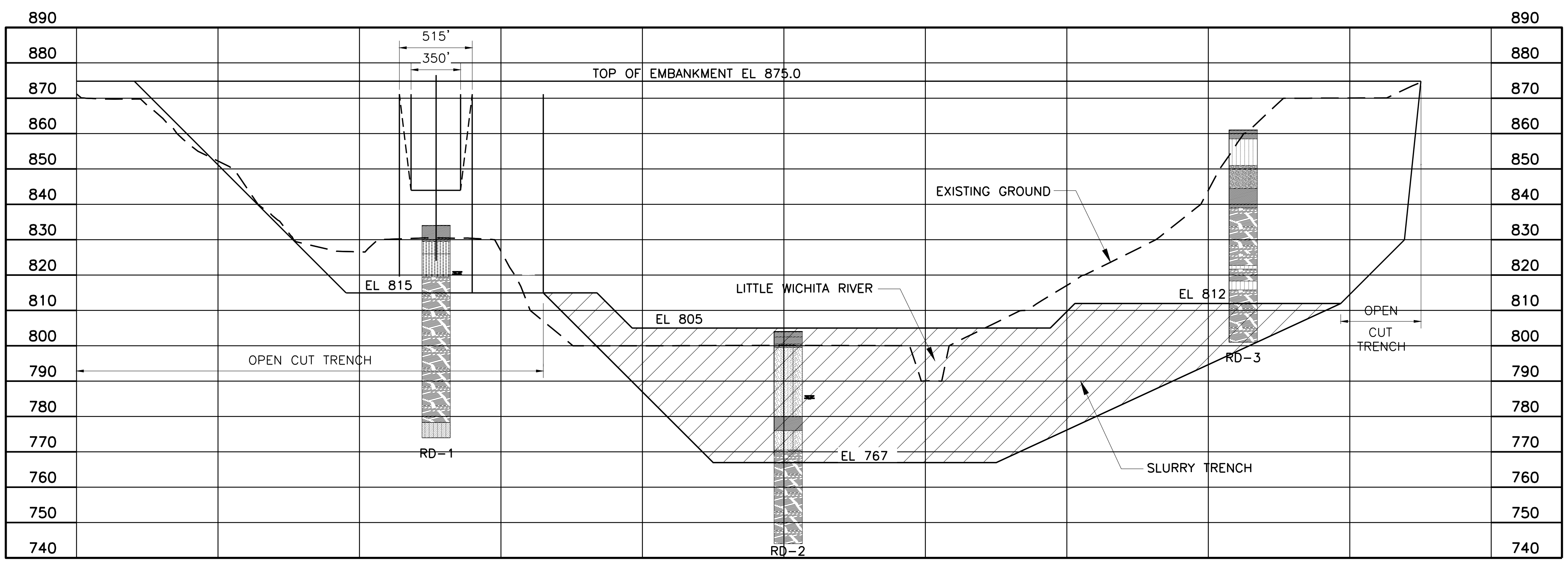
DRAWN:	MLP	CONSULTING ENGINEERS	SCALE: AS SHOWN
TRACED:	–	FORT WORTH, TEXAS	SHEET 2 OF 7
CHECKED:	SK		



LITHOLOGIC SYMBOLS
(UNIFIED SOIL CLASSIFICATION SYSTEM)

- CL: USCS LOW PLASTICITY CLAY
- MUDSTONE: MUDSTONE
- SANDSTONE: SANDSTONE
- SC: USCS CLAYEY SAND
- SHALE: SHALE
- SM: USCS SILTY SAND
- SW: USCS WELL-GRADED SAND



NORTH

0 500 1000
SCALE IN FEET
HORIZONTAL

0 20' 40'
SCALE IN FEET
VERTICAL

04/17/2017

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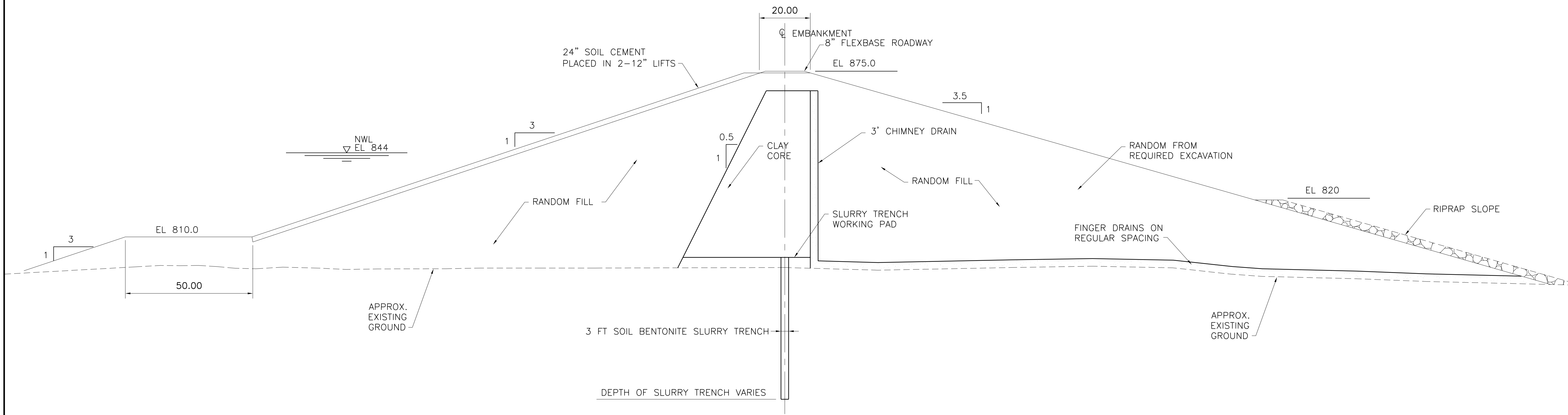
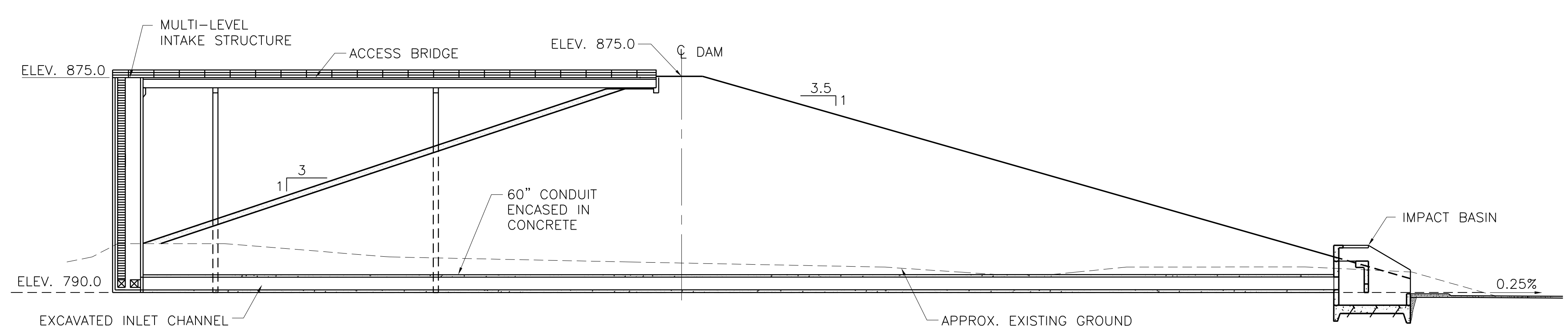
EMBANKMENT PLAN AND PROFILE

DESIGNED: ERN DRAWN: MLP TRACED: – CHECKED: SK		FREESE AND NICHOLS, INC. CONSULTING ENGINEERS FORT WORTH, TEXAS	DATE: APRIL 2017 SCALE: AS SHOWN SHEET 3 OF 7



1 TYPICAL EMBANKMENT SECTION

1"=20'



2 SECTION THROUGH LOW-FLOW OUTLET

0 10' 20' 30' 60'

NOTE:
THE LOW FLOW OUTLET IS A CONCEPTUAL MINIMUM SIZE AS THE PRECISE LOCATION HAS NOT BEEN DETERMINED. THE LOW FLOW OUTLET MAY BE USED AS AN INTAKE PIPE FOR THE PUMP STATION. IF USED, THE CONFIGURATION WILL INCREASE IN SIZE AND COMPLEXITY.

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TYPICAL EMBANKMENT SECTION

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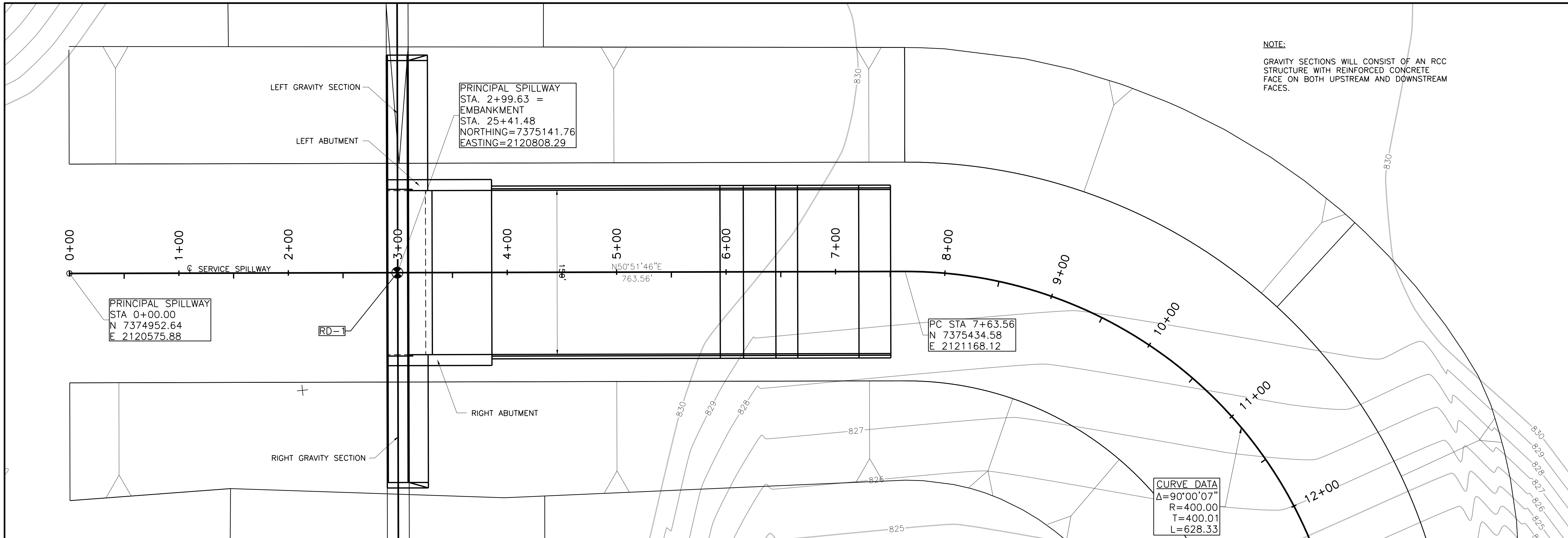
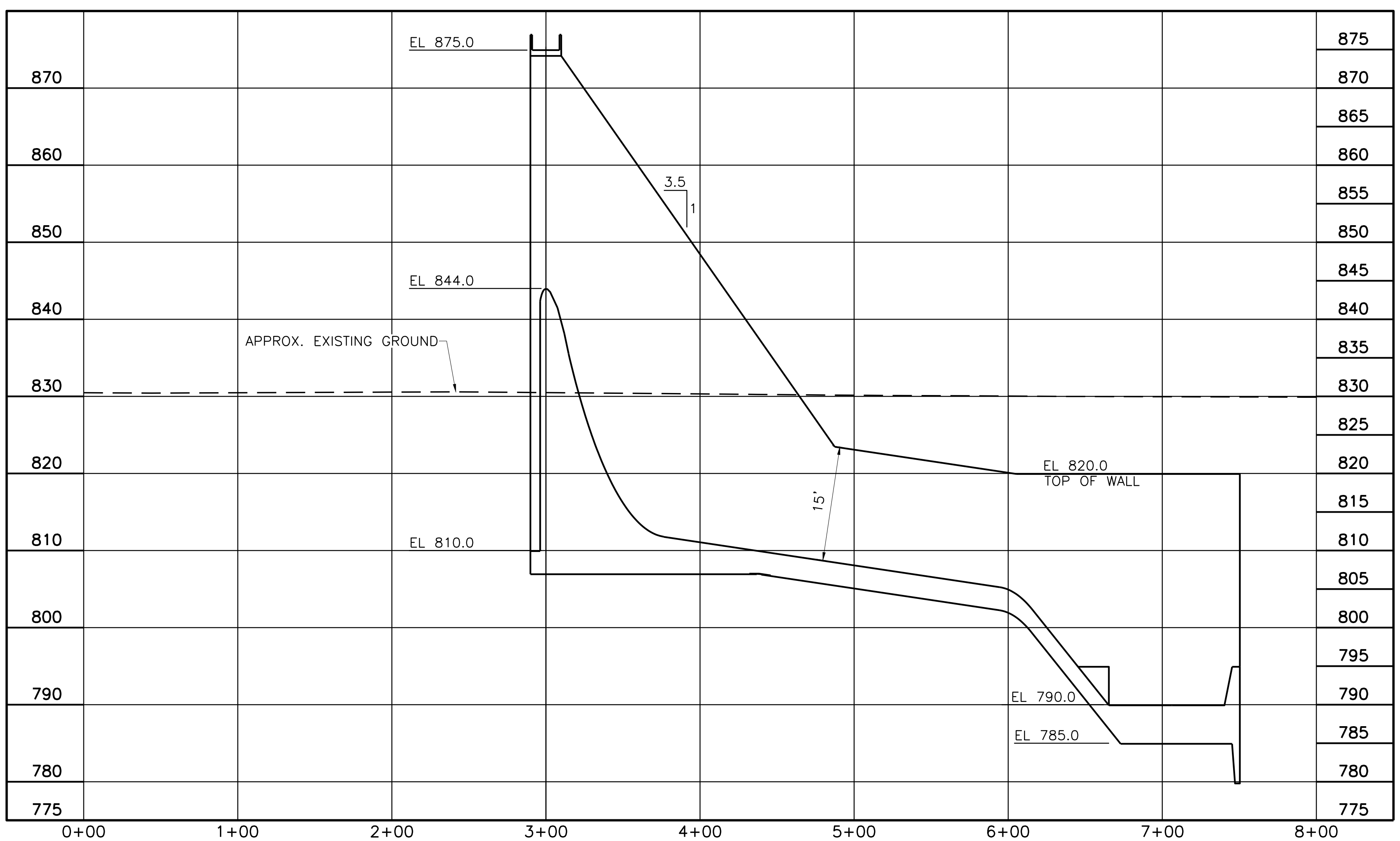
NOTE:

GRAVITY SECTIONS WILL CONSIST OF AN RCC STRUCTURE WITH REINFORCED CONCRETE FACE ON BOTH UPSTREAM AND DOWNSTREAM FACES.





NORTH

0 50' 100'
SCALE IN FEET
HORIZONTAL

0 20' 40'
SCALE IN FEET
VERTICAL

John Lee Rutledge
04/17/2017

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1300 7th STREET
WICHITA FALLS, TX 76301

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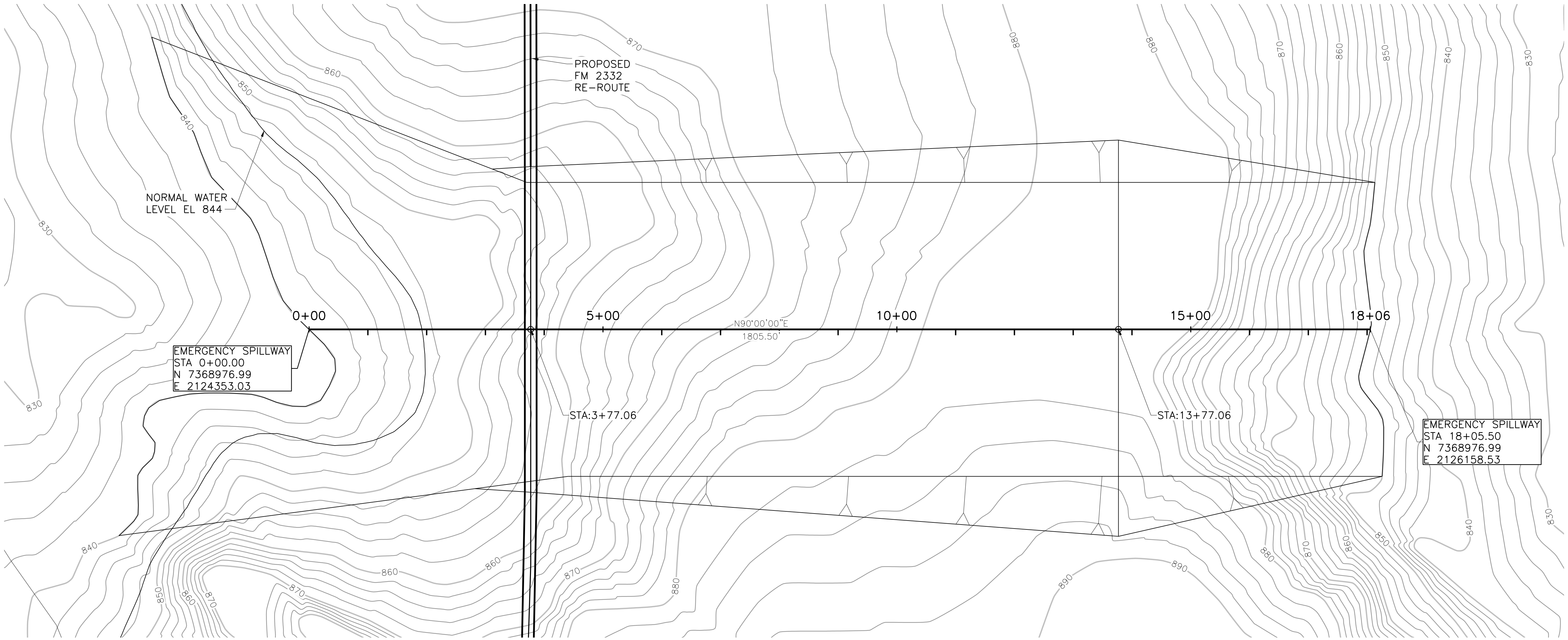
CLAY COUNTY, TEXAS

PRINCIPAL SPILLWAY
PLAN AND SECTION

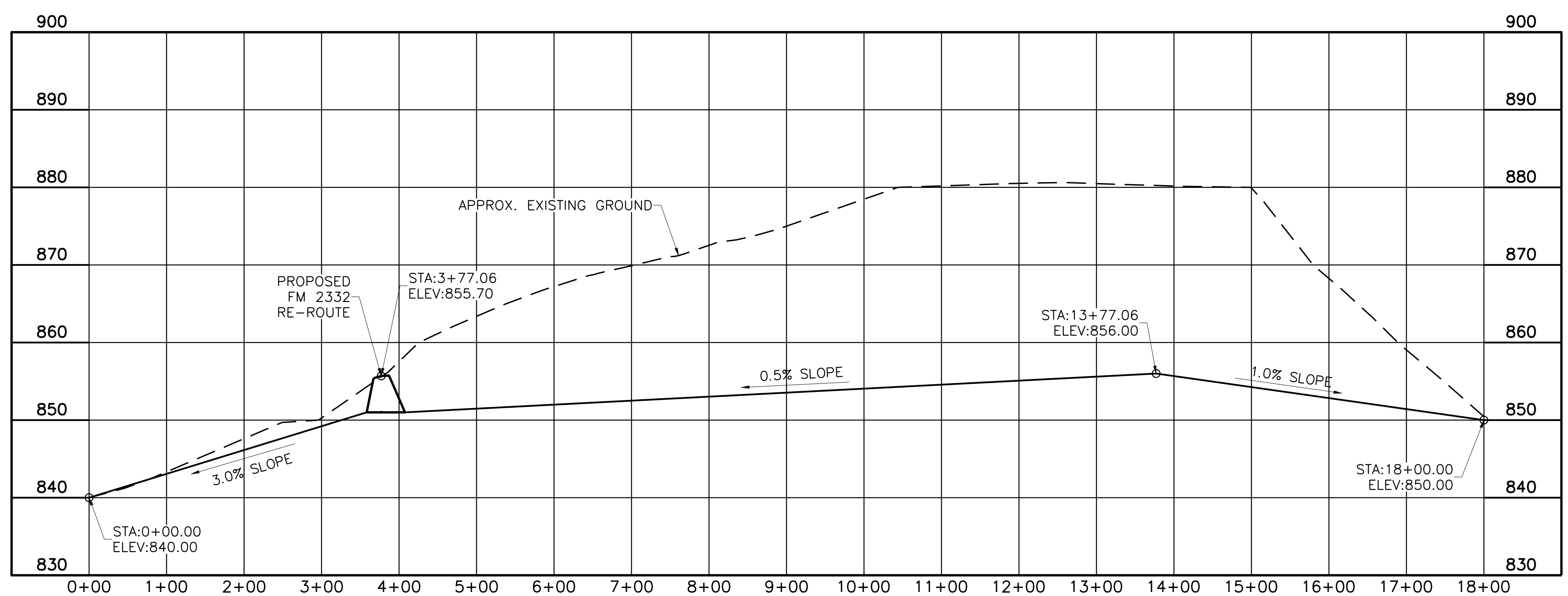
DESIGNED: ERN DRAWN: MLP TRACED: – CHECKED: SK	FREESE AND NICHOLS, INC. CONSULTING ENGINEERS FORT WORTH, TEXAS	DATE: APRIL 2017 SCALE: AS SHOWN SHEET 5 OF 7



NORTH

0 100' 200'
SCALE IN FEET
HORIZONTAL

0 10' 20'
SCALE IN FEET
VERTICAL



John Lee Rutledge

04/17/2017

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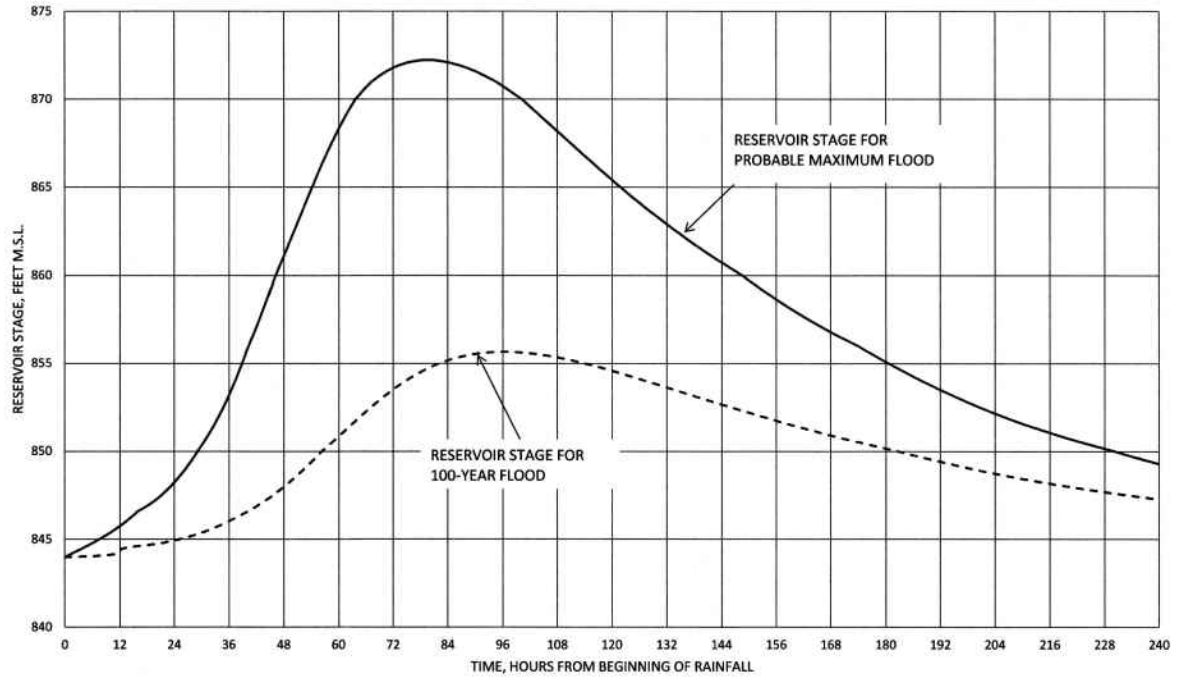
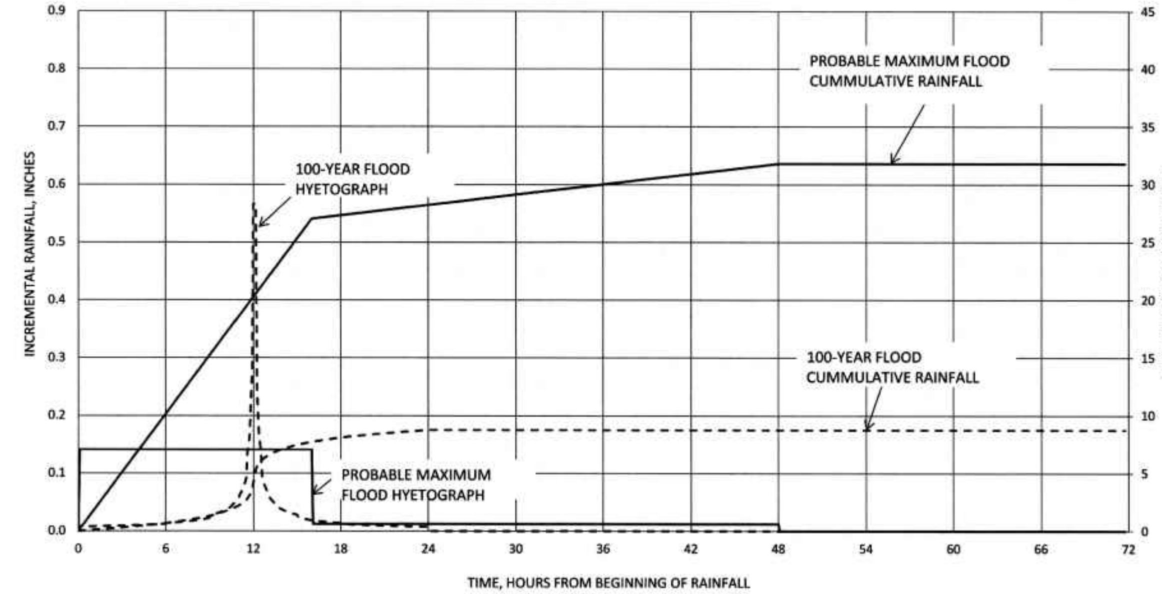
EMERGENCY SPILLWAY
PLAN AND SECTION

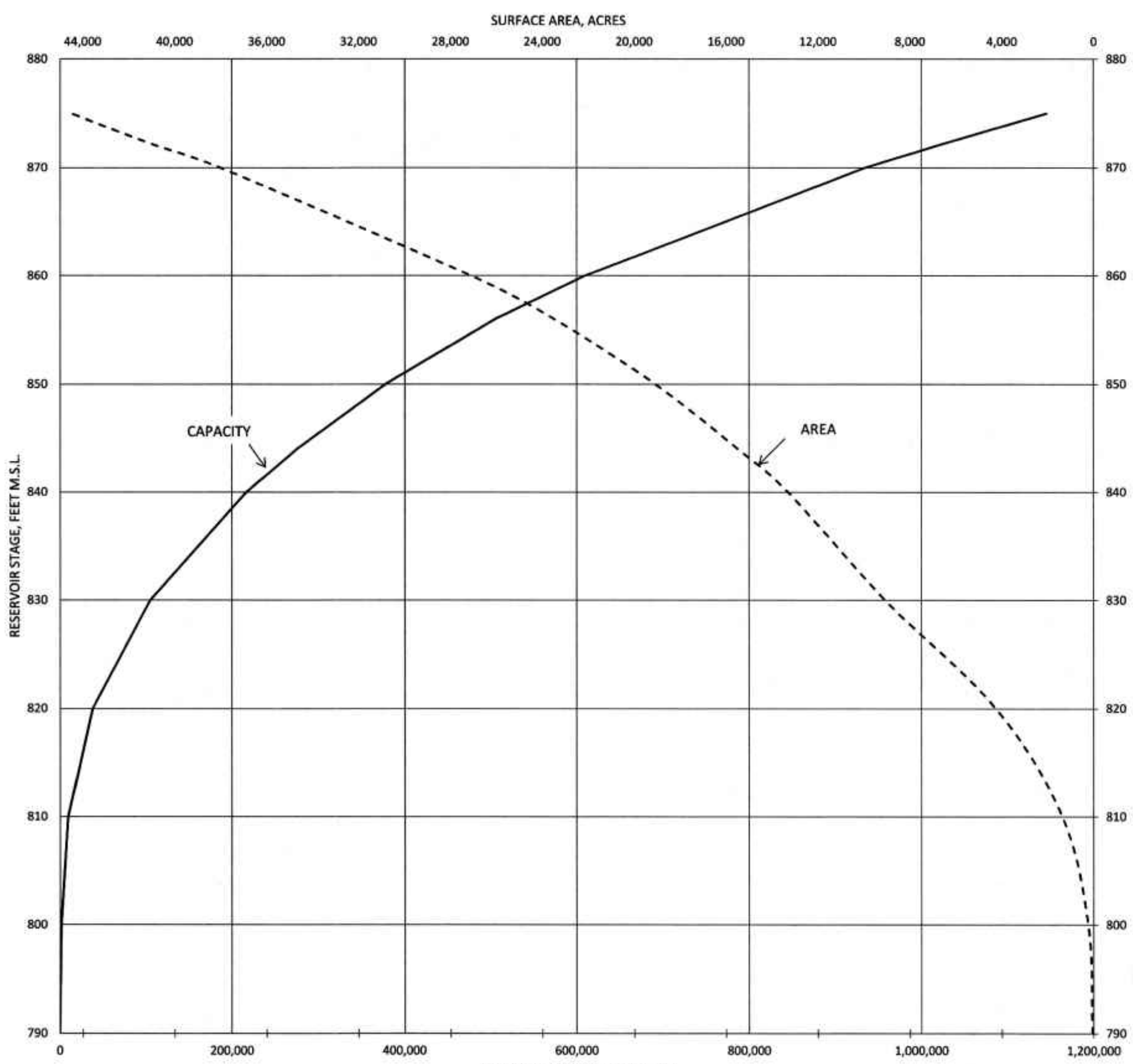
DESIGNED: ERN DRAWN: MLP TRACED: – CHECKED: SK		FREESE AND NICHOLS, INC. CONSULTING ENGINEERS FORT WORTH, TEXAS	DATE: APRIL 2017 SCALE: AS SHOWN SHEET 6 OF 7



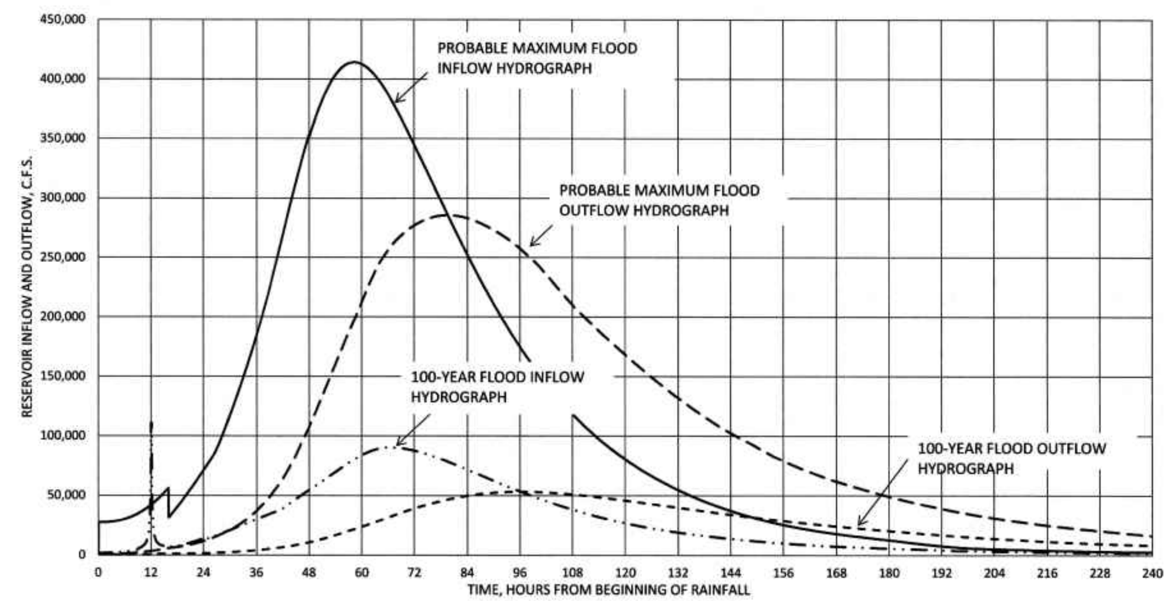
RESERVOIR STAGE FOR PMF AND 100-YEAR FLOOD



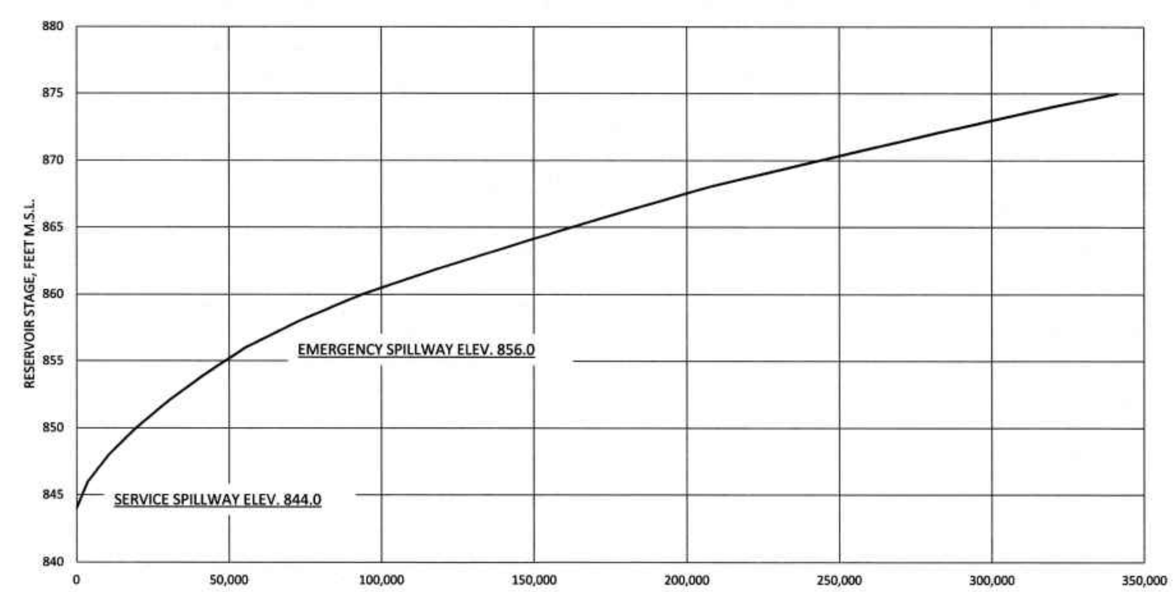
RAINFALL HYETOGRAPH FOR PMF & 100-YEAR FLOODS



AREA - CAPACITY CURVES



PMF AND 100-YEAR FLOOD



SPILLWAY RATING CURVE

PERTINENT DATA LAKE RINGGOLD DAM

MISCELLANEOUS

DRAINAGE AREA ABOVE DAM, SQUARE MILES	1,480
IMPOUNDED AT NORMAL MAX. W.S. ELEV. 844.0	
SURFACE AREA, ACRES	15,500
STORAGE CAPACITY, ACRE-FEET	275,000

PROBABLE MAXIMUM FLOOD ON LAKE RINGGOLD WATERSHED

PEAK INFLOW, C.F.S.	414,217
VOLUME OF RUNOFF, ACRE-FEET	2,191,991
VOLUME OF RUNOFF, INCHES	27.78
PEAK OUTFLOW, CFS	285,578

100-YEAR FLOOD ON LAKE RINGGOLD WATERSHED

PEAK INFLOW, C.F.S.	90,138
VOLUME OF RUNOFF, ACRE-FEET	532,341
VOLUME OF RUNOFF, INCHES	6.75
PEAK OUTFLOW, C.F.S.	52,973

RESERVOIR

FEATURE:

	ELEVATION FEET M.S.L.	AREA ACRES	CAPACITY ACRE-FEET
TOP OF DAM	875.0	44,500	1,145,000
PROBABLE MAX. FLOOD	872.2	41,000	1,025,000
100-YEAR FLOOD	855.7	23,281	66,889
NORMAL W.S.	844.0	15,500	275,000
STREAMBED	790.0	0	0

SERVICE SPILLWAY

TYPE: 350 FOOT WIDE UNCONTROLLED OGEE SPILLWAY WITH HYDRAULIC JUMP STILLING BASIN

EMERGENCY SPILLWAY

TYPE: 500 FOOT WIDE UNCONTROLLED BROAD-CRESTED SPILLWAY

DAM

TYPE: EARTHFILL	
TOTAL LENGTH, FEET	8,585
HEIGHT ABOVE STREAMBED, FEET	85.0
CROWN WIDTH, FEET	20
SIDE SLOPES:	
UPSTREAM	3:1
DOWNSTREAM	3.5:1

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FORT WORTH, TEXAS 76109

4-17-17

CITY OF WICHITA FALLS
1300 7th STREET
WICHITA FALLS, TX 76301

RINGGOLD WATER RIGHTS PERMIT

CLAY COUNTY, TEXAS

HYDRAULIC AND HYDROLOGIC DATA

DESIGNED: ERN DRAWN: MLP TRACED: – CHECKED:		FREESE AND NICHOLS, INC. CONSULTING ENGINEERS FORT WORTH, TEXAS	DATE: APRIL 2017 SCALE: AS SHOWN SHEET 7 OF 7

APPENDIX C

EVALUATION OF CURRENT SUPPLIES

MEMORANDUM

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TO: Russell Schreiber

CC: Simone Kiel, Jon Albright

FROM: Spencer Schnier and Jeremy Rice

SUBJECT: Currently Available Water Supplies for Wichita Falls

DATE: March 15, 2017 – Updated April 10, 2017

PROJECT: WCH15215

1.0 INTRODUCTION

The purpose of this memorandum is to determine the currently available water supplies for Wichita Falls following the end of the recent drought.

2.0 ASSUMPTIONS AND METHODOLOGY

These analyses use an Excel-based hydrologic model of Lakes Arrowhead, Kickapoo and Ringgold developed for use in the Long-Range Water Supply Plan. A similar model for Lakes Kemp and Diversion was also used in the Long-Range Water Supply Plan. The model uses a monthly time step and conducts a monthly mass balance analyses to determine reservoir content at the end of the month. Model input includes reservoir elevation-area-capacity data, reservoir inflows, releases, demand, and evaporation data. The available supply is calculated using an iterative process to determine an annual diversion that causes the reservoir storage to nearly reach zero (for a firm yield analysis) or some other desired storage (for example, 20% of the storage volume) at the end of the worst drought encountered in the simulation. Reservoir inflows and evaporation are based on historical hydrological conditions from 1940 through June 2015. The following sections document the assumptions and methodology used for the analysis.

2.1 VOLUMETRIC SURVEYS

The Texas Water Development Board (TWDB) conducted new volumetric surveys for Lakes Arrowhead, Diversion and Kickapoo in 2013. The 2013 volumetric surveys were used to calculate the yields in this memorandum. The elevation-area-capacity relationship for Lake Kemp is based on the TWDB volumetric survey from 2006 which FNI has adjusted to reflect the unusable storage east of the sediment accumulated at the upstream end of the lake. Table 2-1 shows the current storage at the conservation pool based on the survey or FNI estimate and the estimated storage based on sedimentation in 2070.

Table 2-1: Storage Capacity Comparison for Lakes Arrowhead, Kemp and Kickapoo

	Storage Capacity (Acre-Feet)		
	2010 (FNI Estimate)	2013 (TWDB)	2070 (FNI Estimate)
Lake Arrowhead	--	230,359	189,262
Lake Diversion	--	35,324	30,612
Lake Kemp	221,929*	--	126,790
Lake Kickapoo	--	86,345	69,644

* The storage in the 2006 TWDB survey was 245,434.

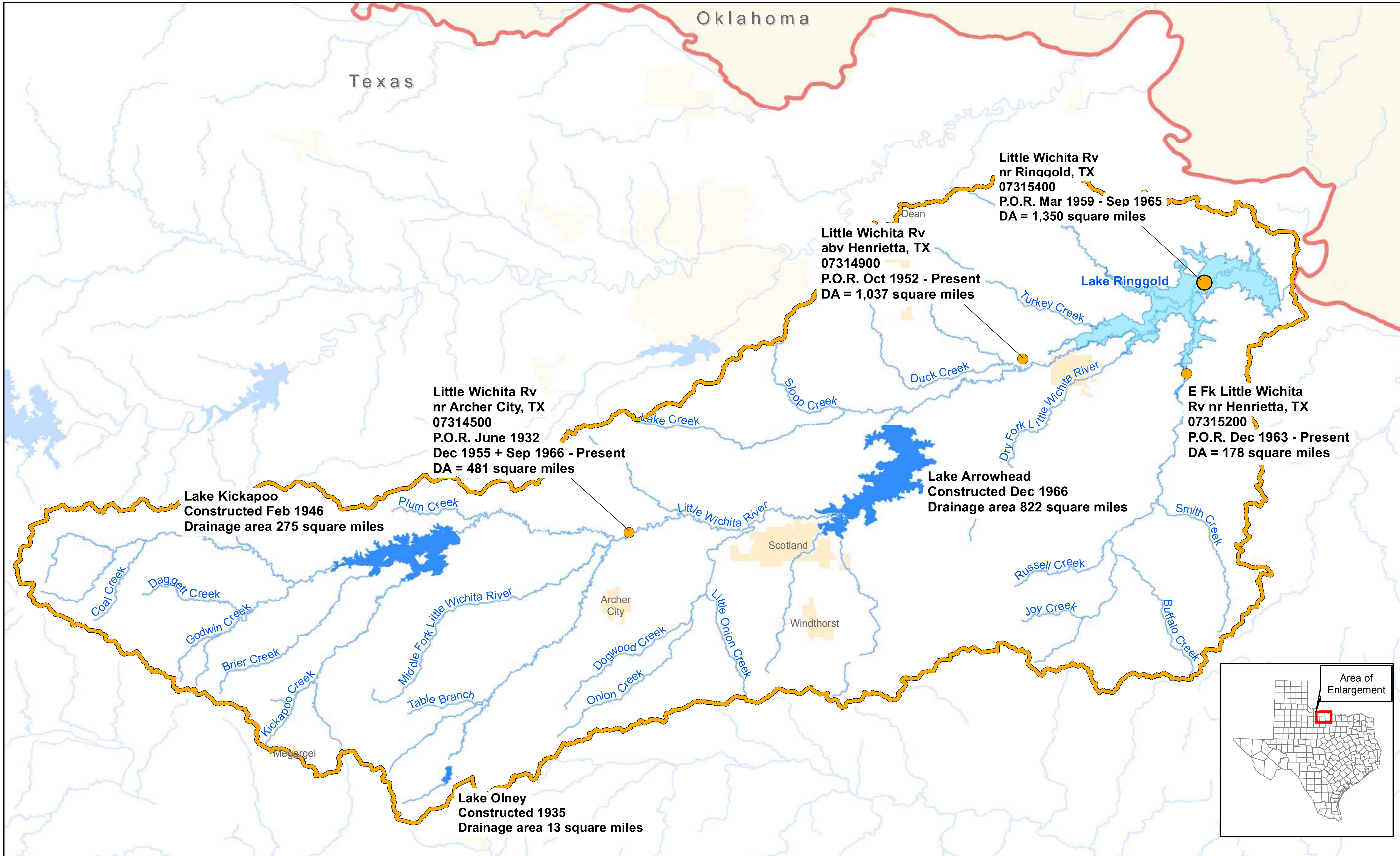
2.2 HYDROLOGY

Hydrologic Data

Table 2-2 shows the name, number, period of record and drainage area for the four USGS gages. Figure 2-1 is a map showing the location of the reservoirs and gages. Figure 2-2 compares the period of record for the stream gages to the reservoirs.

Table 2-2
Historical USGS Stream Gage Records

Gage Name	Gage Number	Period of Record	Drainage Area (sq. mi.)
Little Wichita River near Archer City, TX	07314500	Jun 1932 to Dec 1955 Sep 1968-Present	481
Little Wichita River above Henrietta, TX	07314900	Oct 1952 – Present	1,037
Little Wichita River near Ringgold, TX	07315400	Mar 1959 – Sep 1965	1,350
E Fork Little Wichita River near Henrietta, Tx	07315200	Dec 1963 – Present	178



FN PROJECT NO. WCH12407
DATE CREATED 8/22/2013
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central
FILE NAME Fig3-2_Reservoirs and Stream Gages
PREPARED BY ERN

CITY OF WICHITA FALLS
Proposed Lake Ringgold
Reservoirs and Stream Gages

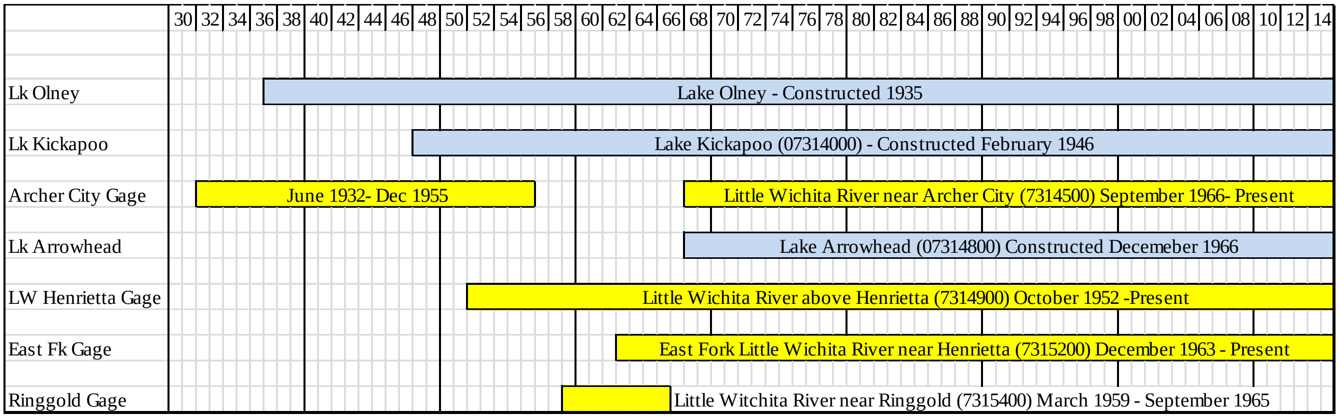
FREESE AND NICHOLS
4500 International Plaza Suite 200
Fort Worth, Texas 76109-4895
(817) 735-7300

USGS Streamflow Stations
Red River
Rivers and Streams
Watershed
Proposed Lake Ringgold
Urban Areas

0 32,000 64,000
Feet

2-1

Figure 2-2
Comparison of Period-of-Record for Stream Gages and Reservoirs in the Little Wichita Watershed

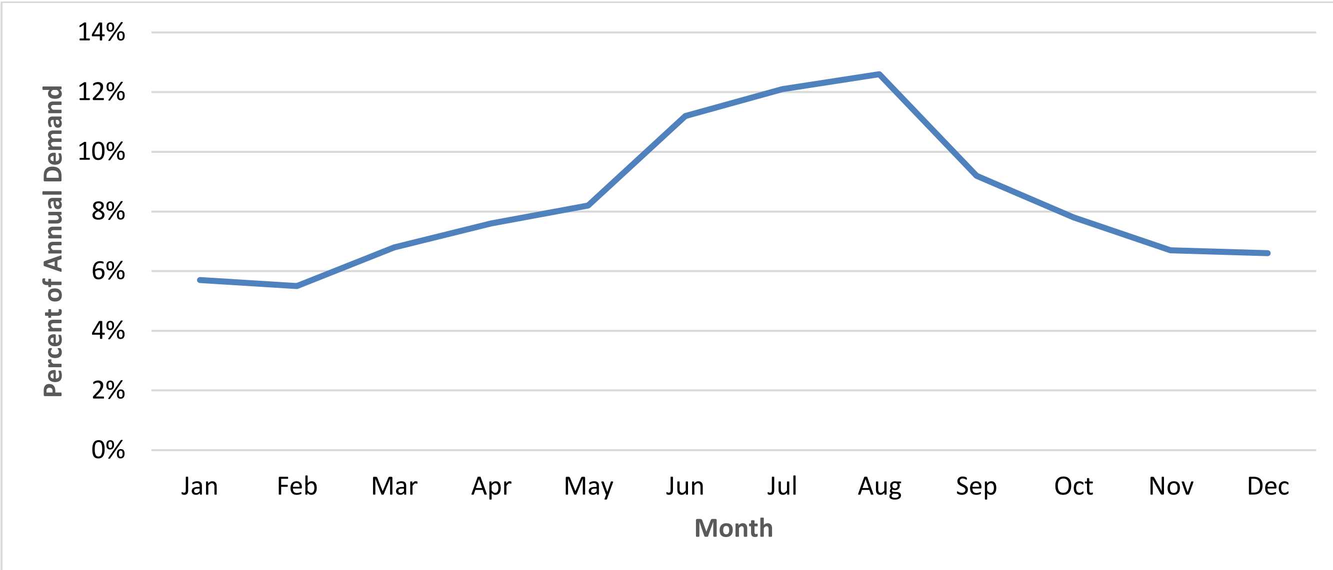


Inflows over the hydrologic period from 1940 to June 2015 were developed for Lakes Kickapoo and Arrowhead using flow data from the Archer City gage, the Henrietta gage, TWDB quadrangle data for evaporation and precipitation, and historical lake operating records. Inflows to Lake Kemp were developed in a similar manner over the hydrologic period from 1940 to June 2015 using flow data from the Mabelle gage, TWDB quadrangle data for evaporation and precipitation, and historical lake operating records.

2.3 DEMAND PATTERN

It was assumed for the purposes of the modeling that Wichita Falls followed a monthly demand pattern based on an analysis of typical historical water use by the city. The demand pattern reflects typical water use without implementation of drought strategies such as lawn watering restrictions that would lower demands in the summer months. Figure 2-3 shows the demand pattern for Wichita Falls used in the modeling.

Figure 2-3: Wichita Falls Normal Demand Pattern by Month



2.4 RESERVOIR OPERATIONS

Lakes Kickapoo and Arrowhead were modeled such that spills from Lake Kickapoo are captured in Lake Arrowhead if Lake Arrowhead is not spilling. The yield of Lake Kemp and Lake Diversion was evaluated as a system with releases made to Lake Diversion and target minimum elevations in Lake Diversion of 1,050.0 feet msl in March and 1,046.0 feet msl the remainder of the year. The elevation of 1,050.0 feet msl is to allow the Dundee Fish Hatchery to divert water during the spring spawning season. The 1,046.0 feet target is based on the intake constraints for American Electric Power (AEP).

3.0 AVAILABLE SUPPLY

During the most recent drought the minimum combined storage of Lakes Arrowhead and Kickapoo hovered near 20% for most of 2014 into early 2015. This level caused Wichita Falls to implement significant drought management strategies to reduce demand and the implementation of an emergency direct potable reuse project. An available supply analysis was conducted that reserves 20% of the storage in Lakes Kickapoo, Arrowhead, and Kemp at the end of the critical period (i.e., 20% minimum yield). This calculation is more conservative than a two-year safe yield calculation and reflects the reality Wichita Falls faced during the drought from 2010-2015. The available supply analysis provides a greater margin of safety compared to firm or safe yield analyses given climate uncertainty and demand uncertainty. The Kemp Municipal (treated supply) accounts for the supply available to the City from Kemp based on the municipal portion of the water right and treatment losses. The available supply from each reservoir is presented in Table 3-1 for current sediment conditions (year 2020) through 2070 sediment conditions. The reduction in available supply over time is due to reduced storage capacity associated with sediment accumulation in the lakes. For Lake Kemp, the amount of supply that would be available to Wichita Falls is also shown.

Table 3-1: Currently Available Supply for Wichita Falls from Lakes Arrowhead, Kemp and Kickapoo[a]
-Values in Acre-Feet/Year-

	Lowest Storage (ac-ft)	2020	2030	2040	2050	2060	2070
Kickapoo	17,435	5,600	5,220	4,840	4,460	4,080	3,700
Arrowhead	46,266	12,200	11,400	10,600	9,800	9,000	8,200
Wichita System Subtotal	--	*17,800*	*16,620*	*15,440*	*14,260*	*13,080*	*11,900*
Kemp Total	44,607	29,000	26,100	23,200	20,300	17,400	14,500
Kemp Municipal (treated supply)[b]	--	*2,948*	*2,652*	*2,357*	*2,063*	*1,768*	*1,474*
Total Current Supply Available to Wichita Falls	--	*20,748*	*19,272*	*17,797*	*16,323*	*14,848*	*13,374*

a All supplies assume a 20% minimum storage in the reservoir.
b Portion of Lake Kemp supplies available to the city taking into account other demands on the reservoir and losses during treatment.

The storage traces for Lakes Kickapoo, Arrowhead, and Kemp from the analyses are shown in Figure 3-1 through Figure 3-3. In all cases the minimum storage occurs in late 2014 or early 2015 with the lakes filling or nearly filling by June 2015.

4.0 CONCLUSION

The available supply analyses for Wichita Falls are based on hydrology through June 2015 and the policy of maintaining a minimum of 20% storage in the City's reservoirs. Under these assumptions, the analyses show that the water supplies currently available to the City of Wichita Falls total 20,748 ac-ft/year in 2020, and decrease to 13,374 ac-ft/year by 2070. The policy of reserving a minimum of 20% storage in the City's reservoirs creates a buffer that would be needed if a drought worse than the most recent drought were to occur, if evaporation were to increase due to climate change or demand increases more than anticipated.

Figure 3-1: Kickapoo Available Supply Analysis for 2020 Conditions through June 2015

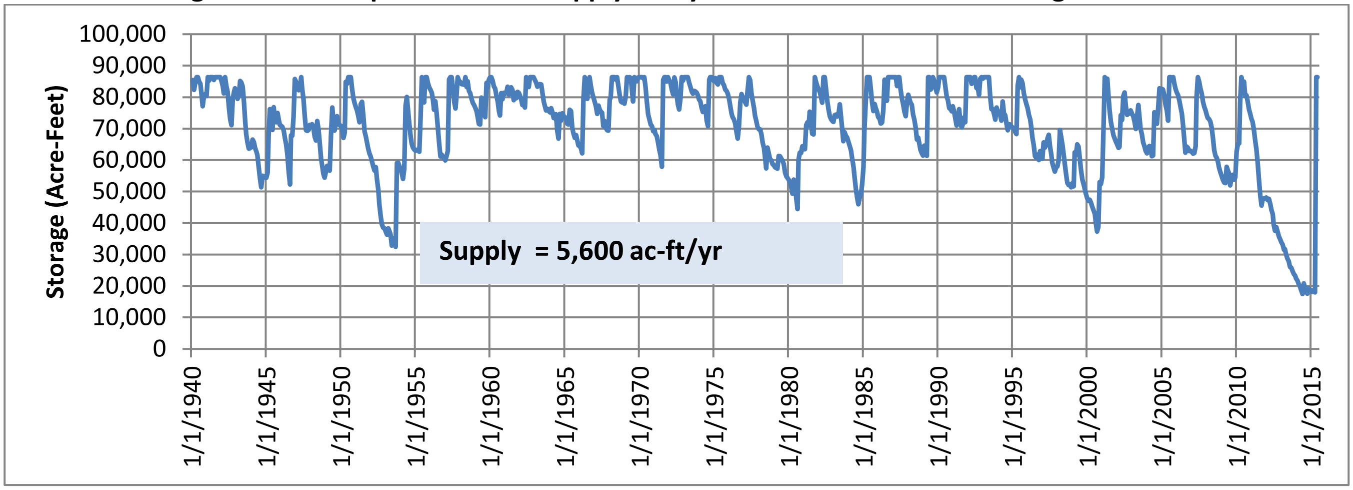


Figure 3-2: Arrowhead Available Supply Analysis for 2020 Conditions through June 2015

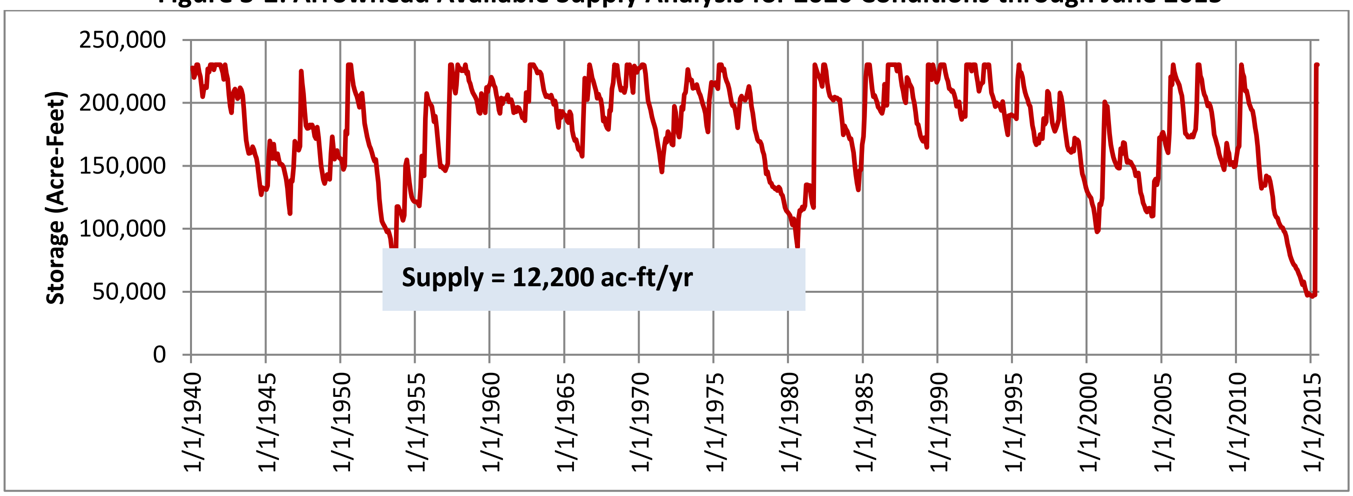
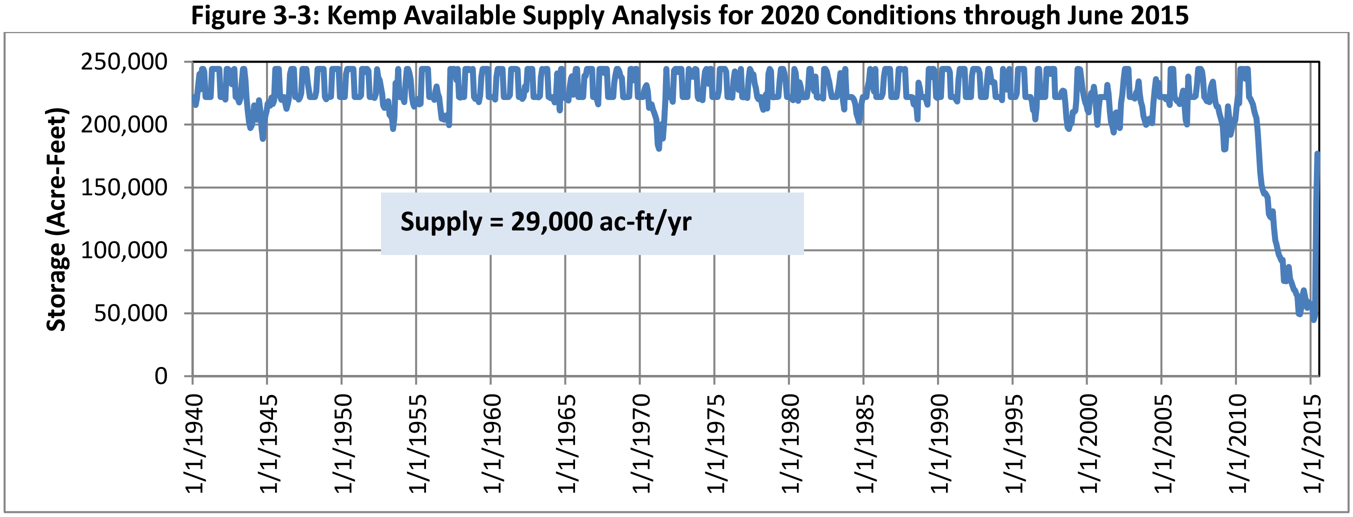


Figure 3-3: Kemp Available Supply Analysis for 2020 Conditions through June 2015



APPENDIX D

GEOTECHNICAL REPORT

TECHNICAL MEMORANDUM

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TO: Russell Schreiber, City of Wichita Falls

FROM Tony Bosecker, P.E.

SUBJECT: Addendum to the Lake Ringgold Geotechnical Investigation

PROJECT: WCH12407/WCH15215 – Lake Ringgold Study

DATE: April 11, 2017

STATE OF TEXAS
TONY BOSECKER
80158
REGISTERED
PROFESSIONAL ENGINEER

04/11/2017

FREESE AND NICHOLS, INC.
TEXAS ENGINEERING FIRM
F-2144

PURPOSE OF ADDENDUM

The purpose of this addendum to the geotechnical investigation memorandum, dated June 13, 2013, is to update the slope stability analysis to reflect updated PMP (Probable Maximum Precipitation) depths for the State of Texas and surrounding areas. These updated depths are based on a new study released by the TCEQ in January 2017.

Due to this study, the PMP depths at the proposed dam increased thereby increasing the elevation of the proposed top of dam from Elevation 871.5 feet-msl to Elevation 875.0 feet-msl. We performed the slope stability analysis again, based on this change. No other changes were made to the embankment cross section or the upstream berm or the material parameters that were used in the original memorandum.

ANALYSIS AND DISCUSSION

The results of the updated slope stability analysis indicate that the proposed slopes (with the upstream earthen berm) are stable under the conditions analyzed. The updated analysis indicated only slight reductions of the factor of safety in some of the conditions analyzed, however, all conditions modeled met or exceeded the TCEQ's recommended minimum factors of safety for that loading condition.

The slope stability analyses are only valid for the conditions that were analyzed. Any further changes to the embankment design or slope angle will necessitate that the slope stability analyses be revised to reflect actual conditions. Further, the slope stability analyses represent end-of-construction stages or final conditions and may not represent temporary conditions during construction. Results from the slope stability analysis are included in the table below.

Table 5 – Results for Slope Stability Analysis (Revised)

Section	Loading	Chimney Drain	Finger Drain	Factor of Safety									
				Recommended	Calculated								
					With Upstream Berm				Without Upstream Berm				
					U/S	U/S - Dam Raise	D/S	D/S - Dam Raise	U/S	U/S - Dam Raise	D/S	D/S - Dam Raise
A-A	EOC	✓	✓	1.25	1.5	1.4	1.7	1.6	1.4	1.4	1.7	1.6
		✓	-		1.5	1.4	1.6	1.5	1.4	1.4	1.6	1.5
	SSS	✓	✓	1.5	2.7	2.5	2	2	2.6	2.5	2	2
		✓	-		2.4	2.3	1.8	1.8	2.3	2.3	1.8	1.8
	RDD from NWL to Bottom	✓	✓	1.2	1.2	1.2	-	-	1	1	-	-
		✓	-		1.2	1.2	-	-	1	1	-	-
	RDD from Max to NWL	✓	✓	1.2	-	1.8	-	-	-	1.8	-	-
		✓	-		-	1.7	-	-	-	1.7	-	-
B-B	EOC	✓	✓	1.25	1.7	1.6	1.8	1.8	1.6	1.6	1.8	1.8
		✓	-		1.7	1.6	1.8	1.7	1.6	1.6	1.8	1.7
	SSS	✓	✓	1.5	2.5	2.4	2.1	2.1	2.5	2.3	2.1	2.1
		✓	-		2.3	2.2	2	2	2.3	2.2	2	2
	RDD from NWL to Bottom	✓	✓	1.2	1.2	1.2	-	-	1.1	1.1	-	-
		✓	-		1.2	1.2	-	-	1.1	1.1	-	-
	RDD from Max to NWL	✓	✓	1.2	-	1.7	-	-	-	1.7	-	-
		✓	-		-	1.7	-	-	-	1.7	-	-

yellow highlighted rows are the new FS values with the 3.5 foot dam raise

U/S = Upstream
D/S = Downstream

RECOMMENDATIONS FOR PROPOSED EMBANKMENT

The recommendations made in the original memorandum are still valid.

LIMITATIONS

This addendum to the memorandum was prepared specifically for use by Freese and Nichols, Inc., Tarrant Regional Water District and the City of Wichita Falls for this project, and shall not be used for other projects or purposes. This work was performed in a manner consistent with the level of care and skill ordinarily exercised by other members of our profession practicing in the same locality, under similar conditions and at the date the services were provided. Freese and Nichols, Inc. makes no other representation, guarantee or warranty, expressed or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided. The recommendations and opinions contained in this memorandum are based on field observations, subsurface explorations and laboratory tests. It is possible that soil or groundwater conditions could vary between or beyond the points explored. Paragraphs, statements, test results, boring logs, figures, etc., should not be taken out of context, nor utilized without a knowledge and awareness of their intent within the purpose of this memorandum.

--END OF MEMORANDUM—

TECHNICAL MEMORANDUM

FREESE AND NICHOLS

Innovative approaches
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4055 International Plaza, Suite 200 • Fort Worth, Texas 76109 • 817-735-7300 • fax 817-735-7491

TO: Russell Schreiber, City of Wichita Falls

FROM: Tony Bosecker, P.E.

SUBJECT: Lake Ringgold Geotechnical Investigation

PROJECT: WCH12407 – Lake Ringgold Study

DATE: June 13, 2013

STATE OF TEXAS
TONY BOSECKER
80158
REGISTERED
PROFESSIONAL ENGINEER
6.13.13

FREESE AND NICHOLS, INC
TEXAS ENGINEERING FIRM
F-2144

PROJECT DESCRIPTION

Lake Ringgold is a proposed reservoir located northeast of Henrietta in Clay County, Texas. The proposed dam is located at the mouth of the Little Wichita River, southwest of the confluence with the Red River on the Oklahoma – Texas state border. The proposed reservoir site would impound water along the Little Wichita and serve as a source of water for both the City of Wichita Falls and the Tarrant Regional Water District.

This technical memorandum presents the results of the geologic and geotechnical feasibility study performed for the Lake Ringgold Study as part of Freese and Nichols, Inc. (FNI) project number WCH12407, authorized by the contract with the City of Wichita Falls.

PURPOSE AND SCOPE

The purpose of the study is to provide a desktop-level review of the proposed dam site to determine if geologic or geotechnical features exist that may have a significant impact on dam design and/or project costs. To accomplish this purpose, this study was conducted according to the following scope:

- Perform a desktop geologic and geotechnical review of the dam site and previous geotechnical studies;
- Supplement existing data with three exploratory borings drilled along or near the proposed centerline of the dam to obtain samples for field observation, testing, and classification;
- Perform laboratory tests on selected samples to determine soil classification and other pertinent engineering properties of the subsurface strata;
- Perform an analysis of the dam site using existing data in combination with the collected data, including suggested embankment geometry based on preliminary seepage and slope stability analyses; and
- Prepare a summary technical memorandum of the findings and recommendations.

SUBSURFACE INVESTIGATION

A subsurface investigation was conducted on March 18, 19, and 20, 2013, in order to supplement existing data for the proposed dam site. The investigation was performed by drilling three exploratory borings near the dam alignment. Boring RD-1 was located along the northern end of the alignment, RD-2 near the middle, and RD-3 along the southern end. The borings were drilled with a truck-mounted CME 75 drill rig owned and operated by Texplor of Dallas, Inc.

The borings were located in the field using GoogleEarth, a hand-held GPS device, and predetermined coordinates selected by FNI based on the proposed alignment of the dam at the time this feasibility study was conducted. The approximate location of each boring is presented on the Cross Section Map (Plate 1) included in the appendix. These locations were not surveyed by a licensed land surveyor and should be considered accurate only to the extent implied by the technique used in their determination.

The borings were advanced using 6¼-inch hollow-stem augers (HSA) and an NX-size core barrel using dry and wet rotary drilling techniques. Each boring was drilled to a termination depth of 60 feet below the ground surface. The subsurface soils within the borings were sampled intermittently using 3-inch diameter, seamless, steel tube samplers and a 2-inch diameter, split-spoon sampler in conjunction with the Standard Penetration Test (SPT). Some rock and rock-like materials were sampled using the split-spoon sampler and SPT method, but the majority was obtained using the NX-size core barrel. At the completion of drilling, the borings were backfilled with a cement-bentonite grout mixture using a tremie pipe.

Infiltration (Packer) tests were performed in all of the borings after core drilling was completed. The tests were performed by setting a single packer in the boring at varying depths and testing the depth of the borehole below the packer. The borings were filled with water and pressure was applied at the top of the riser (up to six feet above the ground surface) using the drill rig pump and a bypass valve. The volume of water accepted in 5 to 15 minutes was then measured. Infiltration rates for the borings ranged from 0.0006 to 0.54 gallons per minute (gpm).

Logging of the borings was performed by Don James, P.G., of FNI. A log of each boring is included with this memorandum. The logs indicate material types, depths, SPT blow counts, hand penetrometer results, sample recovery, rock quality designation (RQD), and other pertinent information. Soil and rock descriptions presented on the logs are a result of field observations and laboratory test results. Recorded hand penetrometer values of "4.5+" indicate that the capacity of the penetrometer device was exceeded. The RQD refers to the sum of all the rock pieces within a core run greater four inches in length expressed as a percentage of the total sample length (core run). A key to the symbols and terms used on the logs is also included with this memorandum.

LABORATORY TESTING

Laboratory testing was performed on selected soil and rock samples collected during the field investigation. Samples were selected as being generally representative of that stratum and/or boring. The laboratory tests were performed by Gorrondona and Associates, Inc. Testing was performed to allow for material classification in accordance with the Unified Soil Classification System (USCS), ASTM D 2487 and to evaluate pertinent engineering properties of the subsurface materials. Samples were selected for Atterberg limits, percent passing a No. 200 sieve, particle size gradation, moisture content, unit dry weight, crumb dispersion, and unconfined compressive strength testing. The results of these tests are included with this memorandum and also shown on the individual boring logs, as appropriate.

SUBSURFACE CONDITIONS

Generalized Geology

According to the Texas Bureau of Economic Geology's Geologic Atlas of Texas, Sherman Sheet, revised 1991, the project site lies within the Quaternary geologic age alluvium, terrace deposits and sand sheet deposits and the Permian geologic age Nocona Formation. Subsurface materials encountered by the borings were consistent with the mapped formation outcroppings and descriptions.

Based on the borings, the subsurface conditions at the site generally consist of clayey and sandy materials underlain by mudstone. The clays were mostly reddish-brown, encountered within 4.5 feet below ground surface (bgs), and exhibited a consistency ranging from stiff to hard, corresponding to an unconfined compressive strength between 1.0 to over 4.0 tons per square foot (tsf). A 10-foot layer of poorly-graded sand was encountered in Boring RD-1 at 4.5 feet bgs. The sand was loose to medium dense and overlaid mudstone (14.5 to 55.7 feet bgs) and sandstone (55.7 to 60 feet bgs). A 29-foot layer of silty sand was encountered in Boring RD-2 at 4.5 feet bgs. The silty sand was loose to medium dense, with a 4-foot layer of lean clay occurring from 24 to 28 feet bgs. Mudstone was encountered at 33.5 feet bgs and extended to the terminal depth of the boring. A 7.5-foot layer of sandstone was encountered in Boring RD-3 at 2.5 feet bgs. The sandstone was underlain by very dense clayey sand (10 to 16.5 feet bgs) and hard lean clay (16.5 to 22 feet bgs). The clayey sand and lean clay overlaid mudstone with sandstone layers (38.3 to 39.3 feet bgs; 42.7 to 45.2 feet bgs). Refer to the attached boring logs for specific subsurface descriptions and thickness of particular strata. Stratigraphy lines shown on the logs correspond to the approximate boundary between strata and are based on discrete samples collected during drilling. The in situ transition can be, and is often, gradual.

Geophysical Exploration

As part of this evaluation a geophysical survey was conducted for the dam and associated lithology. These services were provided by GEHRIG, Inc., Muenster, Texas. The survey was conducted to provide a more detailed subsurface model across the centerline of the proposed dam. The GEHRIG report is included in the appendix.

One geophysical profile was conducted along the proposed dam centerline in December 2012. The profile included a pair of geophysical techniques (electrical resistivity and induced polarization). The geophysical data generally agreed with soil and lithological units logged from the geotechnical borings.

Groundwater

No aquifers are recognized locally with respect to the dam site. However, quaternary deposits may be water bearing locally. Seepage was encountered in Borings RD-1 and RD-2 during drilling. Seepage was not encountered within the depths drilled in Boring RD-3. The water level observations are summarized in Table 1.

Table 1 – Water Level Observations During Drilling

Boring	Termination Depth, ft	Water Level Observations During Drilling*
RD-1	60	13.75
RD-2	60	18.85
RD-3	60	None

*Observations are listed as feet below ground surface

These observations are only indicative of the conditions at the time and location shown. The occurrence of water can vary due to many factors, including seasonal changes, site topography, surface runoff, permeability and layering of subsurface strata, existing utilities, and other factors not evident at the time of this investigation.

ANALYSIS AND DISCUSSION

Due to the type of construction materials available, a homogeneous embankment of lean clay was assumed for the analysis. Borrow material for the embankment may be obtained from the reservoir area, principal spillway channel and excavation of the emergency spillway. Excavation of the spillway channel will generate large quantities of weathered mudstone that readily breaks down into low plasticity clay (CL) and may be used as embankment material. Liquid limits of the mudstone ranged from 28 to 33 with plasticity indices ranging from 14 to 18. The proposed embankment will be approximately 82 feet at its maximum height with a 20-foot wide crest. The top of the proposed embankment will be at Elevation 871.5 feet-msl and will have a 3.5-horizontal to 1-vertical (3.5H:1V) downstream slope and a 3-horizontal to 1-vertical (3H:1V) upstream slope. A sensitivity analysis was performed to determine the impact of an upstream berm. The length and top elevation of the berm was varied until the minimum factor of safety against rapid drawdown was achieved. The results listed in the remainder of this memorandum reflect an embankment with a 50-foot wide upstream berm with top elevation of 810 feet-msl.

Two cross sections were selected for analysis that represents the assumed critical sections for the embankment based on maximum embankment height and foundation material. Section A-A is located along the Little Wichita River centerline and Section B-B represents the left valley section.

Embankment Seepage

Seepage analyses were performed at two cross sections using the SEEP/W module within Geo Studio 2012 (Version 8.0.10.6504) to develop and analyze a two-dimensional model. Seepage parameters were developed according to FNI Process GEO-103 "Guidelines for Selection of Seepage Parameters for Analysis of Earthen Embankments" based on packer testing, laboratory test results, published empirical relationships and engineering judgment. The selected seepage parameters are provided in Table 2.

Table 2 – Seepage Parameters

Material	Hydraulic Conductivity - K_h		Conductivity Ratio – K_v/K_h
	(cm/sec)	(ft/sec)	
CL, Lean Clay – Embankment	5.0e-07	1.6e-08	0.25
CL, Lean Clay – Foundation	2.0e-06	6.6e-08	0.25
SM, Silty Sand – Foundation	3.0e-04	9.8e-06	0.33
Mudstone – Foundation	1.0e-05	3.3e-07	0.1
Sand Drain	2.0e-02	6.6e-04	1
Slurry Trench	1.0e-08	3.3e-10	1

A compacted fill embankment that consists of lean clays and a 3-foot wide slurry trench will provide the primary barriers to seepage through the embankment and foundation. The slurry trench will extend a minimum of three feet into the mudstone. Based on borings drilled in the area of the slurry trench, the maximum depth of the slurry trench will extend about 37 feet below ground surface, although greater depths may become necessary during construction. A chimney drain and downstream finger drains will collect and dispose of seepage through the dam, reduce the possibility of material piping and prevent excessive uplift pressure at the toe. The embankment seepage analysis was performed based on a normal pool elevation of 844 feet-msl. The results of the seepage analysis are provided in Table 3.

Table 3 – Results from Seepage Analysis

Section	Slurry Trench	Internal Drainage		At Final Toe			100ft Downstream of Final Toe		
		Chimney Drain	Finger Drain	Exit Gradient	Q_s/H	Seepage Severity	Exit Gradient	Q_s/H	Seepage Severity
A-A	✓	✓	✓	0.31	2.0e-08	Negligible	0.17	8.6e-09	Negligible
	✓	✓	-	1.69	7.0e-08	Negligible	0.76	3.4e-08	Negligible
	-	✓	✓	0.78	5.8e-08	Negligible	0.40	2.0e-08	Negligible
	-	✓	-	3.88	1.6e-07	Negligible	1.71	7.7e-08	Negligible
B-B	✓	✓	✓	0.00	1.0e-07	Negligible	0.00	9.0e-08	Negligible
	✓	✓	-	0.00	8.8e-08	Negligible	0.00	8.8e-08	Negligible
	-	✓	✓	0.86	3.5e-07	Negligible	0.35	1.4e-07	Negligible
	-	✓	-	1.87	2.7e-07	Negligible	1.07	2.0e-07	Negligible

The seepage results are estimates based on two-dimensional modeling of a three dimensional process. The seepage results indicate that the seepage occurring through the embankment is not significant with the inclusion of a slurry trench and proper internal drainage. However, the critical exit gradient approaches or exceeds 1.0 if finger drains and a slurry trench are not included. An exit gradient of 0.25 is desirable for new construction. Based on the seepage analysis, a 3-foot wide slurry trench should be constructed and a finger drain should specifically be located near the maximum embankment section in order to reduce the exit gradient to acceptable levels. Additional finger drains are recommended and the number and location should be determined during the final design. If the head and exit gradients are high, seepage can result in erosion of foundation soils and piping. Criteria provided by USACE (TM3-424) establishes a threshold of <$2.2x10^{-5}$ cfs/foot of head/foot of embankment below which seepage is negligible. According to the SEEP/W models, the severity of seepage is negligible in regards to erosion and piping in each analyzed cross section. Output from the embankment seepage analysis is included in the appendix.

Embankment Slope Stability

Slope stability analyses were performed at two cross sections for end-of-construction, steady-state seepage and rapid drawdown conditions. The analyses were performed using the SLOPE/W module within Geo Studio 2012 (Version 8.0.10.6504) to develop and analyze a two-dimensional model. The factor of safety was evaluated using the Spencer method of slices, which provides for moment equilibrium for each slice.

The subsurface geometry of the cross sections, including subsurface strata lines, was developed from data acquired during the current study and historic geotechnical investigations. The foundation material was modeled as lean clay and silty sand, and mudstone “bedrock” was modeled below these soil materials.

Shear strength parameters were developed according to FNI Process GEO-105 “Guidelines for Selection of Shear Strength Parameters for Earthen Embankments” based on laboratory test results, published empirical relationships and engineering judgment. The selected shear strength parameters are provided in Table 4. Additional shear strength testing should be performed during final design in order to confirm or adjust the strength parameters used in this analysis.

Table 4 – Shear Strength Parameters

Material	Unit Weight, pcf	Effective/Drained		Total CU		Total UU	
		ϕ’, deg.	c’, psf	ϕ, deg.	c, psf	ϕ, deg.	c, psf
CL, Lean Clay – Embankment	126	27	150	22	300	0	1500
CL, Lean Clay – Foundation	124	27	150	22	300	0	1500
SM, Silty Sand – Foundation	125	31	0	-	-	-	-
Mudstone – Foundation	139	20	3100	-	-	-	-
Sand Drain	110	36	0	-	-	-	-
Slurry Trench*	-	-	-	-	-	-	-

*The slurry trench was modeled in order to calculated pore water pressures but was not assigned shear strength

The embankment was analyzed for deep-seated, circular failures at each cross section. Table 5 summarizes the results of the slope stability analyses and compares the calculated factor of safety to the recommended minimum factor of safety. The recommended minimum factors of safety were selected from TCEQ’s “Design and Construction Guidelines for Dams in Texas, Chapter 4 – Geotechnical Investigation”. The loading conditions analyzed were the end-of-construction, steady-state seepage and rapid drawdown conditions.

Table 5 – Results from Slope Stability Analysis

Section	Loading	Chimney Drain	Finger Drain	Factor of Safety				
				Recommended	Calculated			
					With Upstream Berm		Without Upstream Berm	
					Upstream	Downstream	Upstream	Downstream
A-A	EOC	✓	✓	1.25	1.5	1.7	1.4	1.7
		✓	-		1.5	1.6	1.4	1.6
	SSS	✓	✓	1.5	2.7	2.0	2.6	2.0
		✓	-		2.4	1.8	2.3	1.8
	RDD	✓	✓	1.2	1.2	-	1.0	-
		✓	-		1.2	-	1.0	-
B-B	EOC	✓	✓	1.25	1.7	1.8	1.6	1.8
		✓	-		1.7	1.8	1.6	1.8
	SSS	✓	✓	1.5	2.5	2.1	2.5	2.1
		✓	-		2.3	2.0	2.3	2.0
	RDD	✓	✓	1.2	1.2	-	1.1	-
		✓	-		1.2	-	1.1	-

The results of the slope stability analysis indicate that the proposed slopes (with the upstream earthen berm) are stable under the conditions analyzed. The slope stability analyses are only valid for the conditions that were analyzed. Any changes to the embankment design or slope angle will necessitate that the slope stability analyses be revised to reflect actual conditions. Further, the slope stability analyses represent end-of-construction stages or final conditions and may not represent temporary conditions during construction. Output from the slope stability analysis is included in the appendix.

Recommendations for Proposed Embankment

The following recommendations are based on preliminary seepage and slope stability analyses. Additional lab testing and stability analyses should be performed during final design and may result in modifications to the proposed embankment configuration.

- Based on borings drilled at the proposed reservoir site, a homogenous embankment of lean clay should be constructed. A large quantity of borrow material for the embankment may be obtained from the excavation of the principal spillway channel.
- The upstream slope should be constructed at 3H:1V or flatter.
- The downstream slope should be constructed at 3.5H:1V or flatter to allow for proper maintenance.
- A 50-foot wide earthen berm should be constructed on the upstream slope at elevation 810 feet-msl.
- A 3-foot wide slurry trench should be keyed into the mudstone a minimum of three feet.
- The internal drainage system should consist of a vertical sand chimney drain, sand finger drains and collector pipes and drainage structures. The number and spacing of finger drains should be determined during final design.

LIMITATIONS

This memorandum was prepared specifically for use by Freese and Nichols, Inc., Tarrant Regional Water District and the City of Wichita Falls for this project, and shall not be used for other projects or purposes. This work was performed in a manner consistent with the level of care and skill ordinarily exercised by other members of our profession practicing in the same locality, under similar conditions and at the date the services were provided. Freese and Nichols, Inc. makes no other representation, guarantee or warranty, expressed or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided. The recommendations and opinions contained in this memorandum are based on field observations, subsurface explorations and laboratory tests. It is possible that soil or groundwater conditions could vary between or beyond the points explored. Paragraphs, statements, test results, boring logs, figures, etc., should not be taken out of context, nor utilized without a knowledge and awareness of their intent within the purpose of this memorandum.

--END OF MEMORANDUM—

APPENDIX

LOG OF BORING NO. RD-1

FREESE AND NICHOLS

Project Description: Lake Ringgold Study
Project Location: Clay County, Texas
Date Drilling Started: 3/19/2013
Logged By: DDJ
Rig Type: CME 75
Northing/Latitude: 33.90155

Drilling Co.: Texplor of Dallas, Inc.
Hammer Type: Automatic
Easting/Longitude: -97.998064

Project No.: WCH12407
Phase No.: ****
Date Drilling Completed: 3/19/2013
Drill Method: HSA
Hammer Wt. & Drop: 140 lb.; 30 in.
Elevation: 834.0 ft.

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5+ (P)	80		SANDY LEAN CLAY (CL), red-brown to yellow, red-brown, hard, dry									
	U-2		4.5+ (P)	100											
	U-3		4.5+ (P)	70			7	104	54	30	17	13			
	U-4		4.5+ (P)	50											
5	SPT-5	9-11-11 (22)				4.5/829.5 POORLY-GRADED SAND (SP), with gravel, yellow-red-brown and red-brown, medium dense, silty, dry, with root filament holes, frosted, subangular and subrounded, with clay (Surficial Deposits)									829
	SPT-6	4-5-5 (10)							4						
	SPT-7	4-4-5 (9)				8/826.0 POORLY-GRADED SAND (SP), light yellow-brown and variegated, loose to medium dense, dry to wet, fine- to coarse-grained, subrounded and subangular (Surficial Deposits)			4						
10															824
	SPT-8	3-3-16 (19)				▽									
15						14.5/819.5 MUDSTONE, dark red-brown, gray, yellow-brown and variegated, very soft (rock hardness), weathered, clayey, jointed, with bentonic infills (Nocona Formation)									819
	SPT-9	14-20-42 (62)							81	28	14	14			
20															814
25															809
						-with joints at 25.5, 26, 27.6 feet									
	C-10			94	90		14	120					3.1	1.6	
						-with moderate angle slickensides at 28.8 feet									
30															804
	C-11			94	90				98	33	15	18			

Water Observations:
13.75 ft At Time Of Drilling

Remarks: 0-25 feet - 6 1/4-inch HSA. 25 to 60 feet - NX Core Barrel. Backfilled with cement-bentonite grout upon completeion of drilling and sampling. Boring elevation estimated from Google Earth.

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

LOG OF BORING NO. RD-1

FREESE AND NICHOLS

Project Description: Lake Ringgold Study
Project Location: Clay County, Texas
Date Drilling Started: 3/19/2013
Logged By: DDJ
Rig Type: CME 75
Northing/Latitude: 33.90155

Drilling Co.: Texplor of Dallas, Inc.
Hammer Type: Automatic
Easting/Longitude: -97.998064

Project No.: WCH12407
Phase No.: ****
Date Drilling Completed: 3/19/2013
Drill Method: HSA
Hammer Wt. & Drop: 140 lb.; 30 in.
Elevation: 834.0 ft.

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	C-12			90	52		MUDSTONE, dark red-brown, gray, yellow-brown and variegated, very soft (rock hardness), weathered, clayey, jointed, with bentonic infills (Nocona Formation) *(continued)* -with moderate angle slickensides at 35.8, 38.8, and 39.1 feet									
40							-with low angle jointing and slickensides from 40 to 43 feet									794
	C-13			100	34		-with moderate angle slickensides at 43.7 and 44.2 feet									
45																789
	C-14			100	94		-with moderate angle slickensides at 48.3 and 49 feet									
50							-slightly weathered below 49 feet -with 2 en echelon slickensides at 50.4 feet									784
	C-15			98	96											
55																779
	C-16			100	90		55.7/778.3 SANDSTONE, light blue-gray with red-brown, hard, unweathered, moderately cemented, with large scale crossbedding -intercaled with hard mudstone from 55.9 to 57.5 feet									
60							Total boring depth 60.0 ft.									774
65																769

Water Observations:
13.75 ft At Time Of Drilling

Remarks: 0-25 feet - 6 1/4-inch HSA. 25 to 60 feet - NX Core Barrel. Backfilled with cement-bentonite grout upon completeion of drilling and sampling. Boring elevation estimated from Google Earth.

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

LOG OF BORING NO. RD-2

Project Description: Lake Ringgold Study
Project Location: Clay County, Texas
Date Drilling Started: 3/19/2013
Logged By: DDJ
Rig Type: CME 75
Northing/Latitude: 33.896228

Drilling Co.: Texplor of Dallas, Inc.
Hammer Type: Automatic
Easting/Longitude: -97.992923

Project No.: WCH12407
Phase No.: ****
Date Drilling Completed: 3/19/2013
Drill Method: HSA
Hammer Wt. & Drop: 140 lb.; 30 in.
Elevation: 804.0 ft.

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENETROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1		4.5+ (P)	100			SILTY CLAY (CL), red-brown, hard, dry									
	U-2		4.5+ (P)	90			1.5/802.5 LEAN CLAY (CL), with sand, red-brown, hard, dry, silty									
	U-3		4.5+ (P)	80				10		78	36	14	22			
	U-4		3.0 (P)	60			3.5/800.5 SANDY LEAN CLAY (CL), red-brown to yellow-red-brown, hard, dry, silty									
	U-5			60			4.5/799.5 SILTY SAND (SM), yellow-red-brown, yellow, brown-gray, loose to medium dense, dry to wet, fine-grained (Alluvium)	9		62	23	13	10			
5	SPT-6	6-6-5 (11)														799
	SPT-7	3-4-5 (9)														
10	SPT-8	3-3-5 (8)								17						794
	SPT-9	5-11-12 (23)														
15																789
	SPT-10	1-2-2 (4)					-very loose, with gray organic matter below 18.5 feet									
20																784
	SPT-11	1-1-2 (3)					24/780.0 LEAN CLAY (CL), dark red-brown, soft, wet, intercalated with loose silty sand seams (Alluvium)			92	46	18	28			
25																779
	SPT-12	50					28/776.0 SILTY SAND (SM), light blue-gray, very dense, dry, crossbedded, with weathered, weakly cemented sandstone partings(Nocona Formation)									
30																774
	SPT-13	19-30-44 (74)					33.5/770.5									

Water Observations:
18.85 ft At Time Of Drilling

Remarks: 0-35 feet - 6 1/4-inch HSA. 35 to 60 feet - NX Core Barrel. Backfilled with cement-bentonite grout upon completeion of drilling and sampling. Boring Elevation estimated from Google Earth.

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

FREESE AND NICHOLS

LOG OF BORING NO. RD-2

Project Description: Lake Ringgold Study
Project Location: Clay County, Texas
Date Drilling Started: 3/19/2013
Logged By: DDJ
Rig Type: CME 75
Northing/Latitude: 33.896228

Drilling Co.: Texplor of Dallas, Inc.
Hammer Type: Automatic
Easting/Longitude: -97.992923

Project No.: WCH12407
Phase No.: ****
Date Drilling Completed: 3/19/2013
Drill Method: HSA
Hammer Wt. & Drop: 140 lb.; 30 in.
Elevation: 804.0 ft.

DEPTH, ft	SAMPLE: TYPE	SAMPLE: BLOW COUNTS	SAMPLE: HAND PENE-TROMETER (P) / TORVANE (T), tsf	SAMPLE: RECOVERY, %	SAMPLE: RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	C-14			84	72		MUDSTONE, red-brown, gray, yellow-brown and variegated, very soft (rock hardness), slightly weathered, jointed, montmorillinitic (Nocona Formation) *(continued)* -with moderate angle joint at 36.5 and 39 feet	14	121					6	5.3	
40																764
	C-15			98	98											
45							-with a joint at 45.2 feet									759
	C-16			100	82		-jointed from 47 to 47.6 feet -with a joint at 49.2 feet									
50																754
	C-17			100	100		-with moderate angle slickensides at 51.4 feet									
55																749
	C-18			100	90		-with low to moderate angle jointing and slickensides at 56.3, 57.4 and 58.8 feet									
60							Total boring depth 60.0 ft.									744
65																739

Water Observations:
18.85 ft At Time Of Drilling

Remarks: 0-35 feet - 6 1/4-inch HSA. 35 to 60 feet - NX Core Barrel. Backfilled with cement-bentonite grout upon completeion of drilling and sampling. Boring Elevation estimated from Google Earth.

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

FREESE AND NICHOLS

LOG OF BORING NO. RD-3

Project Description: Lake Ringgold Study
Project Location: Clay County, Texas
Date Drilling Started: 3/19/2013
Logged By: DDJ
Rig Type: CME 75
Northing/Latitude: 33.889345
Drilling Co.: Texplor of Dallas, Inc.
Hammer Type: Automatic
Easting/Longitude: -97.98627
Project No.: WCH12407
Phase No.: ****
Date Drilling Completed: 3/19/2013
Drill Method: HSA
Hammer Wt. & Drop: 140 lb.; 30 in.
Elevation: 861.0 ft.

DEPTH, ft	SAMPLE: TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	U-1			70		SANDY LEAN CLAY (CL), red-brown to yellow-brown, stiff, moist									
	U-2			100			8		57	26	15	11			
	U-3			100											
	TCP-4	50/3" 50/2"				SANDSTONE, light yellow-brown to yellow-brown, soft, weakly to moderately cemented, fine-grained, silty, crossbedded, fissile (Nocona Formation) 2.5/858.5									
	SPT-5	12-50/4.00"													
5															856
	SPT-6	30-50/3.00"				-hard below 6 feet									
	TCP-7	50/1.5" 50/0.50"				-yellow-brown, weakly cemented below 8 feet									
10	SPT-8	24-50/2.00"				CLAYEY SAND (SC), yellow-brown, brown and red-brown, very dense, dry, fine- to medium grained 10/851.0			38						851
						moist, silty below 13 feet									
	SPT-9	14-27-24 (51)							49						
15															846
						LEAN CLAY (CL), silty, brown-gray, gray, red-brown and variegated, hard, moist to dry, silty (Nocona Formation) 16.5/844.5									
	U-10		4.5+ (P)				17	117	92	49	17	32			
20															841
						MUDSTONE, dark brown-gray, yellow-brown, red-brown and variegated, very soft (rock hardness), weathered, jointed (Nocona Formation) 22/839.0									
	SPT-11	15-25-35 (60)													
25															836
						-slickensided at 25.9, 27.5 and 27.7 feet	14								
	C-12			96	84										
							13	127					6.5	1.4	
30															831
						-with moderate angle slickensides at 31.4									
	C-13			100	94										

Water Observations:
None At Time Of Drilling

Remarks: 0-25 feet - 6 1/4-inch HSA. 25 to 60 feet - NX Core Barrel. Backfilled with cement-bentonite grout upon completeion of drilling and sampling. Boring elevation estimated from Google Earth.

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

LOG OF BORING NO. RD-3

Project Description: Lake Ringgold Study
Project Location: Clay County, Texas
Date Drilling Started: 3/19/2013
Logged By: DDJ
Rig Type: CME 75
Northing/Latitude: 33.889345

Drilling Co.: Texplor of Dallas, Inc.
Hammer Type: Automatic
Easting/Longitude: -97.98627

Project No.: WCH12407
Phase No.: ****
Date Drilling Completed: 3/19/2013
Drill Method: HSA
Hammer Wt. & Drop: 140 lb.; 30 in.
Elevation: 861.0 ft.

DEPTH, ft	SAMPLE TYPE	BLOW COUNTS	HAND PENETROMETER (P) / TORVANE (T), tsf	RECOVERY, %	RQD, %	SYMBOL	MATERIAL DESCRIPTION	WATER CONTENT, %	UNIT DRY WEIGHT, pcf	% PASSING NO. 200 SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNC. COMPRESSIVE STRENGTH, tsf	STRAIN AT FAILURE, %	ELEVATION, ft
	C-14			100	94		MUDSTONE, dark brown-gray, yellow-brown, red-brown and variegated, very soft (rock hardness), weathered, jointed (Nocona Formation) *(continued)*									
							-with light gray, indicated silty sandstone seams below 36 feet (38.3/822.7)									
40							SANDSTONE, light gray, hard, moderately cemented, silty (39.3/821.7)									821
	C-15			100	88		MUDSTONE, red-brown, very soft (rock hardness)									
							SANDSTONE, light gray, hard, moderately cemented (42.7/818.3)									
45																816
	C-16			100	94		MUDSTONE, red-brow and light gray, very soft (rock hardness) (Nocona Formation) (45.2/815.8)									
50							-with low angle slickensides at 49.8 feet									811
	C-17			100	100											
55																806
	C-18			100	78		-gray below 57 feet -with moderate angle slickensides at 57.2 and 58.9 feet									
60							Total boring depth 60.0 ft.									801
65																796

Water Observations:
None At Time Of Drilling

Remarks: 0-25 feet - 6 1/4-inch HSA. 25 to 60 feet - NX Core Barrel. Backfilled with cement-bentonite grout upon completeion of drilling and sampling. Boring elevation estimated from Google Earth.

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

BORING LOG LEGEND AND NOMENCLATURE

Abbreviations		
U – Undisturbed Sample (tube)	SPT – Standard Penetration Test	TV – Torvane
A – Auger Sample	TCP – Texas Cone Penetration	NP – Non Plastic
CS – Continuous Sample	CFA – Continuous Flight Auger	ATD – At Time of Drilling
C – Rock Core	HSA – Hollow Stem Auger	AD – After Drilling

General Terms

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

Consistency of Cohesive Soil

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

Apparent Density of Cohesionless Soil

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

Soil Structure

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

Moisture Condition

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

Textural Adjectives

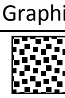
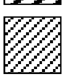
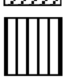
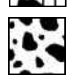
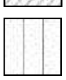
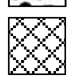
Textural Item	Description
Pit	Pinhole sized openings
Vug	Small openings up to 4 inches in size
Cavity	Opening larger than 4 inches
Honeycomb	Numerous and grouped pits and vugs
Vesicle	Small openings in volcanic rocks

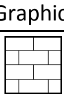
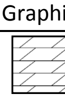
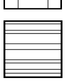
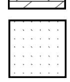
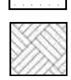
BORING LOG LEGEND AND NOMENCLATURE

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

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

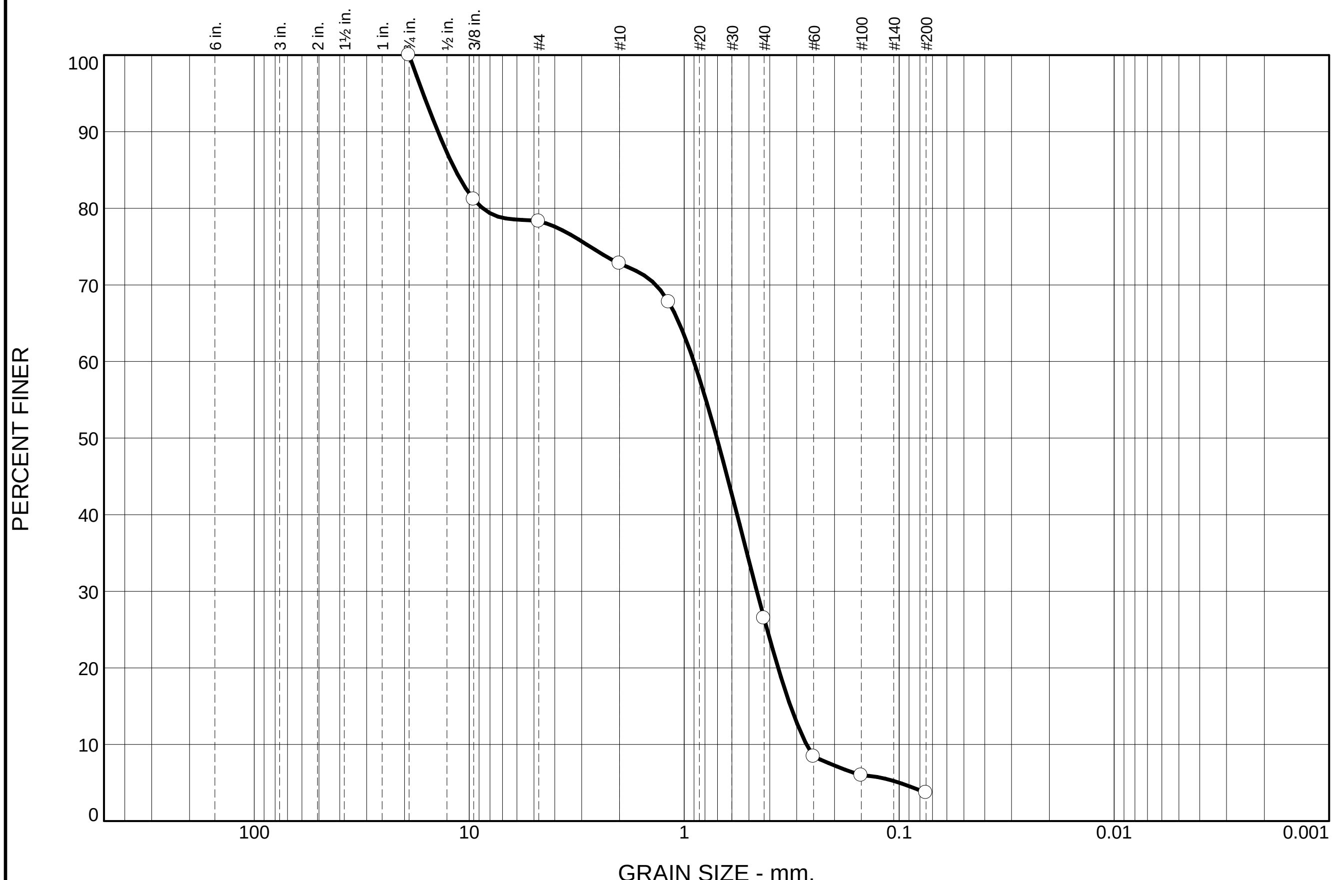
Rock Bedding Structure	
Description	Criteria
Laminated	< 3/8 inch
Very Thinly Bedded	3/8—1 inch
Thinly Bedded	1 inch—4 inches
Moderately Bedded	4 inches—1 foot
Thickly Bedded	1 foot—3 feet
Very Thickly Bedded	3– 10 feet
Massive	> 10 feet

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

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

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

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	21.7	5.5	46.3	22.8	3.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			11.6052	0.9017	0.7046	0.4590	0.3201	0.2699	0.87	3.34

	Material Description	USCS	AASHTO
○		SP	

Project No. WCH12407 **Client:** Freese & Nichols, Inc.
Project: Lake Ringgold

○ **Depth:** 6-7.5 ft. **Sample Number:** RD-1

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

Tested By: Scott Ellis **Checked By:** Lee Gurecky

GRAIN SIZE DISTRIBUTION TEST DATA

4/3/2013

Client: Freese & Nichols, Inc.
Project: Lake Ringgold
Project Number: WCH12407
Depth: 6-7.5 ft.
Sample Number: RD-1
USCS Classification: SP
Tested by: Scott Ellis
Checked by: Lee Gurecky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
142.27	0.00	0.00	3/4	0.00	100.0
			3/8	26.80	81.2
			#4	30.90	78.3
			#10	38.70	72.8
			#16	45.90	67.7
			#40	104.60	26.5
			#60	130.30	8.4
			#100	133.80	6.0
			#200	137.00	3.7

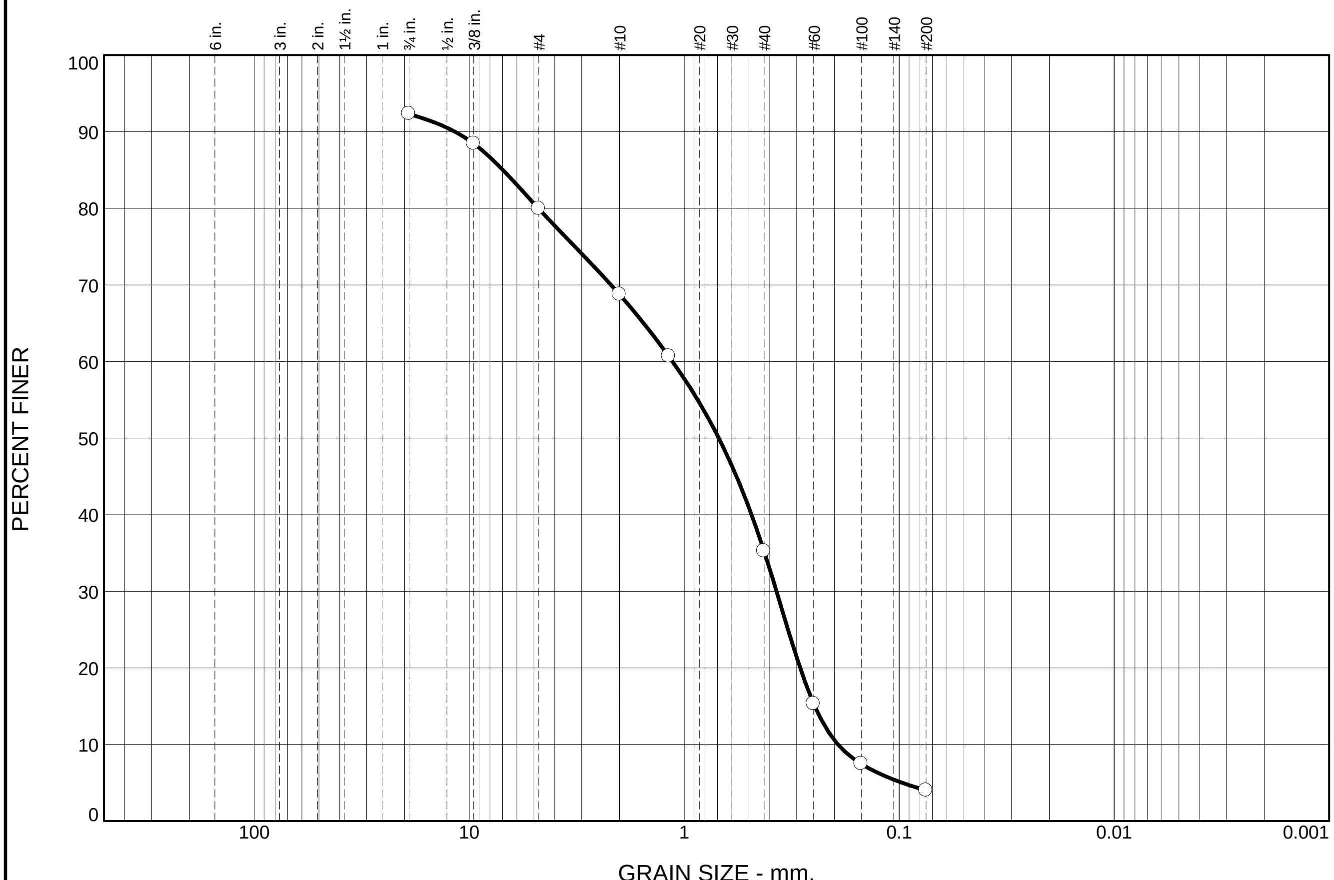
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	21.7	21.7	5.5	46.3	22.8	74.6			3.7

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.2699	0.3201	0.3656	0.4590	0.7046	0.9017	8.6501	11.6052	13.9684	16.3865

Fineness Modulus	C_u	C_c
3.37	3.34	0.87

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○			12.4	11.1	33.6	31.2	4.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			6.9674	1.1339	0.6902	0.3721	0.2472	0.1927	0.63	5.88

	Material Description	USCS	AASHTO
○		SP	

Project No. WCH12407 **Client:** Freese & Nichols, Inc.

Project: Lake Ringgold

○ **Depth:** 8-9.5 ft. **Sample Number:** RD-1

Gorrondona & Associates, Inc.

Houston, Texas

Remarks:

Figure

Tested By: Scott Ellis **Checked By:** Lee Gurecky

GRAIN SIZE DISTRIBUTION TEST DATA

4/3/2013

Client: Freese & Nichols, Inc.
Project: Lake Ringgold
Project Number: WCH12407
Depth: 8-9.5 ft. **Sample Number:** RD-1
USCS Classification: SP
Tested by: Scott Ellis **Checked by:** Lee Gurecky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
167.08	0.00	0.00	3/4	12.80	92.3
			3/8	19.30	88.4
			#4	33.50	79.9
			#10	52.20	68.8
			#16	65.70	60.7
			#40	108.20	35.2
			#60	141.50	15.3
			#100	154.60	7.5
			#200	160.40	4.0

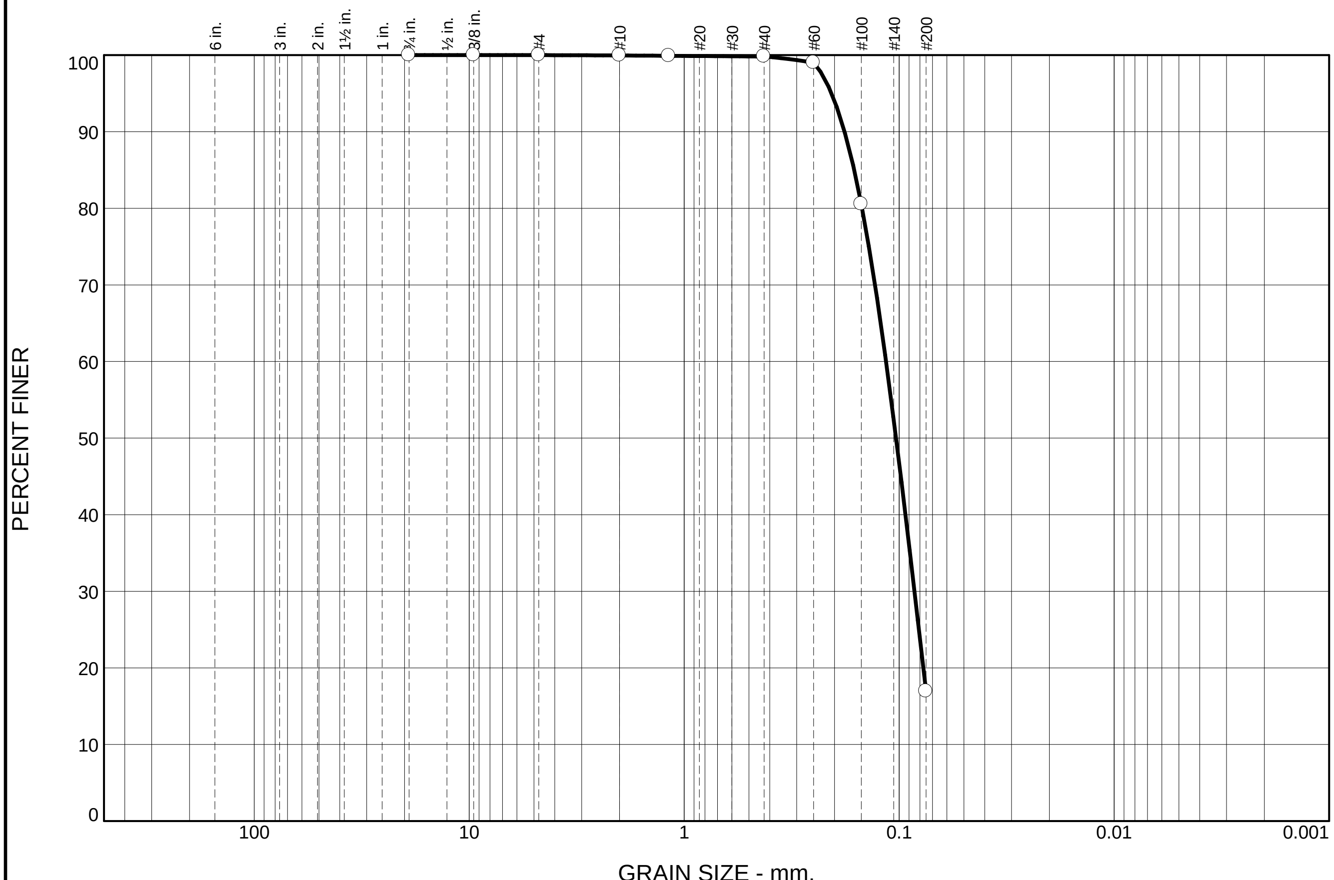
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
		12.4		11.1	33.6	31.2	75.9			4.0

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
0.1927	0.2472	0.2887	0.3721	0.6902	1.1339	4.7681	6.9674	11.6412	

Fineness Modulus	C_u	C_c
3.32	5.88	0.63

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.2	82.9	16.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1618	0.1151	0.1034	0.0849				

	Material Description	USCS	AASHTO
○			

Project No. WCH12407 **Client:** Freese & Nichols, Inc.

Project: Lake Ringgold

○ **Depth:** 9-10.5 ft. **Sample Number:** RD-2

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

Tested By: Scott Ellis **Checked By:** Lee Gurecky

GRAIN SIZE DISTRIBUTION TEST DATA

4/3/2013

Client: Freese & Nichols, Inc.
Project: Lake Ringgold
Project Number: WCH12407
Depth: 9-10.5 ft.
Sample Number: RD-2
Tested by: Scott Ellis
Checked by: Lee Gurecky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
445.61	0.00	0.00	3/4	0.00	100.0
			3/8	0.00	100.0
			#4	0.00	100.0
			#10	0.20	100.0
			#16	0.40	99.9
			#40	0.80	99.8
			#60	4.40	99.0
			#100	86.70	80.5
			#200	370.10	16.9

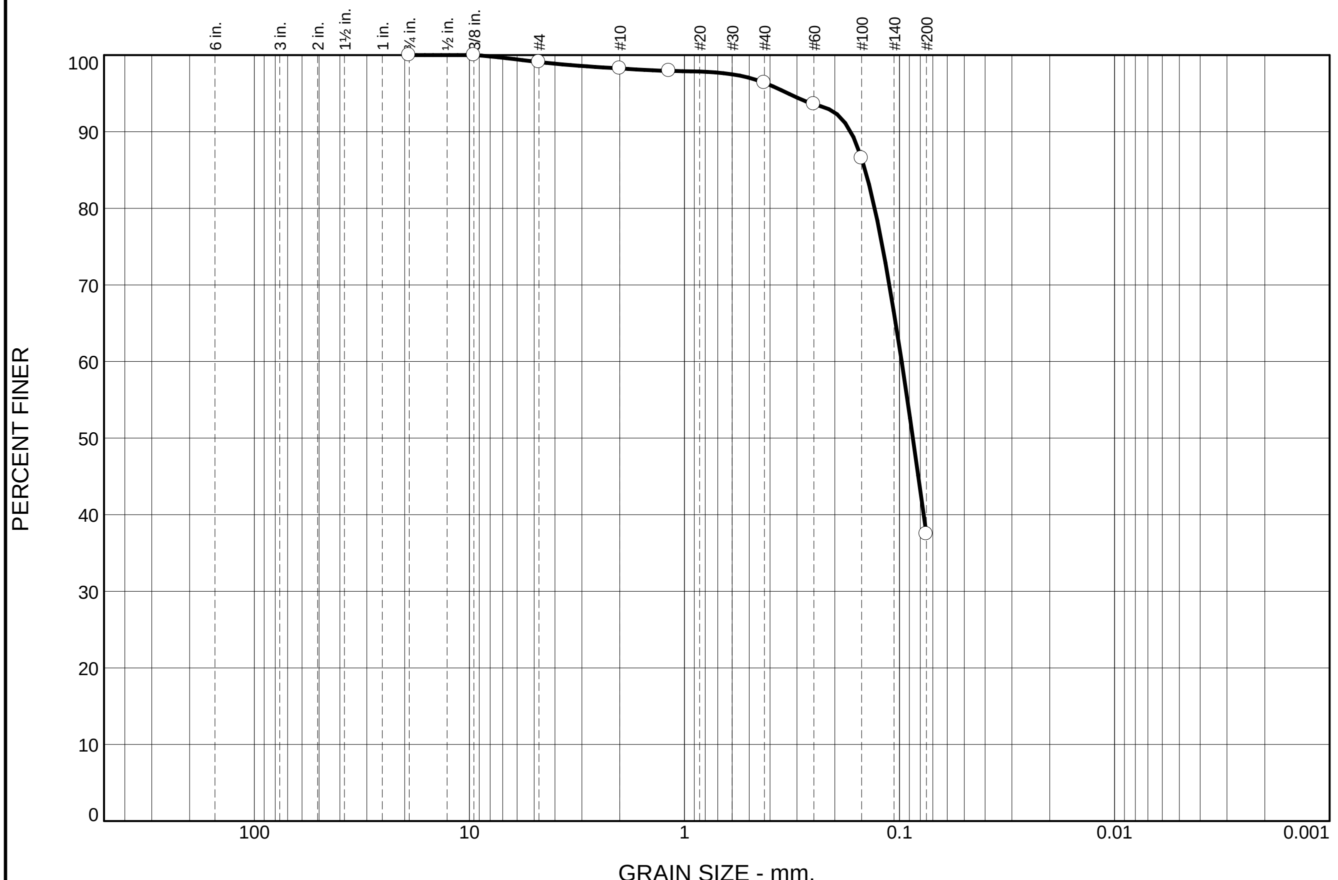
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.0	0.0	0.0	0.2	82.9	83.1			16.9

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
		0.0772	0.0849	0.1034	0.1151	0.1487	0.1618	0.1794	0.2063

Fineness Modulus
0.20

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.9	0.8	1.9	58.9	37.5	

LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
		0.1443	0.0977	0.0866					

Material Description	USCS	AASHTO

Project No. WCH12407 **Client:** Freese & Nichols, Inc.
Project: Lake Ringgold

Depth: 10-12.5 ft. **Sample Number:** RD-3

Remarks:

Gorrondona & Associates, Inc.

Houston, Texas

Figure

Tested By: Scott Ellis **Checked By:** Lee Gurecky

GRAIN SIZE DISTRIBUTION TEST DATA

4/3/2013

Client: Freese & Nichols, Inc.
Project: Lake Ringgold
Project Number: WCH12407
Depth: 10-12.5 ft.
Sample Number: RD-3
Tested by: Scott Ellis
Checked by: Lee Gurecky

Sieve Test Data

Dry Sample and Tare (grams)	Tare (grams)	Cumulative Pan Tare Weight (grams)	Sieve Opening Size	Cumulative Weight Retained (grams)	Percent Finer
252.69	0.00	0.00	3/4	0.00	100.0
			3/8	0.00	100.0
			#4	2.30	99.1
			#10	4.40	98.3
			#16	5.20	97.9
			#40	9.10	96.4
			#60	16.20	93.6
			#100	34.00	86.5
			#200	158.00	37.5

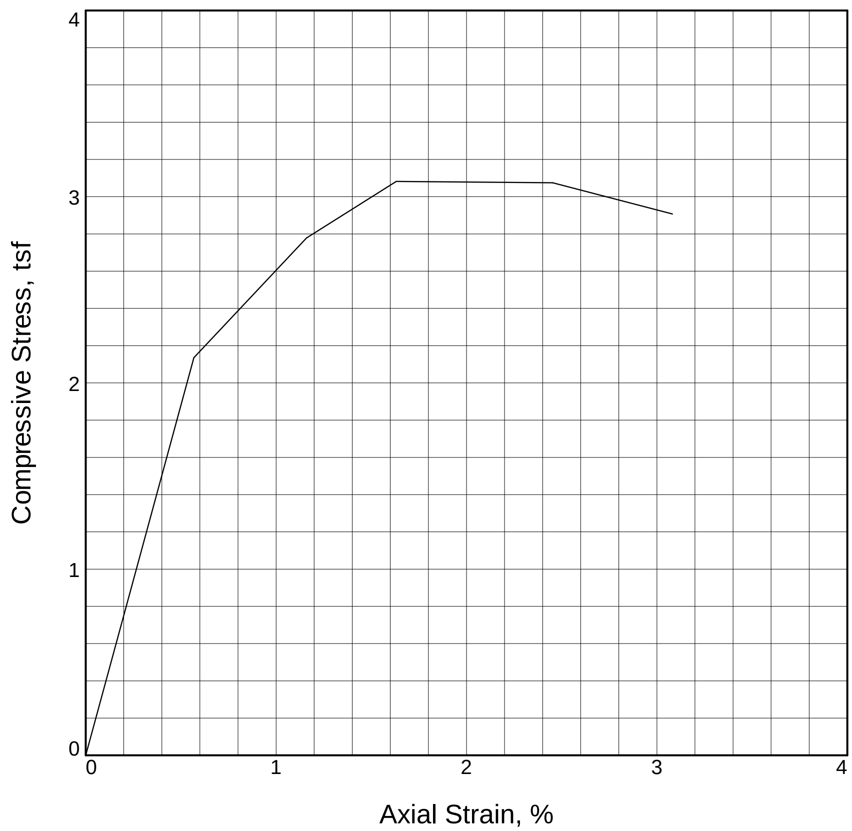
Fractional Components

Cobbles	Gravel			Sand				Fines		
	Coarse	Fine	Total	Coarse	Medium	Fine	Total	Silt	Clay	Total
0.0	0.0	0.9	0.9	0.8	1.9	58.9	61.6			37.5

D_{10}	D_{15}	D_{20}	D_{30}	D_{50}	D_{60}	D_{80}	D_{85}	D_{90}	D_{95}
				0.0866	0.0977	0.1304	0.1443	0.1686	0.3298

Fineness Modulus
0.26

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	3.082			
Undrained shear strength, tsf	1.541			
Failure strain, %	1.6			
Strain at peak, %	1.6			
Water content, %	14.4			
Wet density, pcf	136.7			
Dry density, pcf	119.5			
Saturation, %	94.5			
Void ratio	0.4107			
Specimen diameter, in.	1.96			
Specimen height, in.	4.31			
Height/diameter ratio	2.20			

Description:

LL =	PL =	PI =	Assumed GS= 2.7	Type: Rock Core

Project No.: WCH12407
Date Sampled: 3/19/2013
Remarks:

Figure ________

Client: Freese & Nichols, Inc.

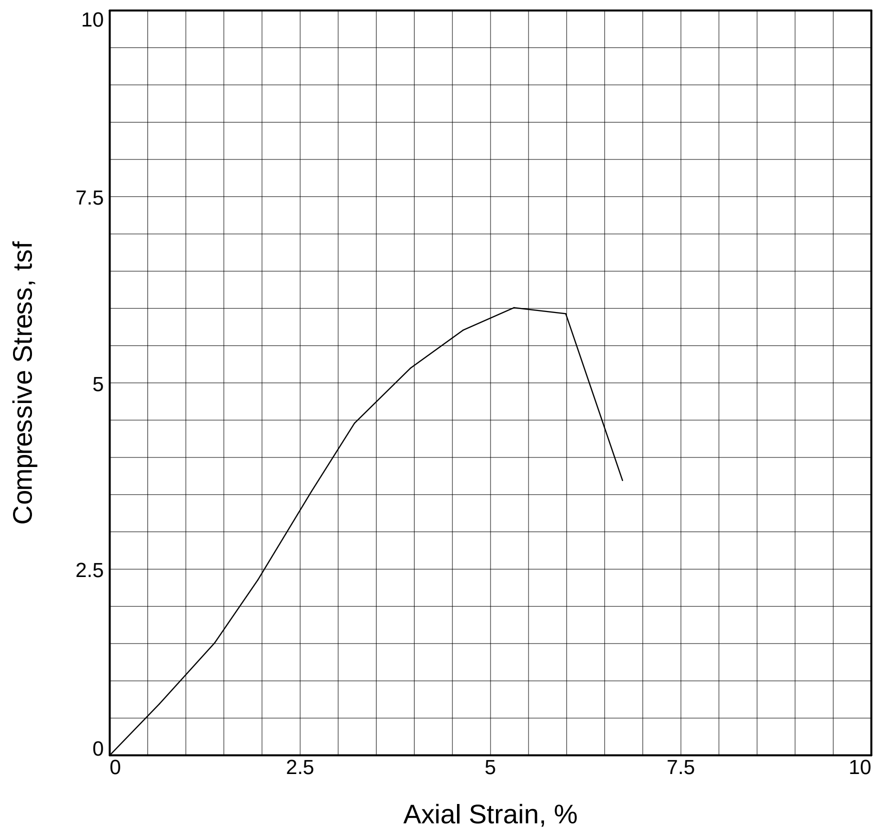
Project: Lake Ringgold

Sample Number: RD-1 **Depth:** 27-28 ft.

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

Tested By: Jason Bartholomew **Checked By:** Lee Gurecky

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	6.010			
Undrained shear strength, tsf	3.005			
Failure strain, %	5.3			
Strain at peak, %	5.3			
Water content, %	13.6			
Wet density, pcf	137.6			
Dry density, pcf	121.1			
Saturation, %	93.9			
Void ratio	0.3914			
Specimen diameter, in.	2.03			
Specimen height, in.	4.05			
Height/diameter ratio	2.00			

Description:

LL =	**PL =**	**PI =**	**Assumed GS=** 2.7	**Type:** Rock Core

Project No.: WCH12407
Date Sampled: 3/18/2013
Remarks:

Figure ________

Client: Freese & Nichols, Inc.

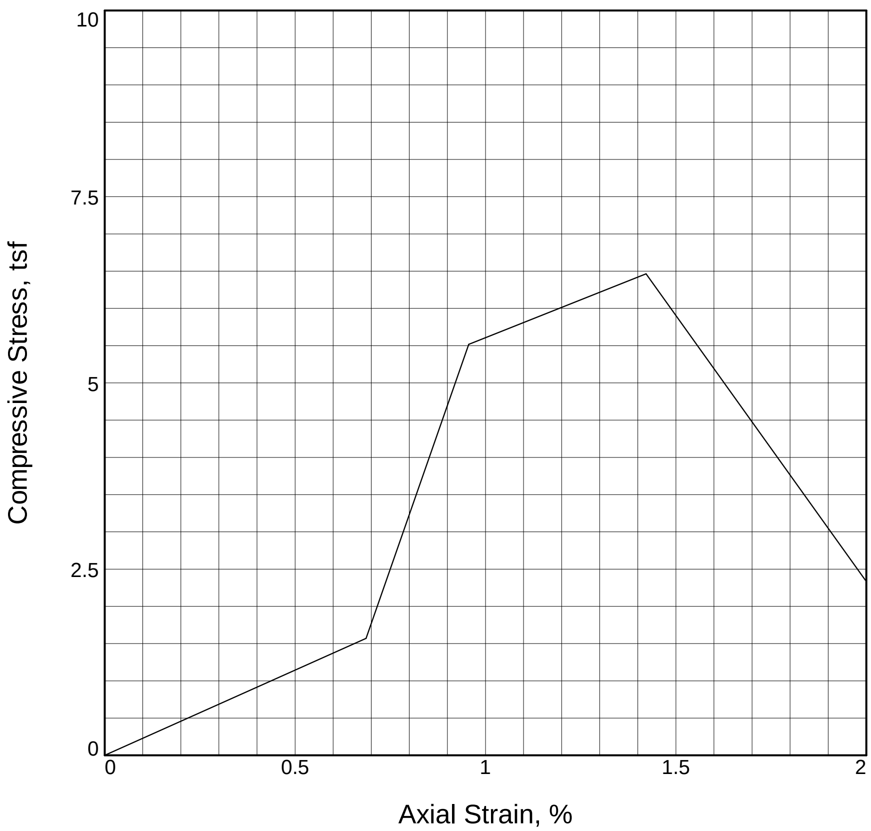
Project: Lake Ringgold

Sample Number: RD-2 **Depth:** 36.6-38.1 ft.

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

Tested By: Scott Ellis **Checked By:** Lee Gurecky

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	6.464			
Undrained shear strength, tsf	3.232			
Failure strain, %	1.4			
Strain at peak, %	1.4			
Water content, %	13.5			
Wet density, pcf	144.0			
Dry density, pcf	126.9			
Saturation, %	100.0			
Void ratio	0.3776			
Specimen diameter, in.	2.01			
Specimen height, in.	4.08			
Height/diameter ratio	2.03			

Description:

LL =	PL =	PI =	Assumed GS= 2.8	Type: Rock Core

Project No.: WCH12407
Date Sampled: 3/20/2013
Remarks:

Figure ________

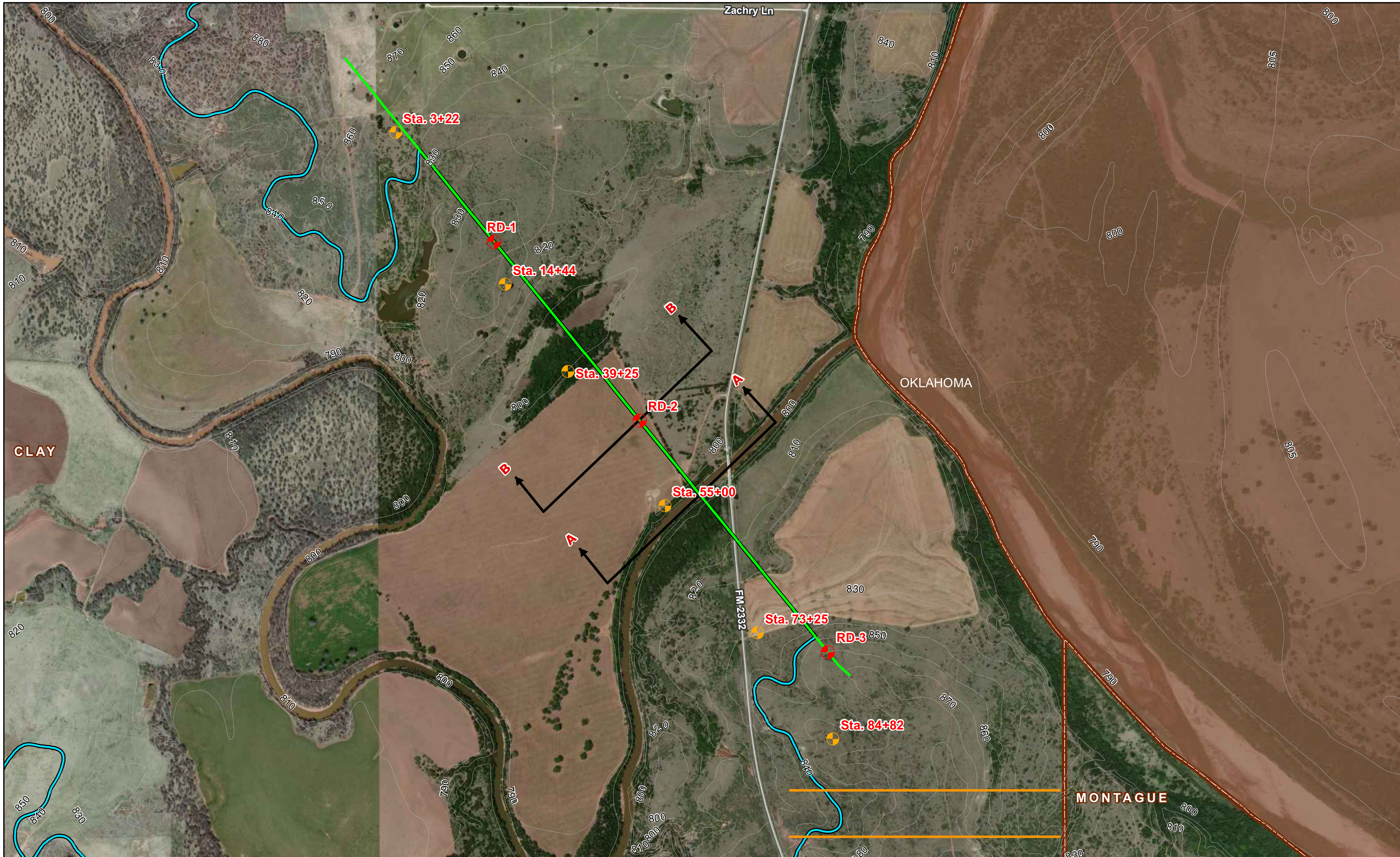
Client: Freese & Nichols, Inc.

Project: Lake Ringgold

Sample Number: RD-3 **Depth:** 28-29.7 ft.

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

Tested By: Jason Bartholomew **Checked By:** Lee Gurecky



FN PROJECT NO.	WCH12407
DATE CREATED	6/12/2013
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas North Central
FILE NAME	Cross_Sections
PREPARED BY	NBB

CITY OF WICHITA FALLS

Proposed Lake Ringgold

Boring and Cross Section Location Map

N W E S

FREESE AND NICHOLS
4500 International Plaza Suite 200
Fort Worth, Texas 76109-4895
(817) 735-7300

Dam Centerline
County Boundary
Proposed Lake Ringgold
FNI Borings
Historical Borings

0 1,000 2,000
Feet

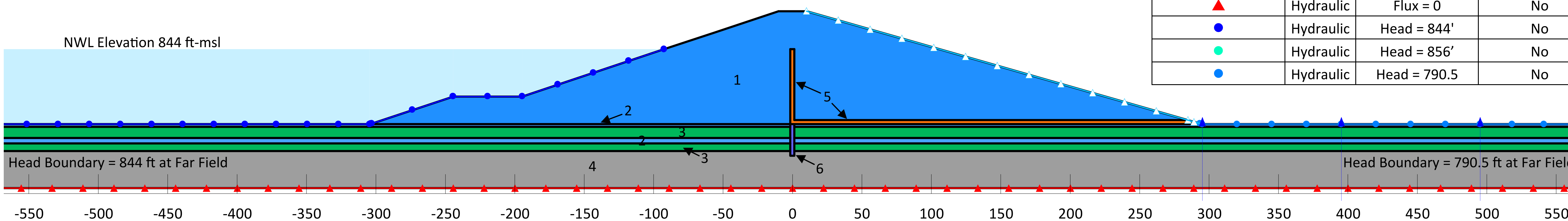
1
PLATE

Path:H:\WR_DESIGN\GEOTECH\Cross_Sections.mxd

Material		Unit Weight	Effective/Drained		Total CU		Total UU		K_{sat}	K_{sat}	Conductivity Ratio
		(pcf)	c'	ϕ'	c	ϕ	c	ϕ	(cm/sec)	(ft/sec)	(K_v/K_h)
1	CL—Embankment	126	150	27	300	22	1500	0	5.0E-07	1.6E-08	0.25
2	CL—Foundation	124	150	27	300	22	1500	0	2.0E-06	6.6E-08	0.25
3	SM—Silty Sand	125	0	31	-	-	-	-	3.0E-04	9.8E-06	0.33
4	Mudstone	139	3100	20	-	-	-	-	1.0E-05	3.3E-07	0.1
5	Sand Drain	110	0	36	-	-	-	-	2.0E-02	6.6E-04	1
6	Slurry Trench	-	-	-	-	-	-	-	1.0E-08	3.3E-10	1

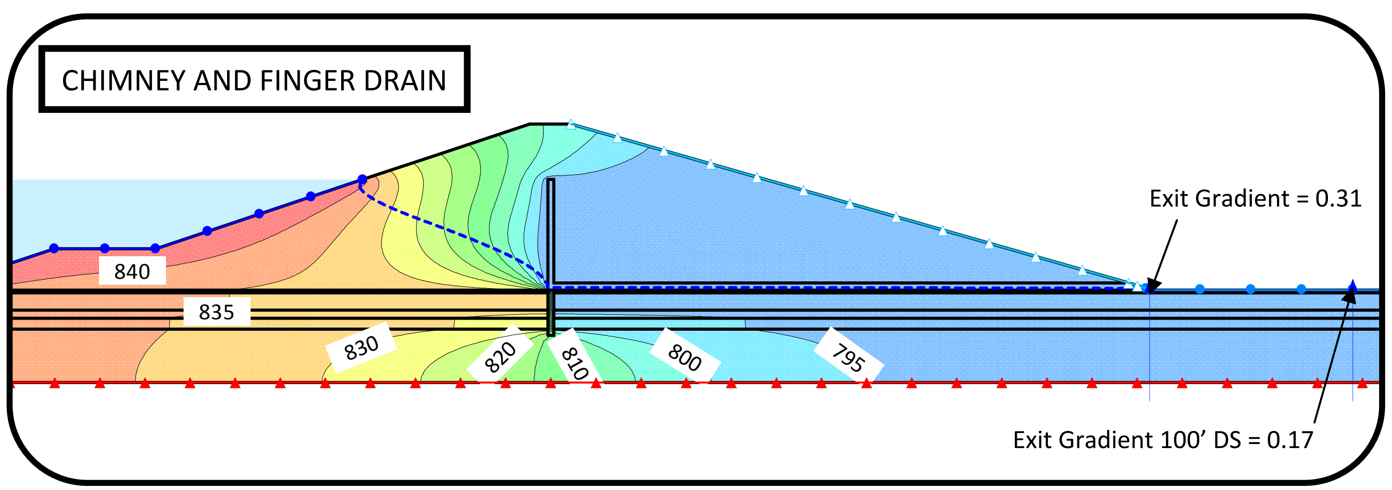
Cross Section Location:	A-A (Creek Centerline)
Loading Condition:	NWL Elevation 844 ft-msl
Upstream Slope:	3H:1V (with Berm)
Downstream Slope:	3.5H:1V
Internal Drainage:	Chimney and Finger Drains
Analysis Type:	Seepage Through Embankment

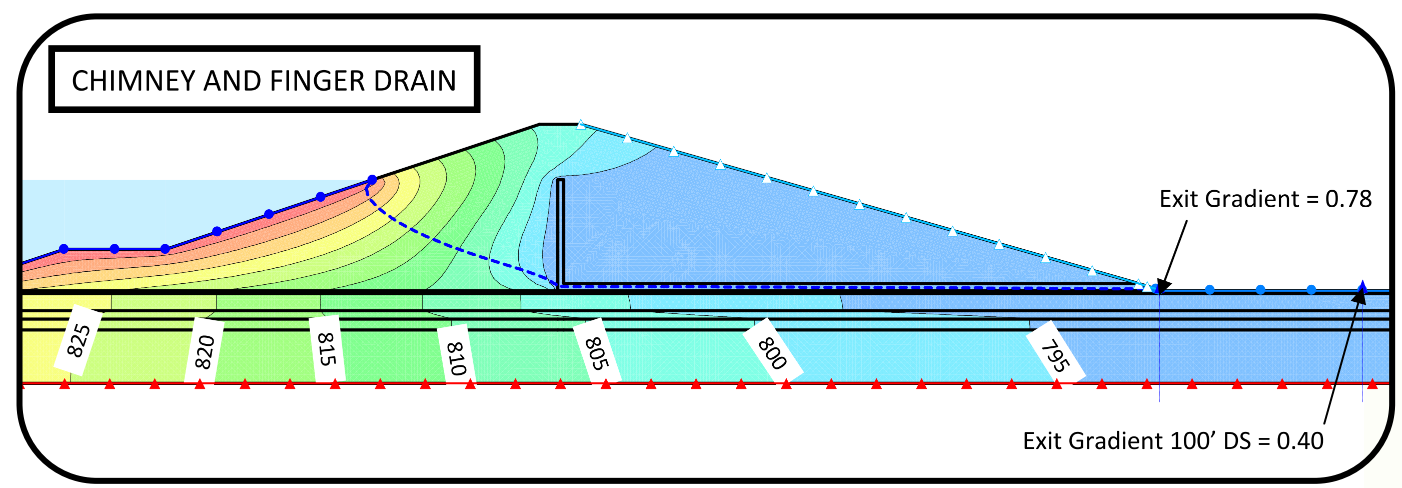
Boundary Condition Symbol	Type	Value	Potential Seepage Face Review
△	Hydraulic	Flux = 0	Yes
▲ (red)	Hydraulic	Flux = 0	No
● (blue)	Hydraulic	Head = 844'	No
● (cyan)	Hydraulic	Head = 856'	No
● (light blue)	Hydraulic	Head = 790.5	No

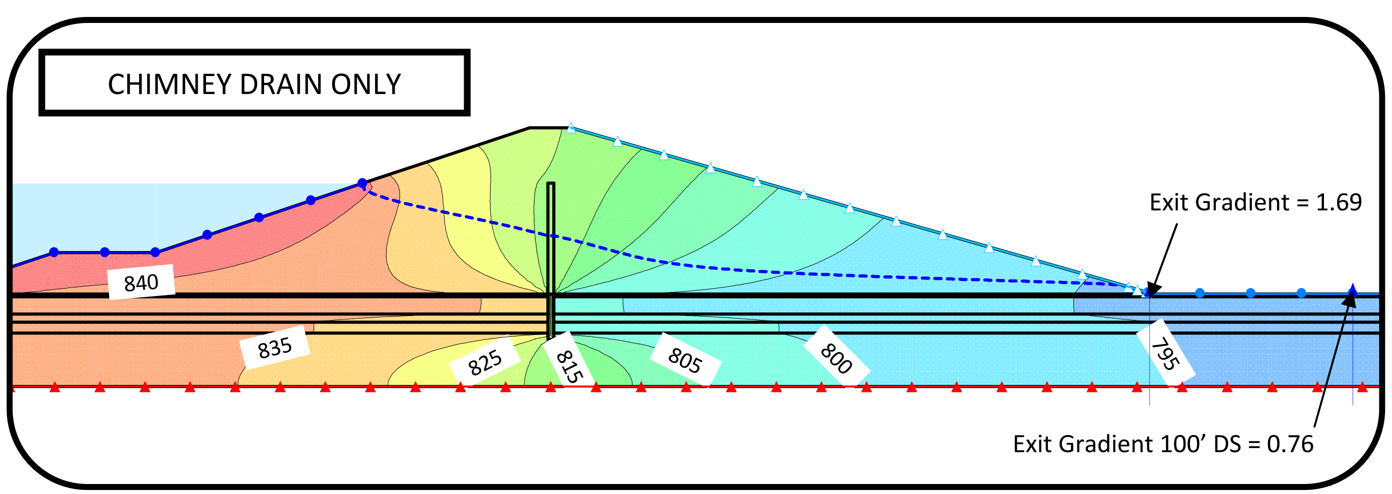


SSS RESULTS (SLURRY TRENCH)

SSS RESULTS (NO SLURRY TRENCH)







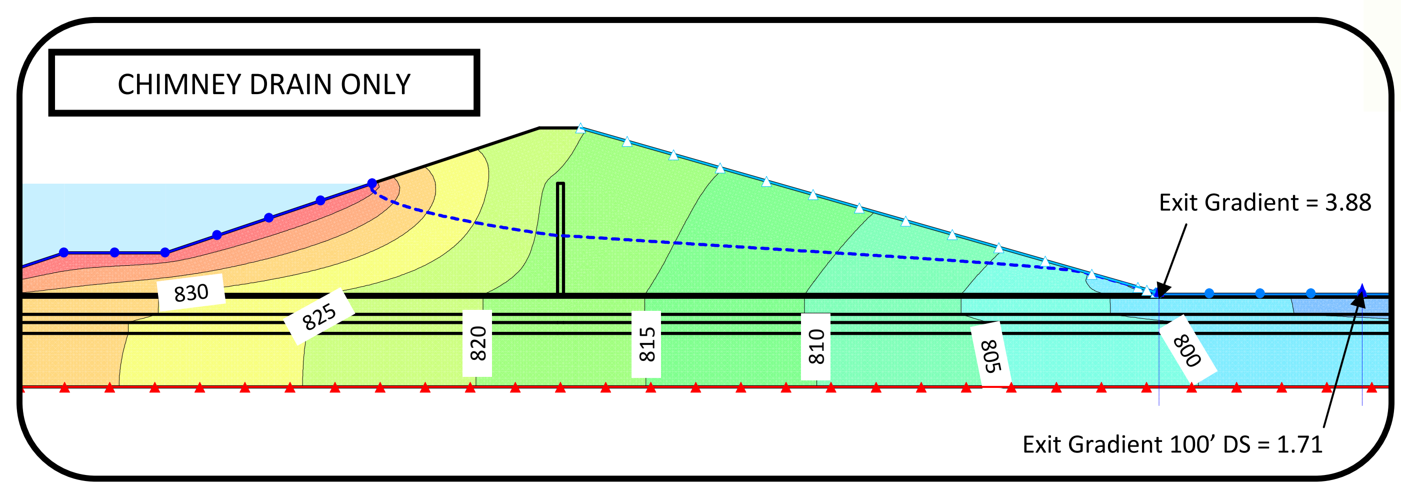


PLATE 2

CITY OF WICHITA FALLS

Proposed Lake Ringgold

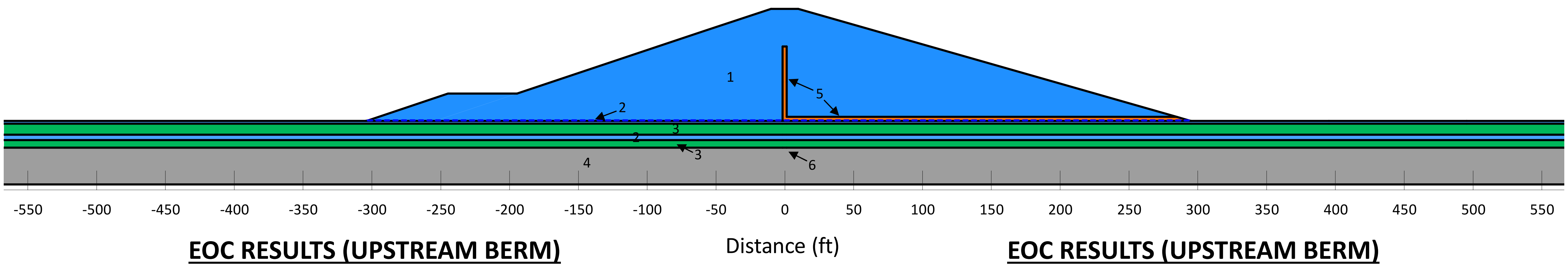
SEEPAGE ANALYSIS—SECTION A-A

FREESE NICHOLS
4055 International Plaza Suite 200
Fort Worth, TX 76109

FNI PROJECT: WCH12407
FILE: T:\Geotech\Stability Models
DATE: May 30, 2013
PREPARED: MAI

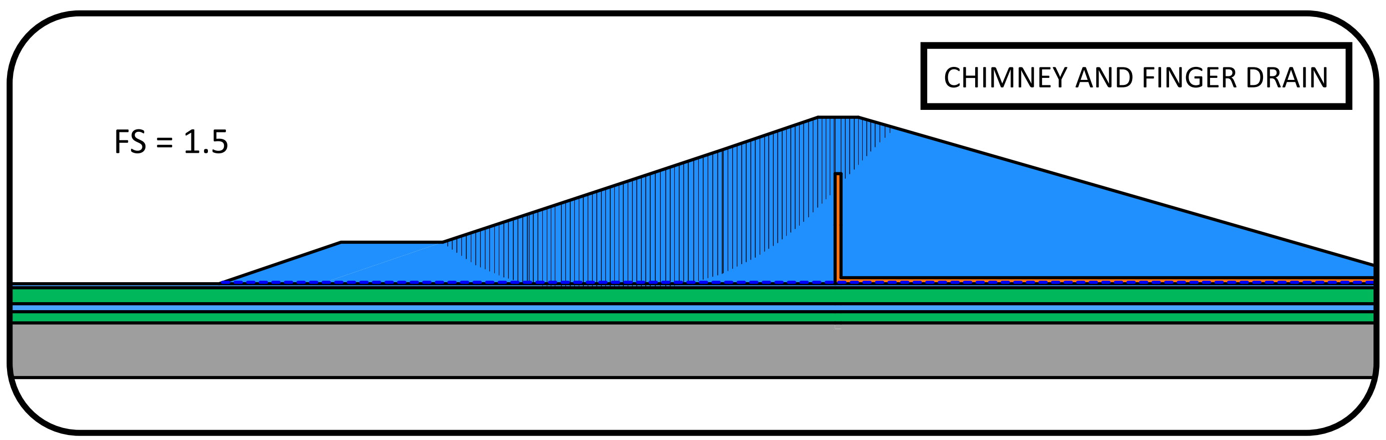
Material		Unit Weight	Effective/Drained		Total CU		Total UU		K_{sat}	K_{sat}	Conductivity Ratio
		(pcf)	c'	ϕ'	c	ϕ	c	ϕ	(cm/sec)	(ft/sec)	(K_v/K_h)
1	CL—Embankment	126	150	27	300	22	1500	0	5.0E-07	1.6E-08	0.25
2	CL—Foundation	124	150	27	300	22	1500	0	2.0E-06	6.6E-08	0.25
3	SM—Silty Sand	125	0	31	-	-	-	-	3.0E-04	9.8E-06	0.33
4	Mudstone	139	3100	20	-	-	-	-	1.0E-05	3.3E-07	0.1
5	Sand Drain	110	0	36	-	-	-	-	2.0E-02	6.6E-04	1
6	Slurry Trench	-	-	-	-	-	-	-	1.0E-08	3.3E-10	1

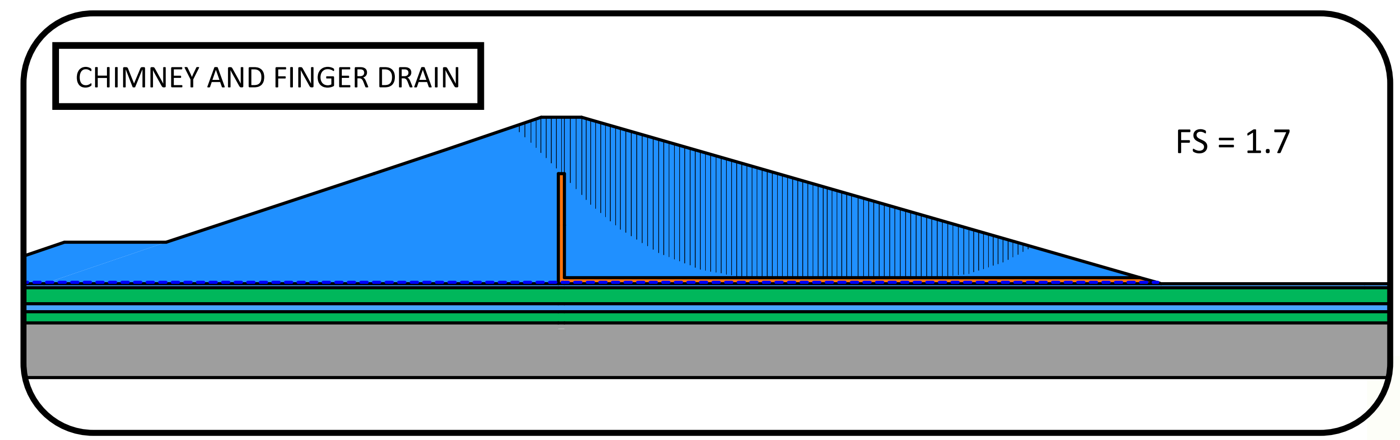
Cross Section Location:	A-A (Creek Centerline)
Loading Condition:	Ground Seepage Elevation 790.5 ft-msl
Upstream Slope:	3H:1V
Downstream Slope:	3.5H:1V
Upstream Berm:	50 ft Wide (Top Elevation 810 ft-msl)
Analysis Type:	End-of-Construction

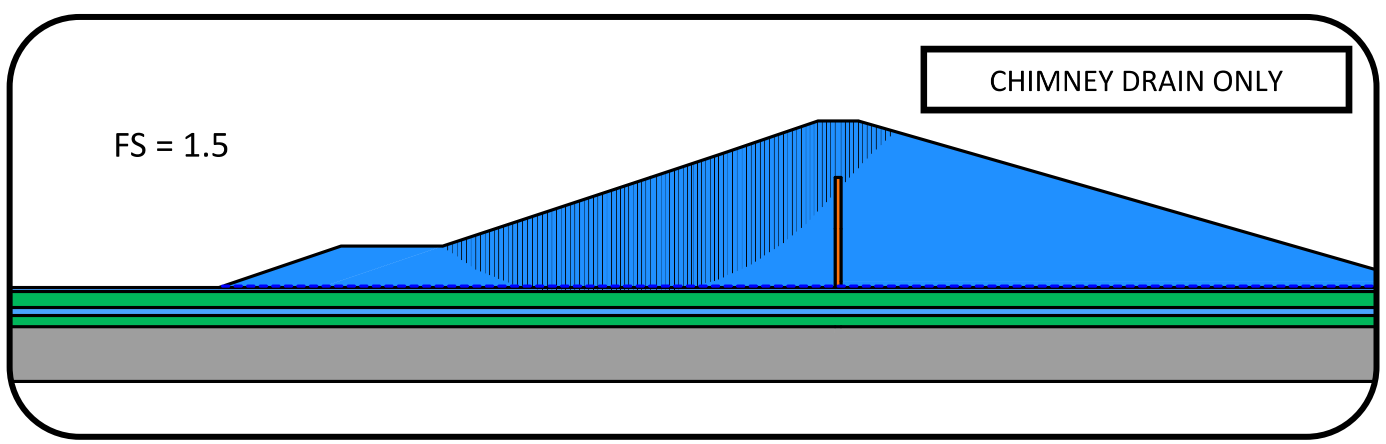


EOC RESULTS (UPSTREAM BERM)

EOC RESULTS (UPSTREAM BERM)







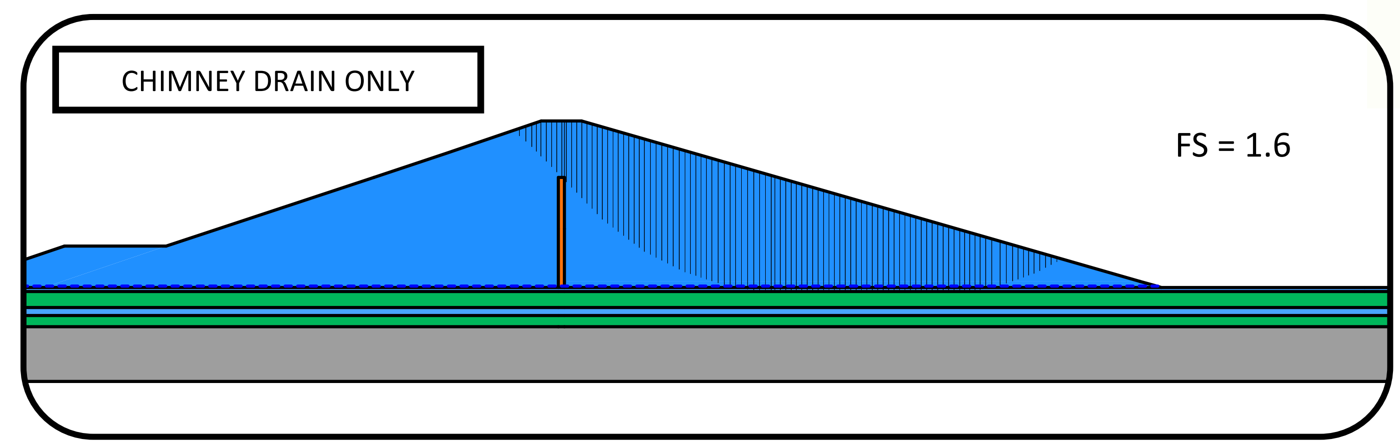


PLATE 3

CITY OF WICHITA FALLS

Proposed Lake Ringgold

SLOPE STABILITY ANALYSIS—SECTION A-A

FREESE AND NICHOLS

4055 International Plaza Suite 200 Fort Worth, TX 76109

FNI PROJECT: WCH12407

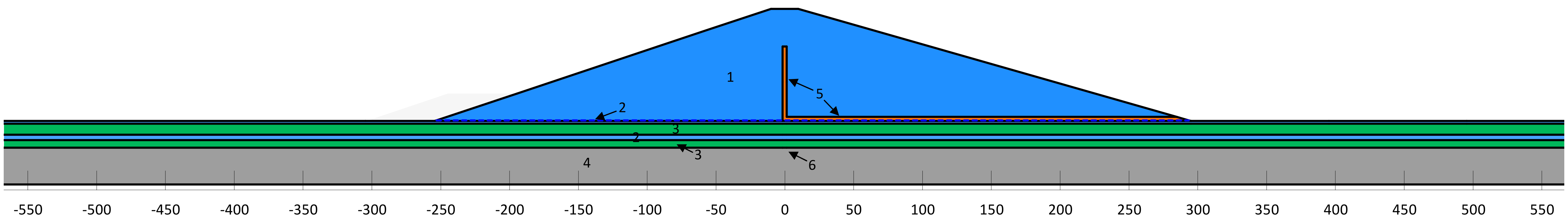
FILE: T:\Geotech\Stability Models

DATE: May 30, 2013

PREPARED: MAI

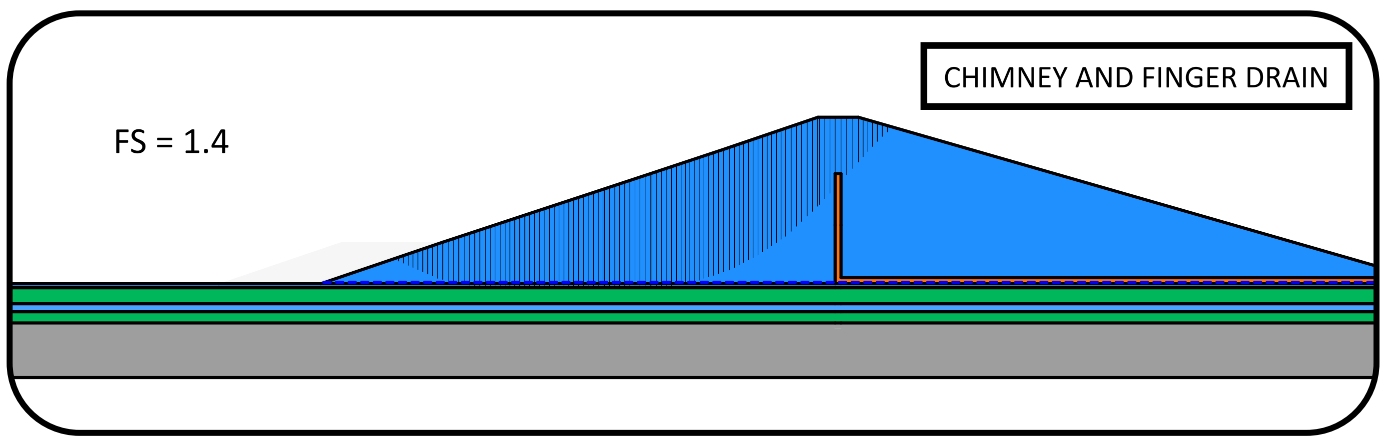
Material		Unit Weight	Effective/Drained		Total CU		Total UU		K_{sat}	K_{sat}	Conductivity Ratio
		(pcf)	c'	ϕ'	c	ϕ	c	ϕ	(cm/sec)	(ft/sec)	(K_v/K_h)
1	CL—Embankment	126	150	27	300	22	1500	0	5.0E-07	1.6E-08	0.25
2	CL—Foundation	124	150	27	300	22	1500	0	2.0E-06	6.6E-08	0.25
3	SM—Silty Sand	125	0	31	-	-	-	-	3.0E-04	9.8E-06	0.33
4	Mudstone	139	3100	20	-	-	-	-	1.0E-05	3.3E-07	0.1
5	Sand Drain	110	0	36	-	-	-	-	2.0E-02	6.6E-04	1
6	Slurry Trench	-	-	-	-	-	-	-	1.0E-08	3.3E-10	1

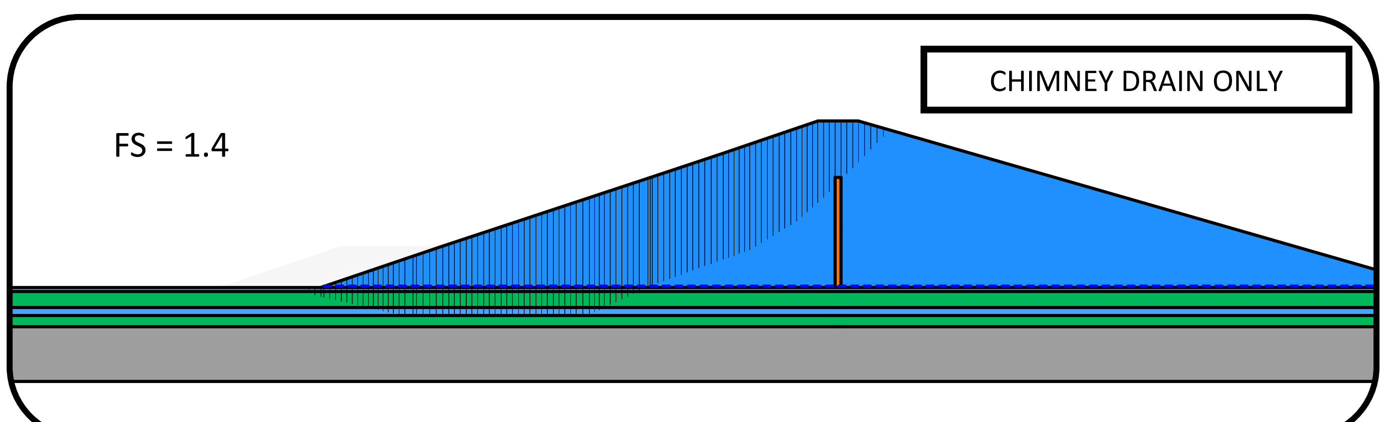
Cross Section Location:	A-A (Creek Centerline)
Loading Condition:	Ground Seepage Elevation 790.5 ft-msl
Upstream Slope:	3H:1V
Downstream Slope:	3.5H:1V
Upstream Berm:	None
Analysis Type:	End-of-Construction



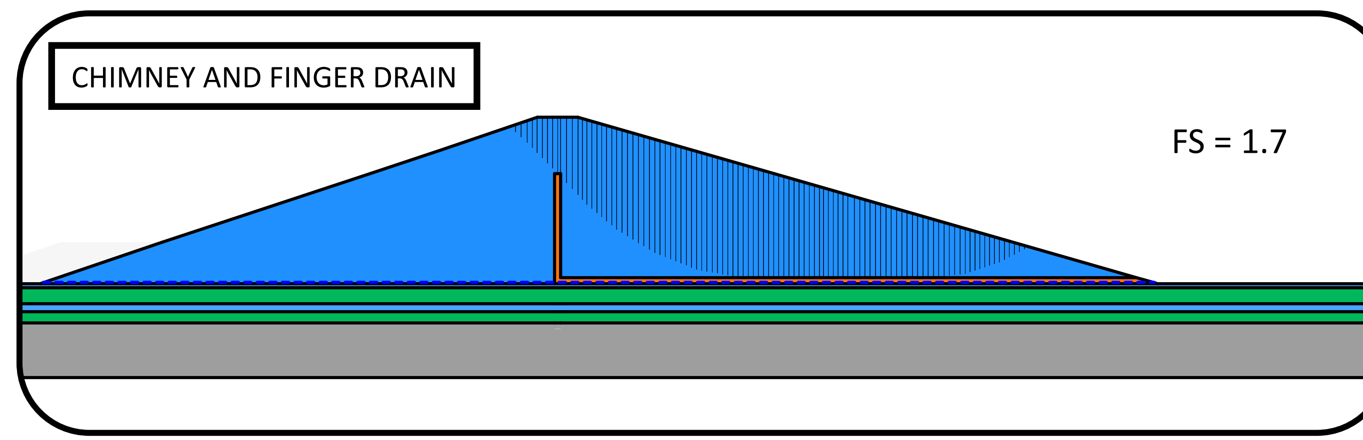
Distance (ft)

EOC RESULTS (NO UPSTREAM BERM)





EOC RESULTS (NO UPSTREAM BERM)



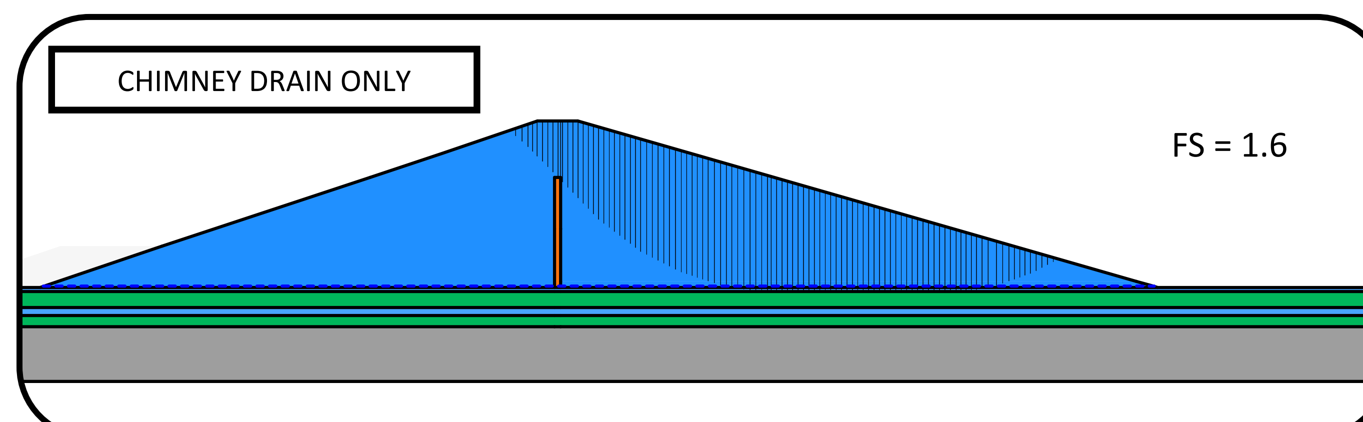


PLATE 4

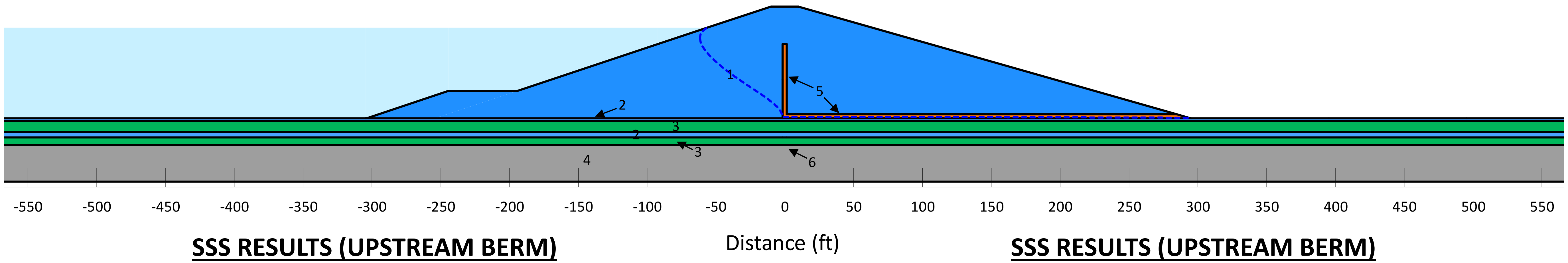
CITY OF WICHITA FALLS
Proposed Lake Ringgold
SLOPE STABILITY ANALYSIS—SECTION A-A

FREESE AND NICHOLS
4055 International Plaza Suite 200
Fort Worth, TX 76109

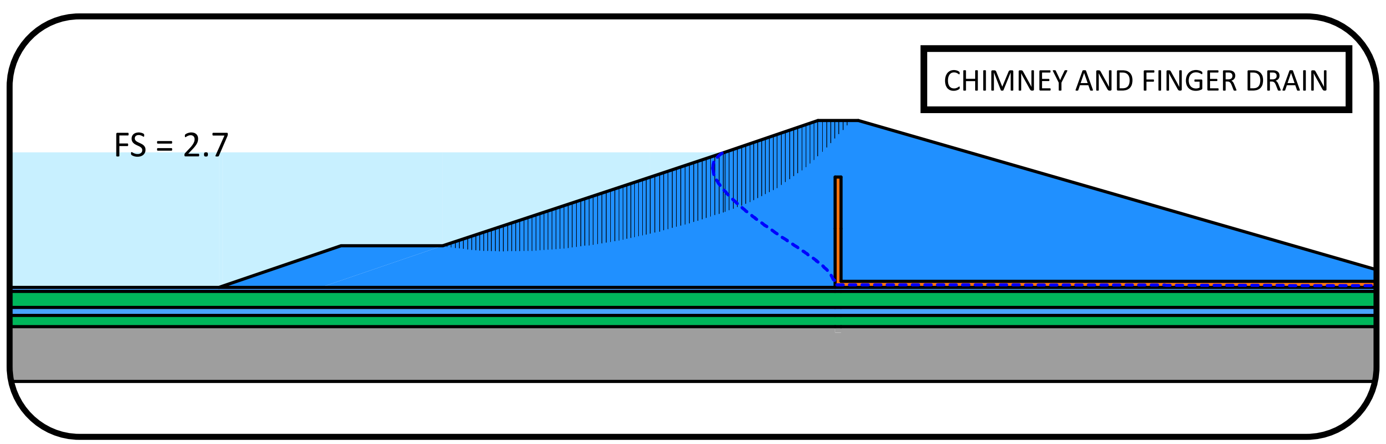
FNI PROJECT: WCH12407
FILE: T:\Geotech\Stability Models
DATE: May 30, 2013
PREPARED: MAI

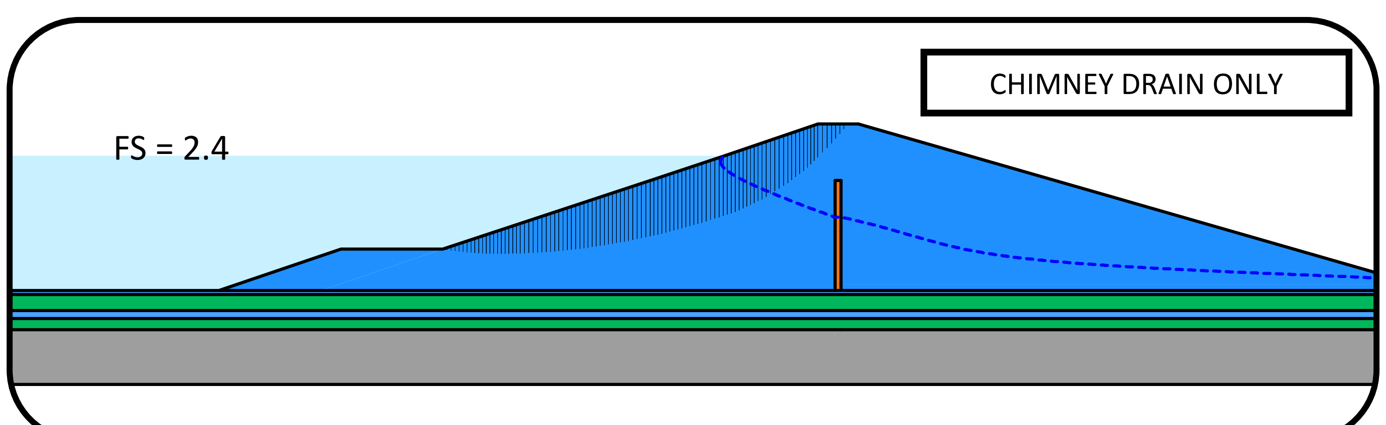
Material		Unit Weight	Effective/Drained		Total CU		Total UU		K_{sat}	K_{sat}	Conductivity Ratio
		(pcf)	c'	ϕ'	c	ϕ	c	ϕ	(cm/sec)	(ft/sec)	(K_v/K_h)
1	CL—Embankment	126	150	27	300	22	1500	0	5.0E-07	1.6E-08	0.25
2	CL—Foundation	124	150	27	300	22	1500	0	2.0E-06	6.6E-08	0.25
3	SM—Silty Sand	125	0	31	-	-	-	-	3.0E-04	9.8E-06	0.33
4	Mudstone	139	3100	20	-	-	-	-	1.0E-05	3.3E-07	0.1
5	Sand Drain	110	0	36	-	-	-	-	2.0E-02	6.6E-04	1
6	Slurry Trench	-	-	-	-	-	-	-	1.0E-08	3.3E-10	1

Cross Section Location:	A-A (Creek Centerline)
Loading Condition:	Emergency Spillway Elevation 856 ft-msl
Upstream Slope:	3H:1V
Downstream Slope:	3.5H:1V
Upstream Berm:	50 ft Wide (Top Elevation 810 ft-msl)
Analysis Type:	Steady-State Seepage

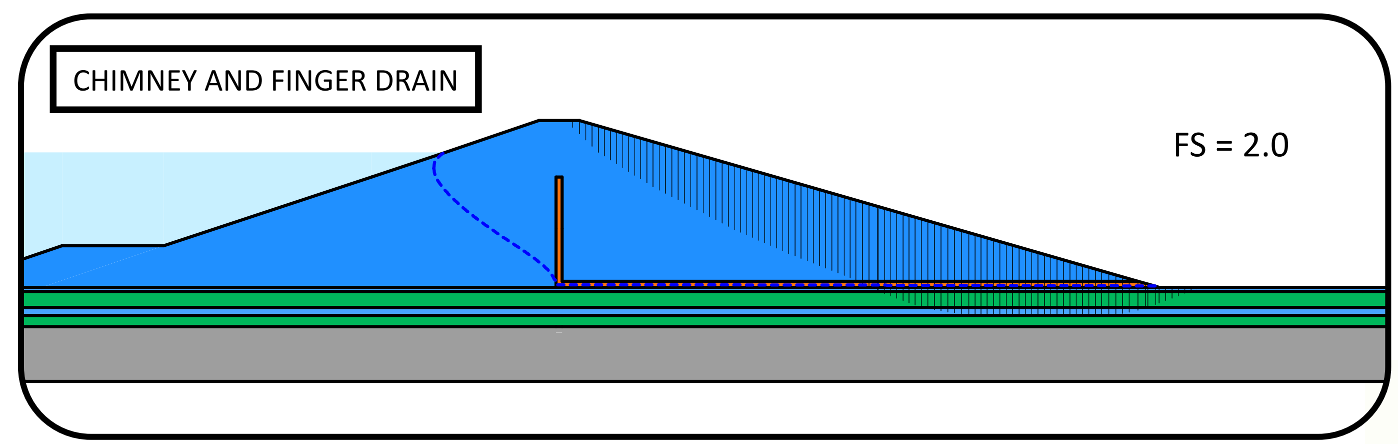


SSS RESULTS (UPSTREAM BERM)





SSS RESULTS (UPSTREAM BERM)



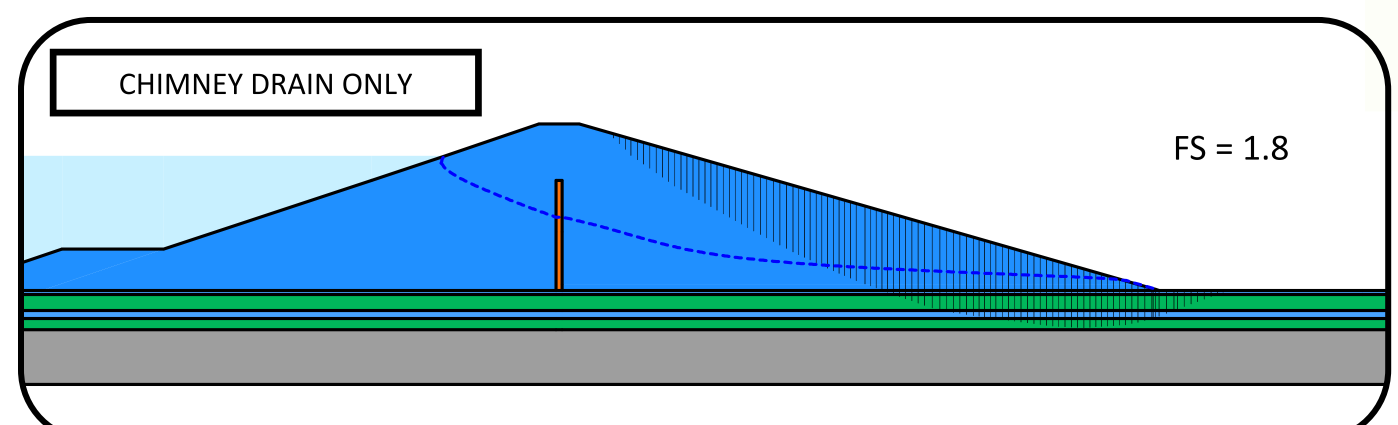


PLATE 5

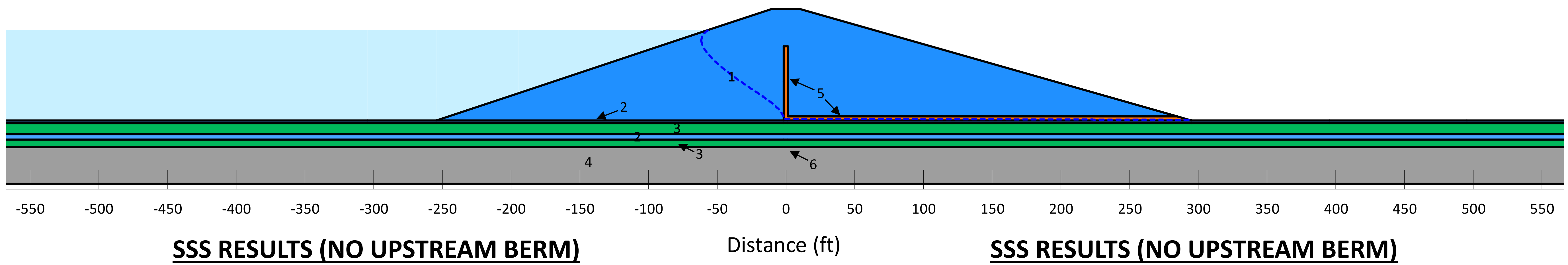
CITY OF WICHITA FALLS
Proposed Lake Ringgold
SLOPE STABILITY ANALYSIS—SECTION A-A

FREESE AND NICHOLS
4055 International Plaza Suite 200
Fort Worth, TX 76109

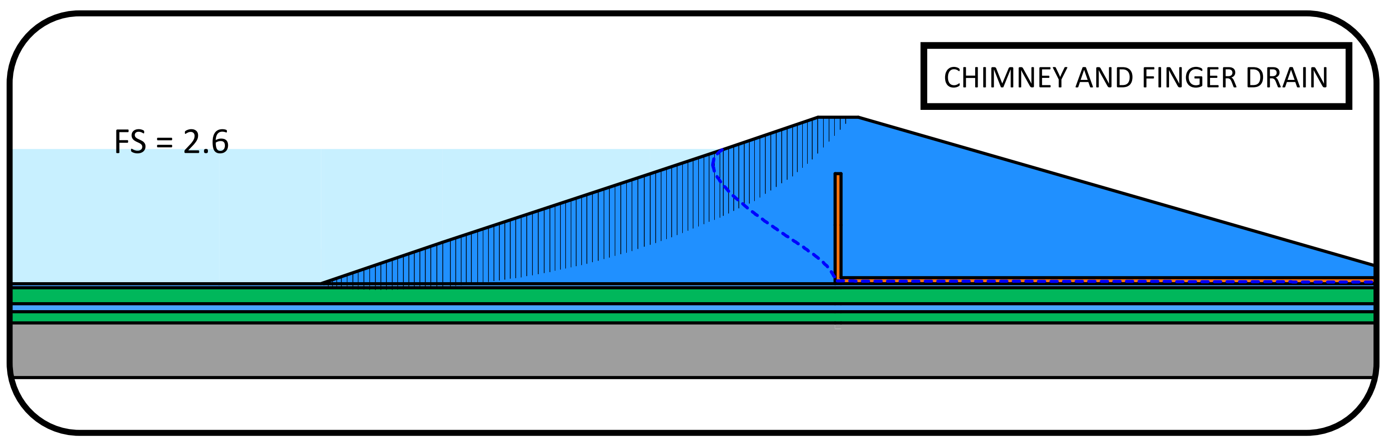
FNI PROJECT: WCH12407
FILE: T:\Geotech\Stability Models
DATE: May 30, 2013
PREPARED: MAI

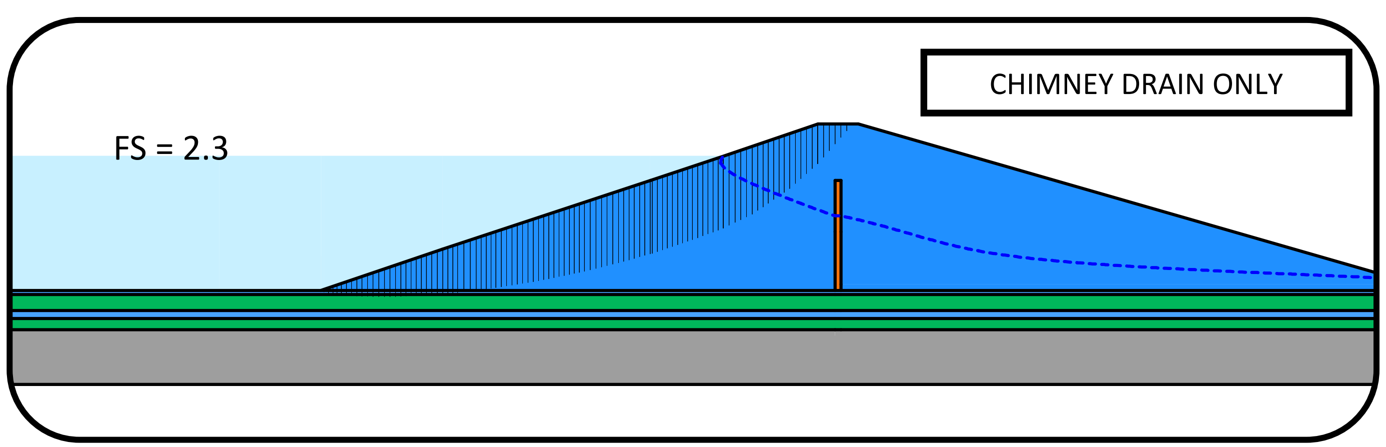
Material		Unit Weight	Effective/Drained		Total CU		Total UU		K_{sat}	K_{sat}	Conductivity Ratio
		(pcf)	c'	ϕ'	c	ϕ	c	ϕ	(cm/sec)	(ft/sec)	(K_v/K_h)
1	CL—Embankment	126	150	27	300	22	1500	0	5.0E-07	1.6E-08	0.25
2	CL—Foundation	124	150	27	300	22	1500	0	2.0E-06	6.6E-08	0.25
3	SM—Silty Sand	125	0	31	-	-	-	-	3.0E-04	9.8E-06	0.33
4	Mudstone	139	3100	20	-	-	-	-	1.0E-05	3.3E-07	0.1
5	Sand Drain	110	0	36	-	-	-	-	2.0E-02	6.6E-04	1
6	Slurry Trench	-	-	-	-	-	-	-	1.0E-08	3.3E-10	1

Cross Section Location:	A-A (Creek Centerline)
Loading Condition:	Emergency Spillway Elevation 856 ft-msl
Upstream Slope:	3H:1V
Downstream Slope:	3.5H:1V
Upstream Berm:	None
Analysis Type:	Steady-State Seepage

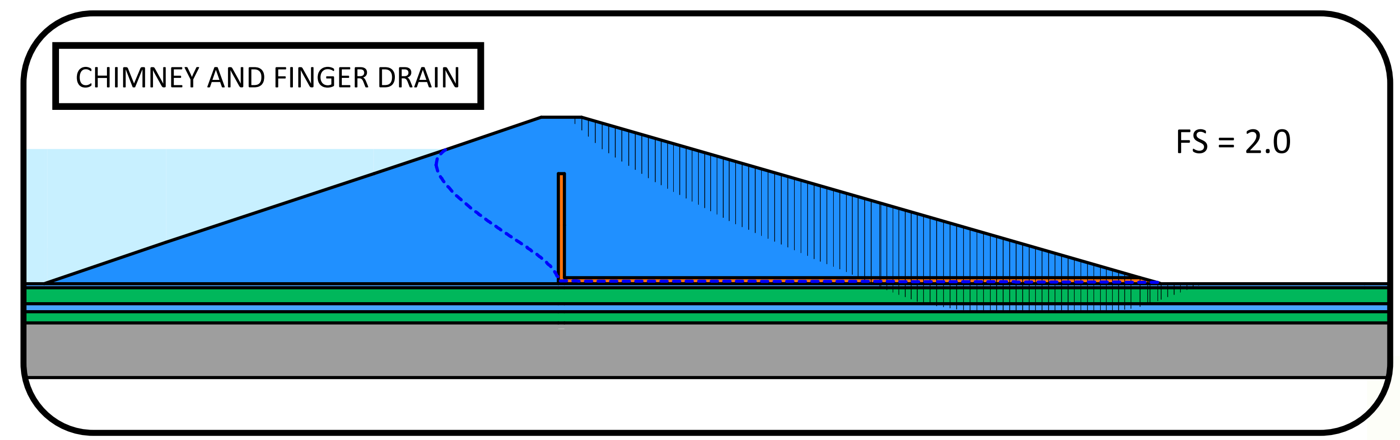


SSS RESULTS (NO UPSTREAM BERM)





SSS RESULTS (NO UPSTREAM BERM)



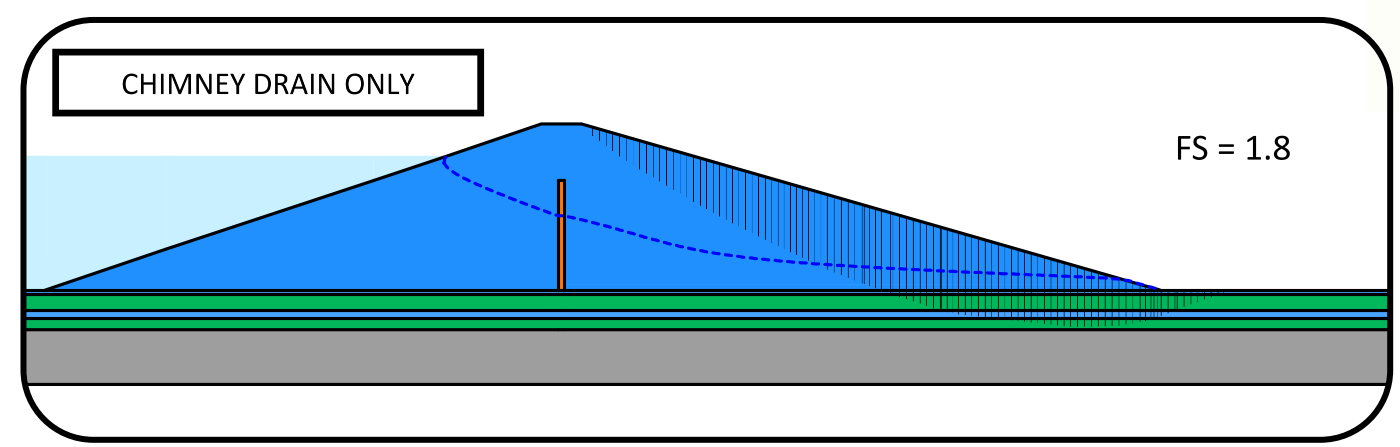


PLATE 6

CITY OF WICHITA FALLS

Proposed Lake Ringgold

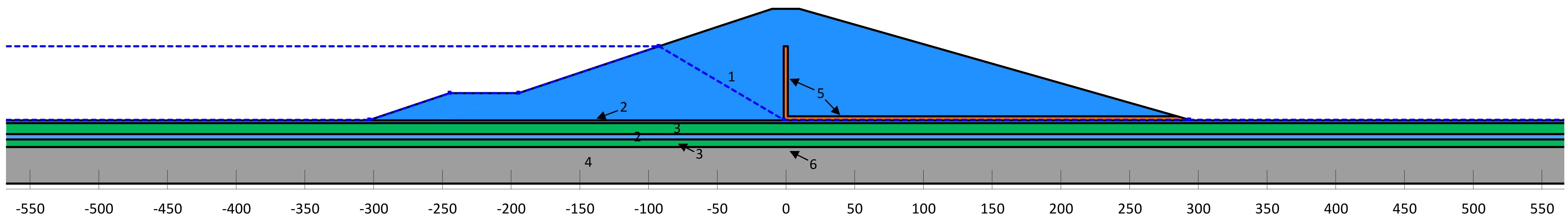
SLOPE STABILITY ANALYSIS—SECTION A-A

FREESE NICHOLS
4055 International Plaza Suite 200
Fort Worth, TX 76109

FNI PROJECT: WCH12407
FILE: T:\Geotech\Stability Models
DATE: May 30, 2013
PREPARED: MAI

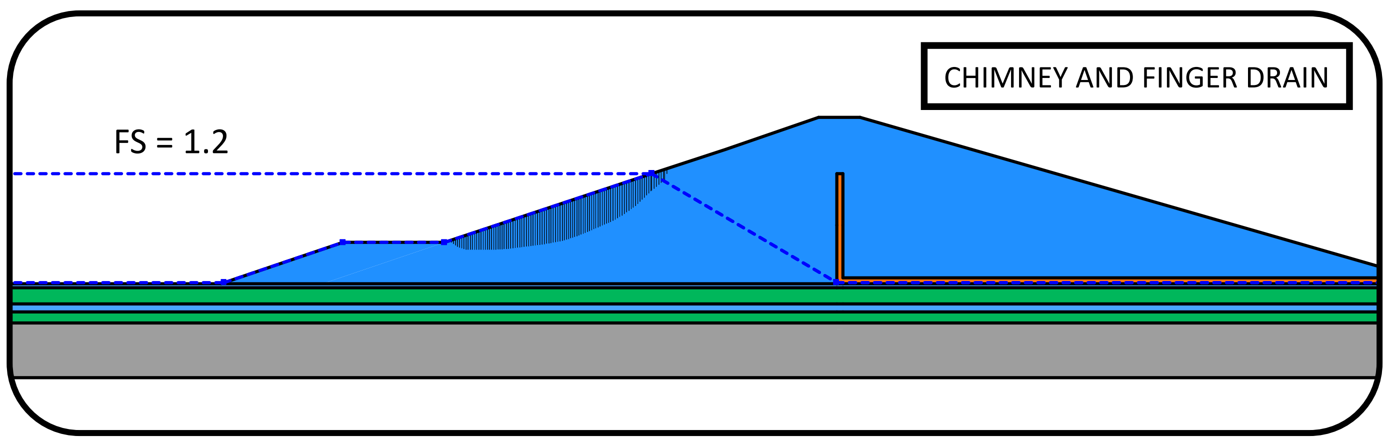
Material		Unit Weight	Effective/Drained		Total CU		Total UU		K_{sat}	K_{sat}	Conductivity Ratio
		(pcf)	c'	ϕ'	c	ϕ	c	ϕ	(cm/sec)	(ft/sec)	(K_v/K_h)
1	CL—Embankment	126	150	27	300	22	1500	0	5.0E-07	1.6E-08	0.25
2	CL—Foundation	124	150	27	300	22	1500	0	2.0E-06	6.6E-08	0.25
3	SM—Silty Sand	125	0	31	-	-	-	-	3.0E-04	9.8E-06	0.33
4	Mudstone	139	3100	20	-	-	-	-	1.0E-05	3.3E-07	0.1
5	Sand Drain	110	0	36	-	-	-	-	2.0E-02	6.6E-04	1
6	Slurry Trench	-	-	-	-	-	-	-	1.0E-08	3.3E-10	1

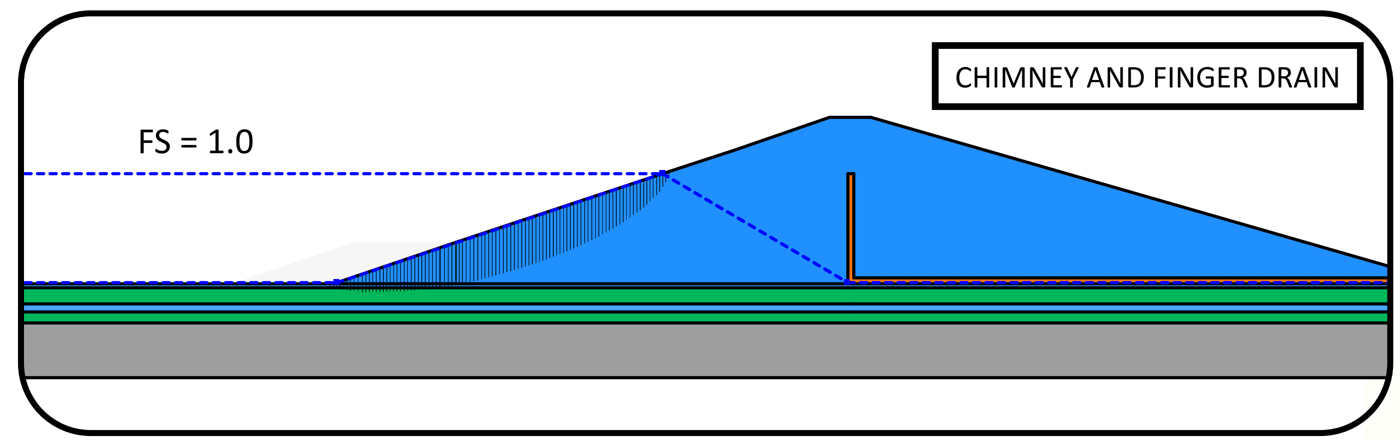
Cross Section Location:	A-A (Creek Centerline)
Loading Condition:	Elevation 844 ft-msl to 790.5 ft-msl
Upstream Slope:	3H:1V
Downstream Slope:	3.5H:1V
Upstream Berm:	Varies
Analysis Type:	Multi-Stage Rapid Drawdown

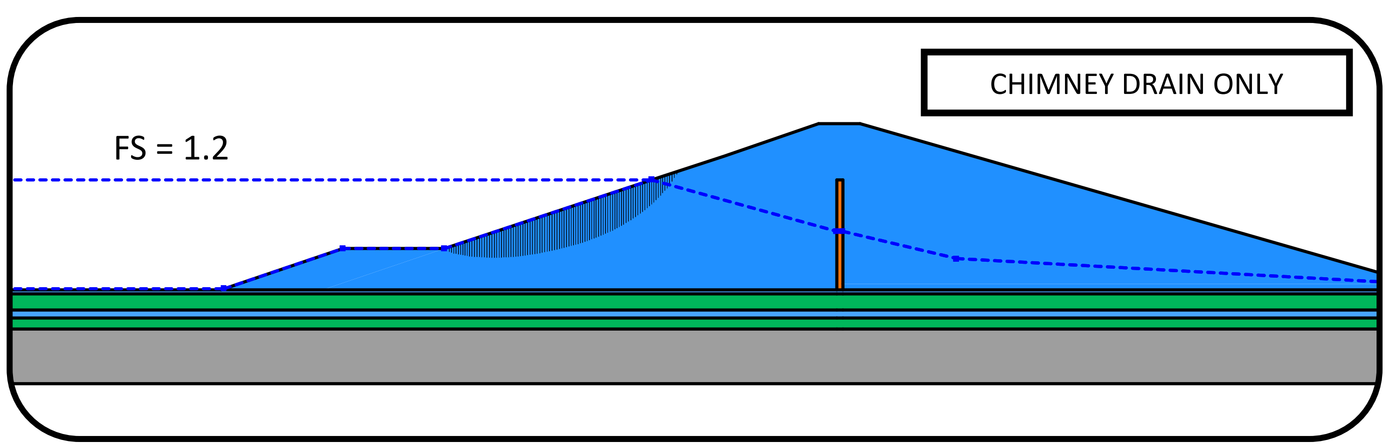


RDD RESULTS (UPSTREAM BERM)

RDD RESULTS (NO UPSTREAM BERM)







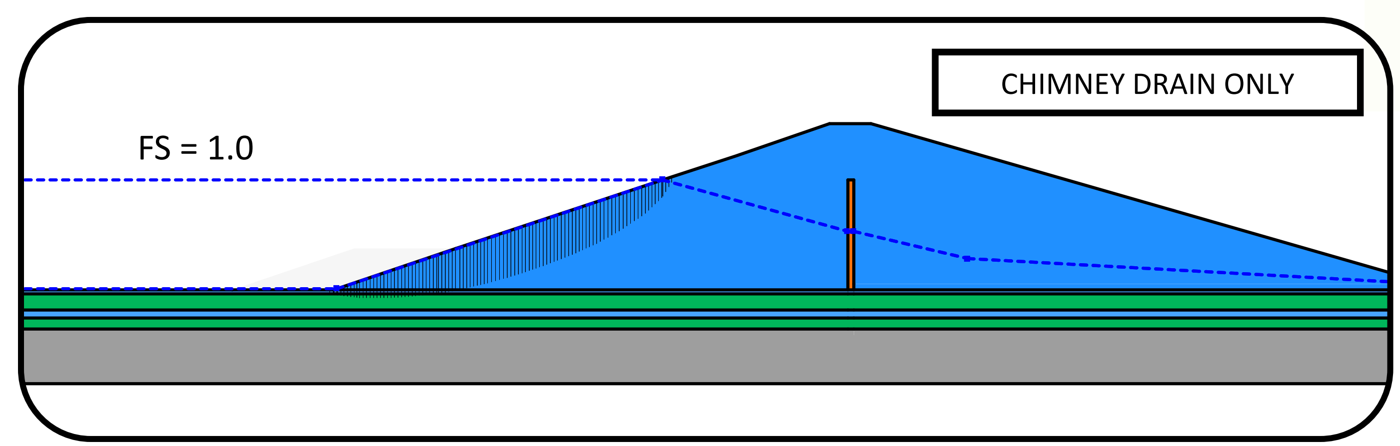


PLATE 7

CITY OF WICHITA FALLS

Proposed Lake Ringgold

SLOPE STABILITY ANALYSIS—SECTION A-A

FREESE NICHOLS
4055 International Plaza Suite 200
Fort Worth, TX 76109

FNI PROJECT: WCH12407

FILE: T:\Geotech\Stability Models

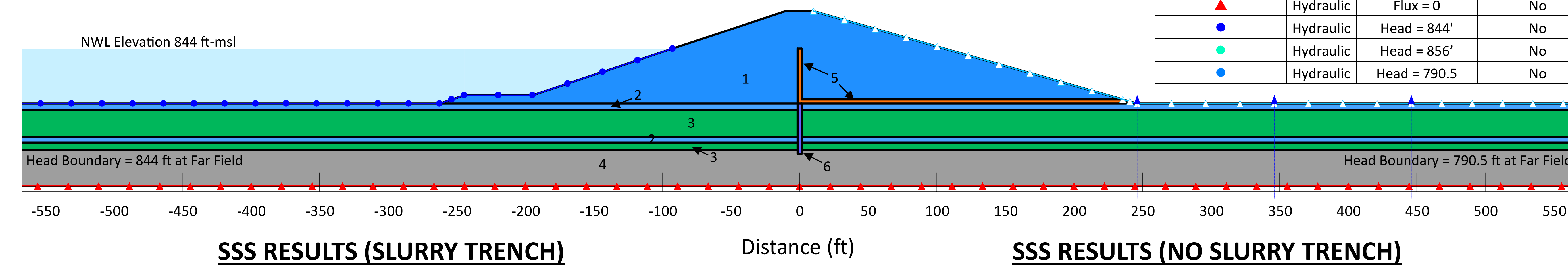
DATE: May 30, 2013

PREPARED: MAI

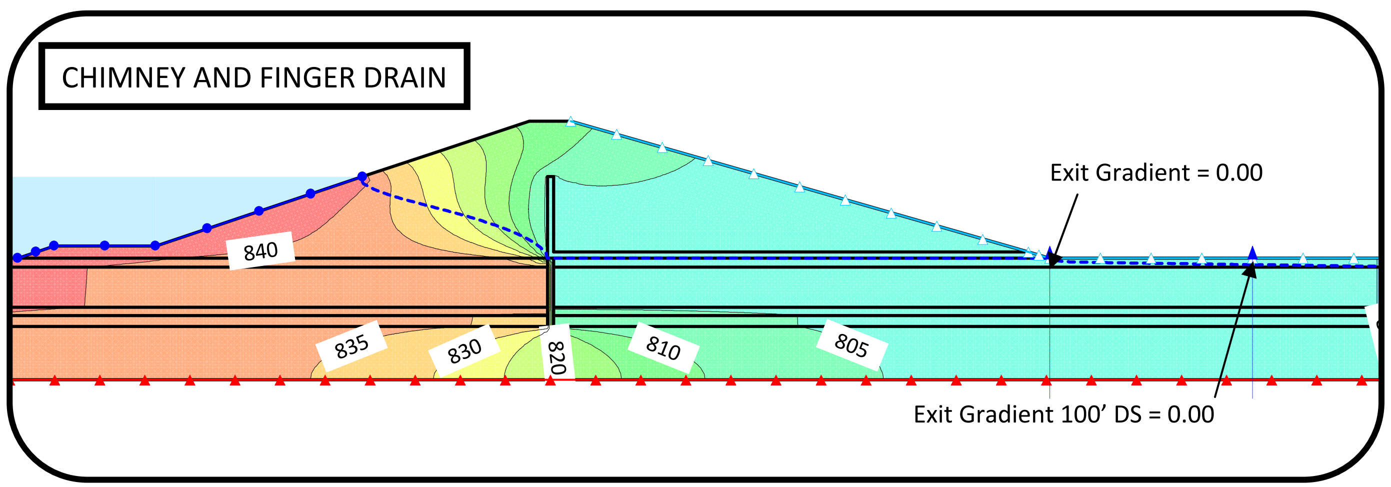
Material		Unit Weight	Effective/Drained		Total CU		Total UU		K_{sat}	K_{sat}	Conductivity Ratio
		(pcf)	c'	ϕ'	c	ϕ	c	ϕ	(cm/sec)	(ft/sec)	(K_v/K_h)
1	CL—Embankment	126	150	27	300	22	1500	0	5.0E-07	1.6E-08	0.25
2	CL—Foundation	124	150	27	300	22	1500	0	2.0E-06	6.6E-08	0.25
3	SM—Silty Sand	125	0	31	-	-	-	-	3.0E-04	9.8E-06	0.33
4	Mudstone	139	3100	20	-	-	-	-	1.0E-05	3.3E-07	0.1
5	Sand Drain	110	0	36	-	-	-	-	2.0E-02	6.6E-04	1
6	Slurry Trench	-	-	-	-	-	-	-	1.0E-08	3.3E-10	1

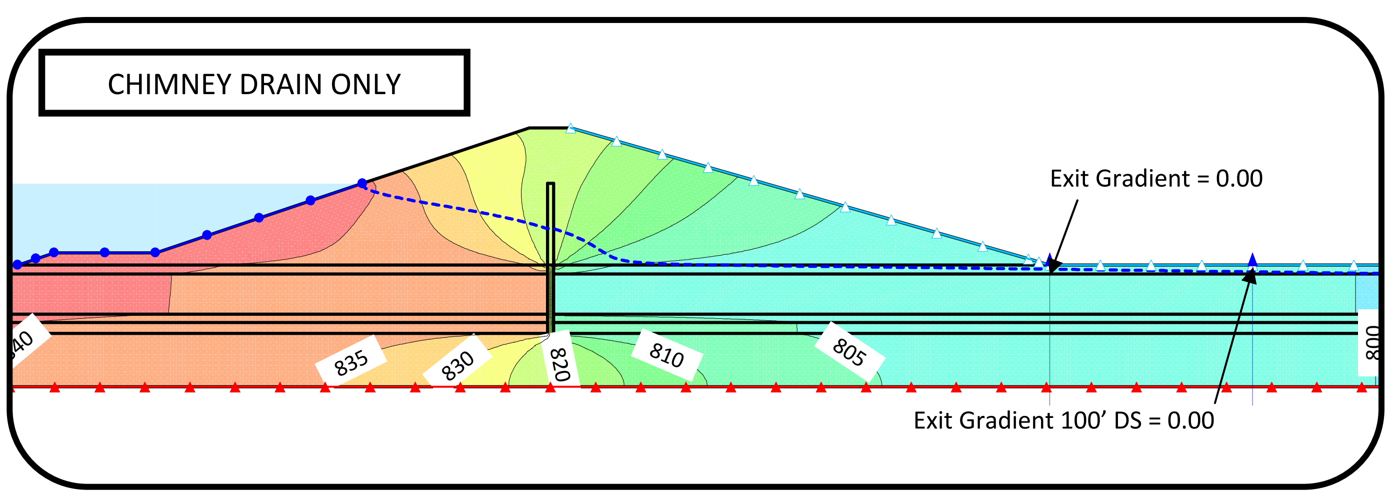
Cross Section Location:	B-B (Left Valley Section)
Loading Condition:	NWL Elevation 844 ft-msl
Upstream Slope:	3H:1V (with Berm)
Downstream Slope:	3.5H:1V
Internal Drainage:	Chimney and Finger Drains
Analysis Type:	Seepage Through Embankment

Boundary Condition Symbol	Type	Value	Potential Seepage Face Review
△ (open cyan triangle)	Hydraulic	Flux = 0	Yes
▲ (red triangle)	Hydraulic	Flux = 0	No
● (blue dot)	Hydraulic	Head = 844'	No
● (cyan dot)	Hydraulic	Head = 856'	No
● (light blue dot)	Hydraulic	Head = 790.5	No

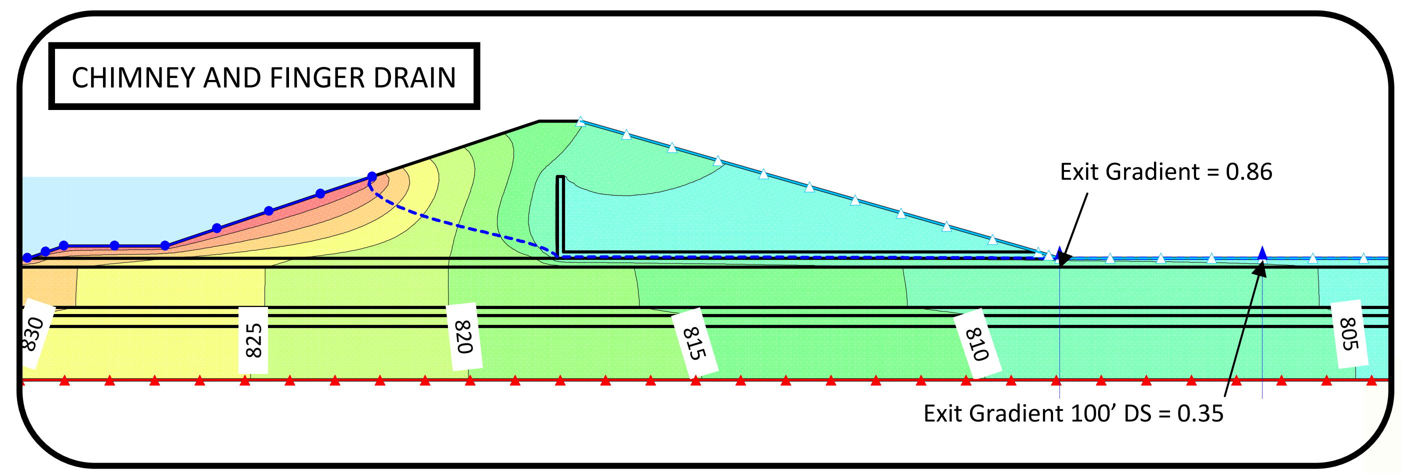


SSS RESULTS (SLURRY TRENCH)





SSS RESULTS (NO SLURRY TRENCH)



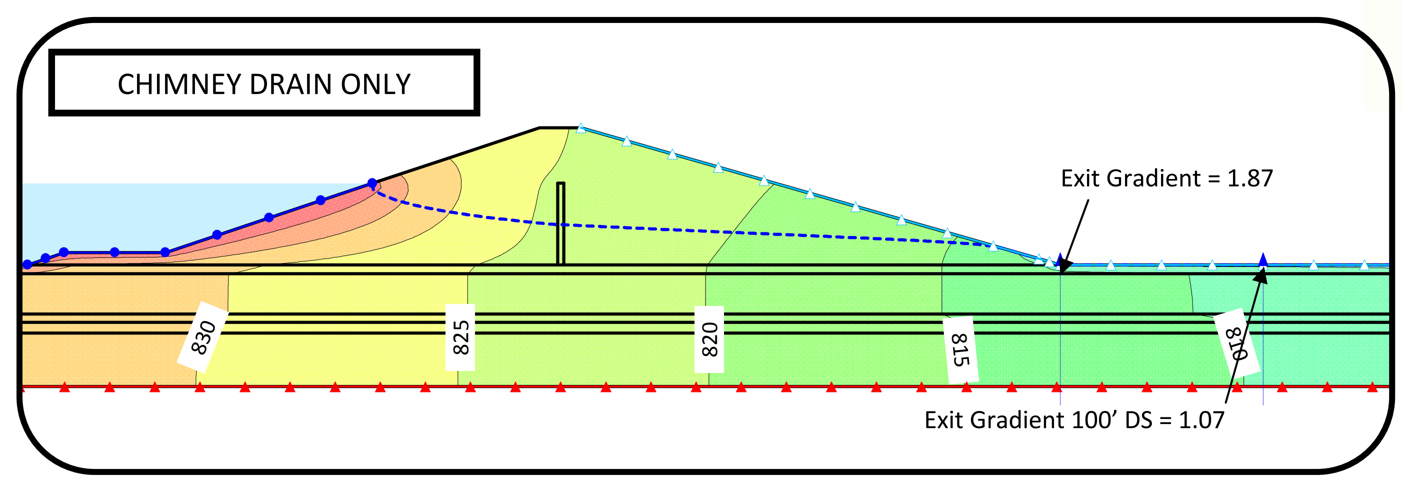


PLATE 8

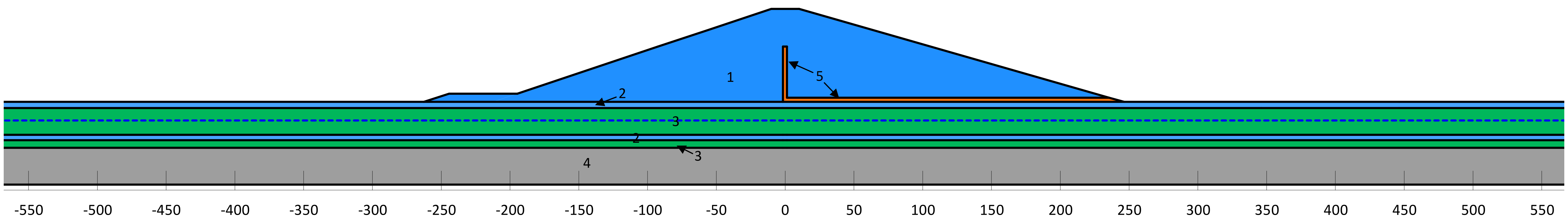
CITY OF WICHITA FALLS
Proposed Lake Ringgold
SEEPAGE ANALYSIS—SECTION B-B

FREESE NICHOLS
4055 International Plaza Suite 200
Fort Worth, TX 76109

FNI PROJECT: WCH12407
FILE: T:\Geotech\Stability Models
DATE: May 30, 2013
PREPARED: MAI

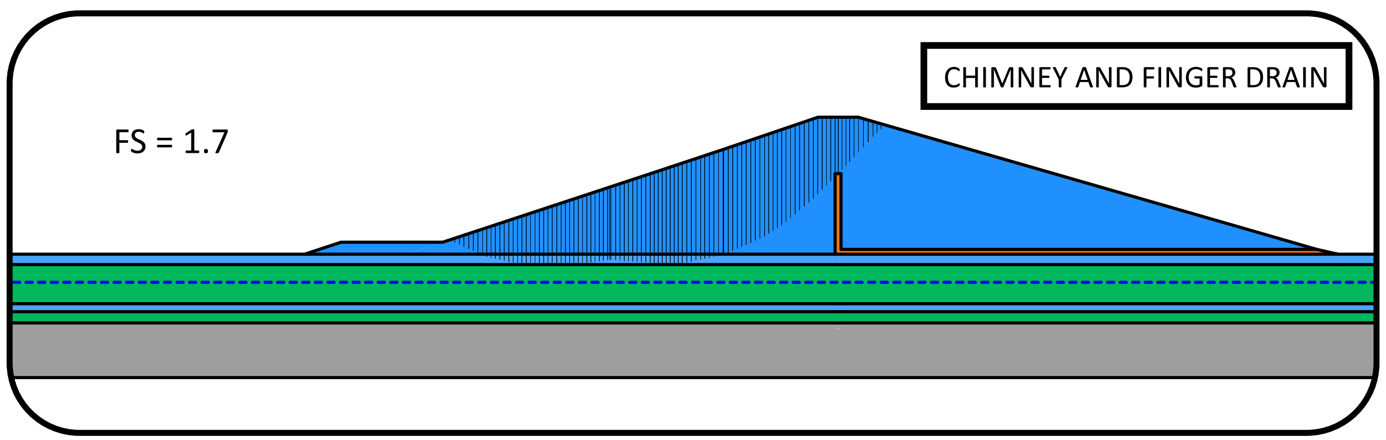
Material		Unit Weight	Effective/Drained		Total CU		Total UU		K_{sat}	K_{sat}	Conductivity Ratio
		(pcf)	c'	ϕ'	c	ϕ	c	ϕ	(cm/sec)	(ft/sec)	(K_v/K_h)
1	CL—Embankment	126	150	27	300	22	1500	0	5.0E-07	1.6E-08	0.25
2	CL—Foundation	124	150	27	300	22	1500	0	2.0E-06	6.6E-08	0.25
3	SM—Silty Sand	125	0	31	-	-	-	-	3.0E-04	9.8E-06	0.33
4	Mudstone	139	3100	20	-	-	-	-	1.0E-05	3.3E-07	0.1
5	Sand Drain	110	0	36	-	-	-	-	2.0E-02	6.6E-04	1
6	Slurry Trench	-	-	-	-	-	-	-	1.0E-08	3.3E-10	1

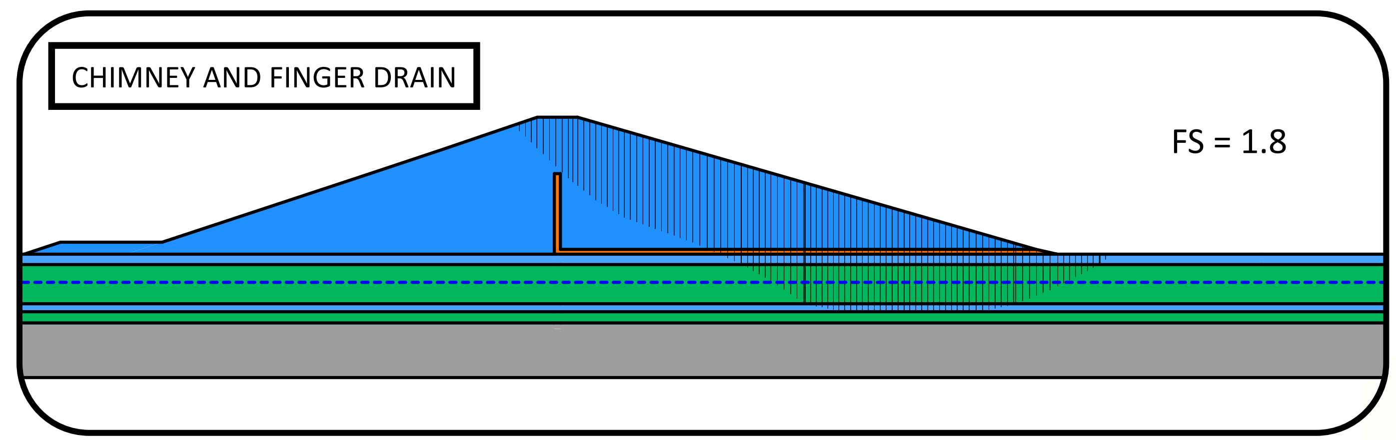
Cross Section Location:	B-B (Left Valley Section)
Loading Condition:	Ground Seepage Elevation 790.5 ft-msl
Upstream Slope:	3H:1V
Downstream Slope:	3.5H:1V
Upstream Berm:	50 ft Wide (Top Elevation 810 ft-msl)
Analysis Type:	End-of-Construction

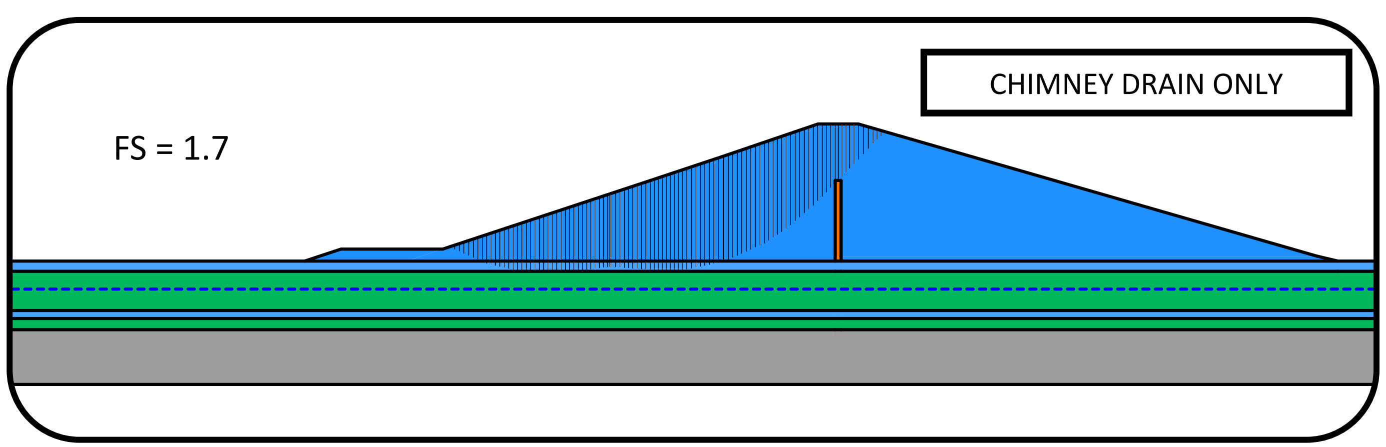


EOC RESULTS (UPSTREAM BERM)

EOC RESULTS (UPSTREAM BERM)







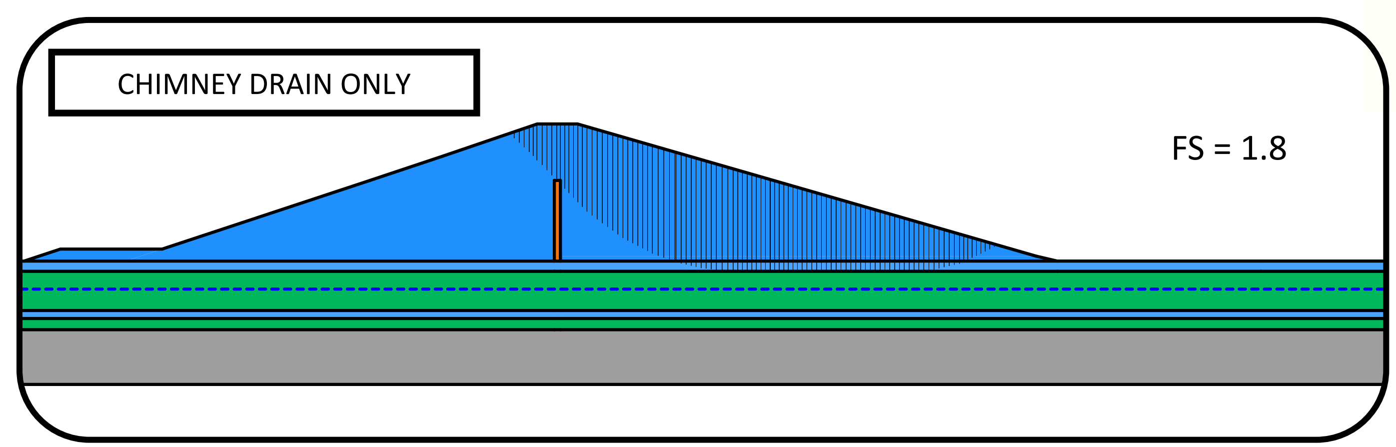


PLATE 9

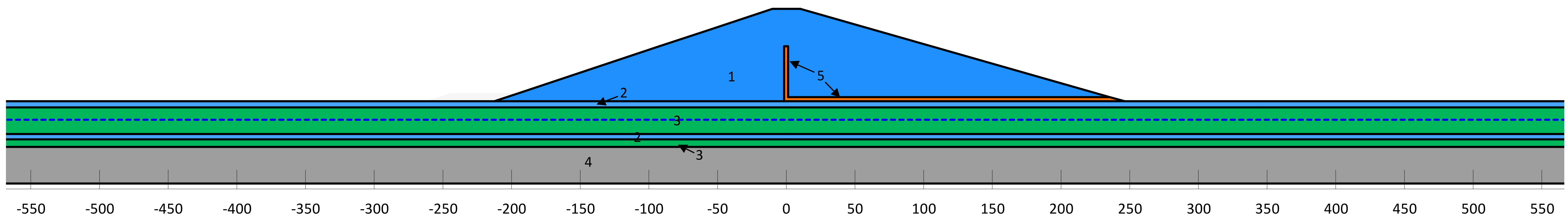
CITY OF WICHITA FALLS
Proposed Lake Ringgold
SLOPE STABILITY ANALYSIS—SECTION B-B

FREESE NICHOLS
4055 International Plaza Suite 200
Fort Worth, TX 76109

FNI PROJECT: WCH12407
FILE: T:\Geotech\Stability Models
DATE: May 30, 2013
PREPARED: MAI

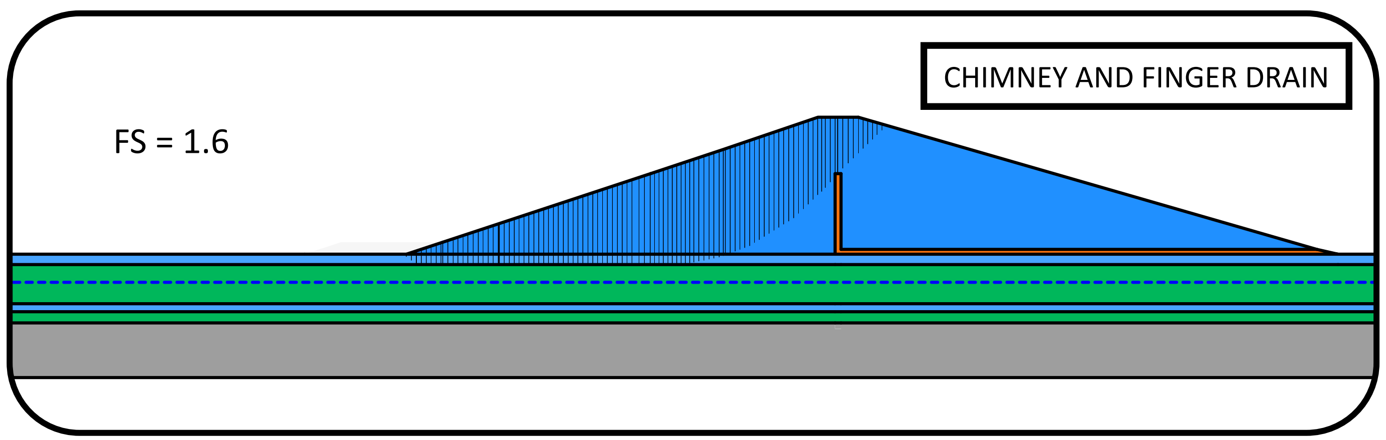
	Material	Unit Weight	Effective/Drained		Total CU		Total UU		K_{sat}	K_{sat}	Conductivity Ratio
		(pcf)	c'	ϕ'	c	ϕ	c	ϕ	(cm/sec)	(ft/sec)	(K_v/K_h)
1	CL—Embankment	126	150	27	300	22	1500	0	5.0E-07	1.6E-08	0.25
2	CL—Foundation	124	150	27	300	22	1500	0	2.0E-06	6.6E-08	0.25
3	SM—Silty Sand	125	0	31	-	-	-	-	3.0E-04	9.8E-06	0.33
4	Mudstone	139	3100	20	-	-	-	-	1.0E-05	3.3E-07	0.1
5	Sand Drain	110	0	36	-	-	-	-	2.0E-02	6.6E-04	1
6	Slurry Trench	-	-	-	-	-	-	-	1.0E-08	3.3E-10	1

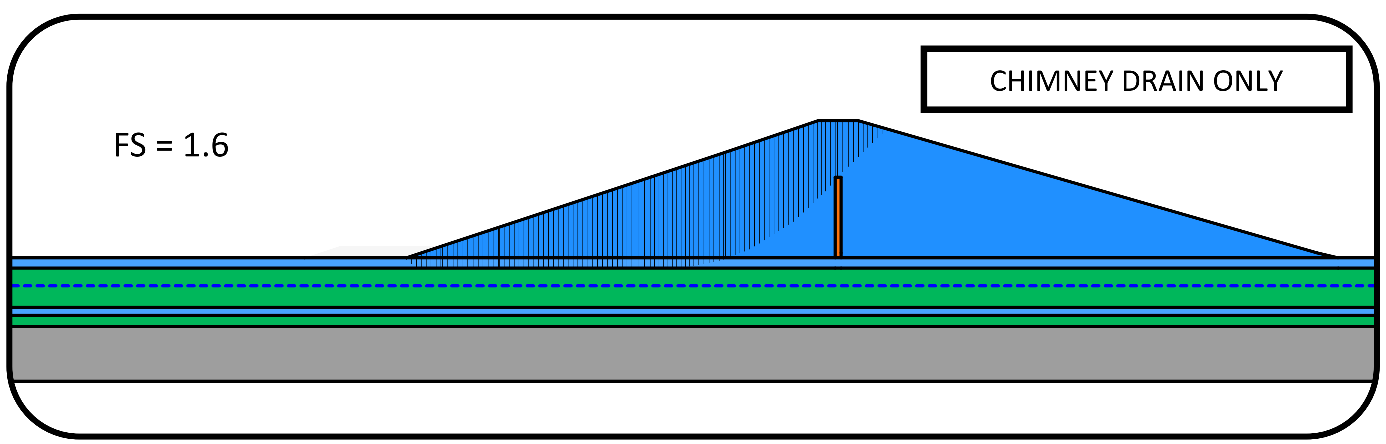
Cross Section Location:	B-B (Left Valley Section)
Loading Condition:	Ground Seepage Elevation 790.5 ft-msl
Upstream Slope:	3H:1V
Downstream Slope:	3.5H:1V
Upstream Berm:	None
Analysis Type:	End-of-Construction



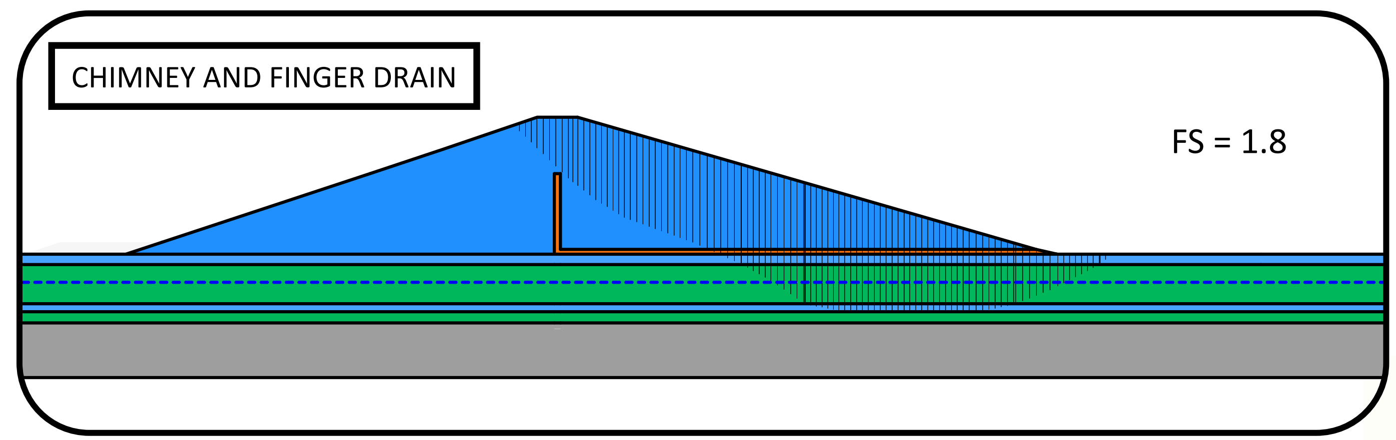
Distance (ft)

EOC RESULTS (NO UPSTREAM BERM)





EOC RESULTS (NO UPSTREAM BERM)



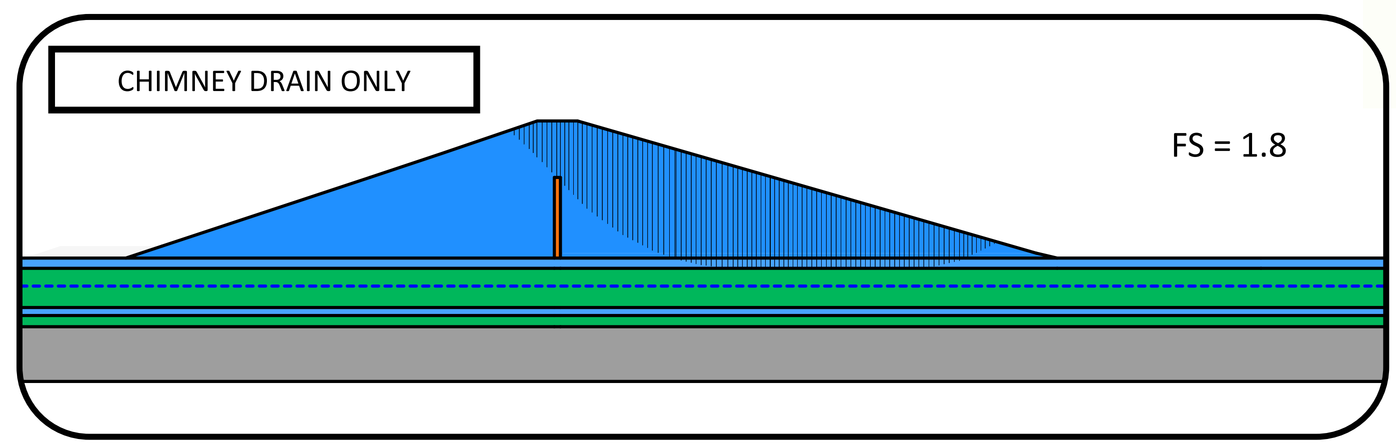


PLATE 10

CITY OF WICHITA FALLS

Proposed Lake Ringgold

SLOPE STABILITY ANALYSIS—SECTION B-B

FREESE NICHOLS
4055 International Plaza Suite 200
Fort Worth, TX 76109

FNI PROJECT: WCH12407

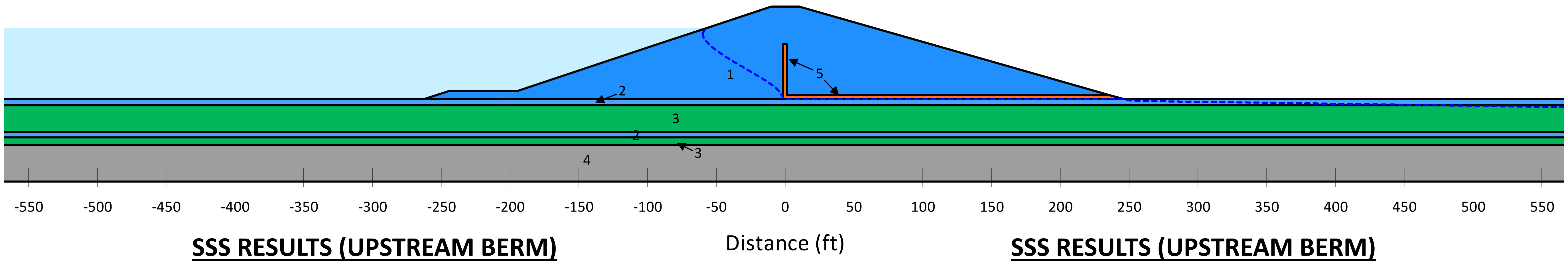
FILE: T:\Geotech\Stability Models

DATE: May 30, 2013

PREPARED: MAI

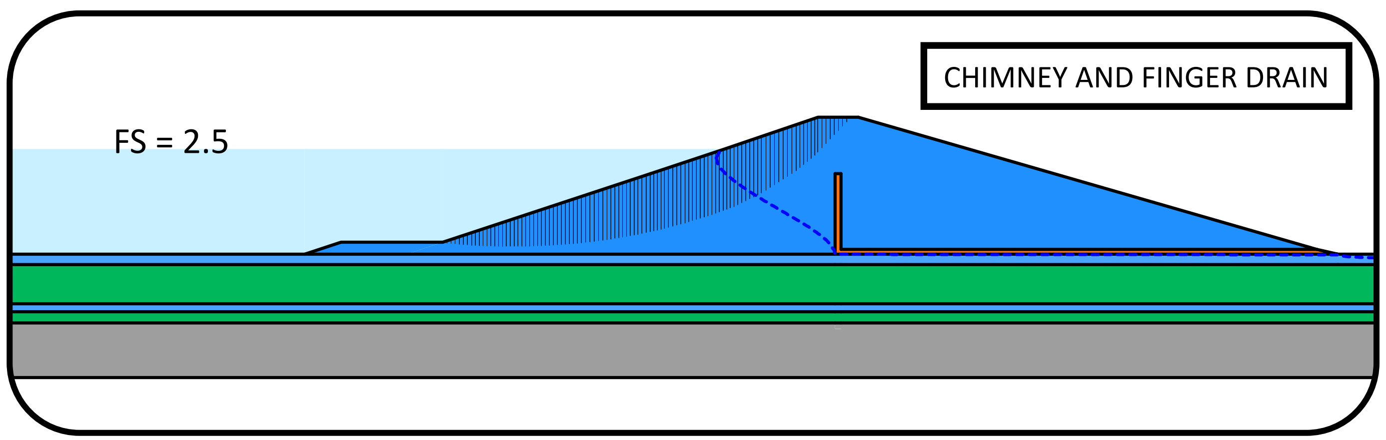
Material		Unit Weight	Effective/Drained		Total CU		Total UU		K_{sat}	K_{sat}	Conductivity Ratio
		(pcf)	c'	ϕ'	c	ϕ	c	ϕ	(cm/sec)	(ft/sec)	(K_v/K_h)
1	CL—Embankment	126	150	27	300	22	1500	0	5.0E-07	1.6E-08	0.25
2	CL—Foundation	124	150	27	300	22	1500	0	2.0E-06	6.6E-08	0.25
3	SM—Silty Sand	125	0	31	-	-	-	-	3.0E-04	9.8E-06	0.33
4	Mudstone	139	3100	20	-	-	-	-	1.0E-05	3.3E-07	0.1
5	Sand Drain	110	0	36	-	-	-	-	2.0E-02	6.6E-04	1
6	Slurry Trench	-	-	-	-	-	-	-	1.0E-08	3.3E-10	1

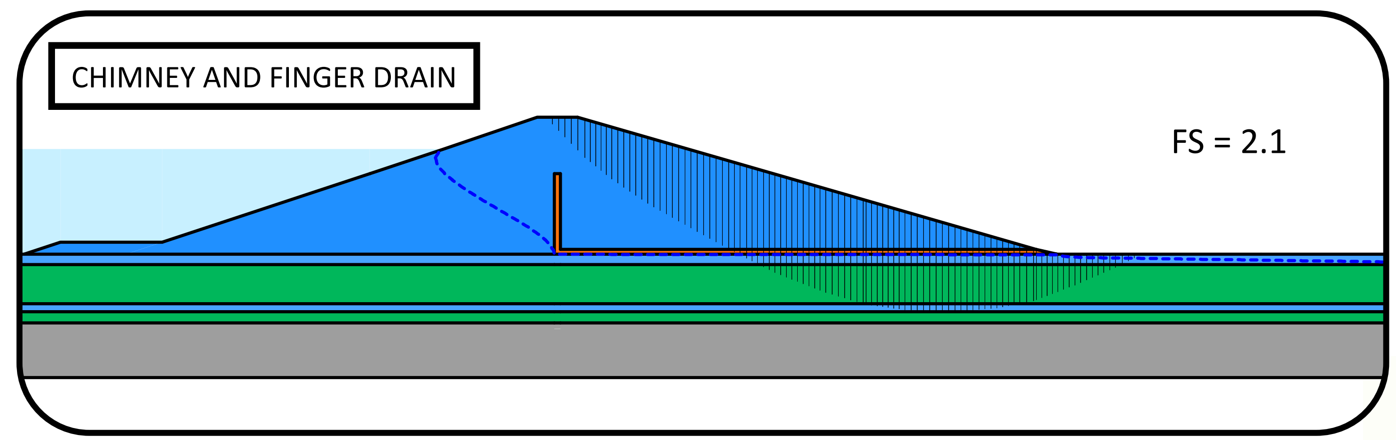
Cross Section Location:	B-B (Left Valley Section)
Loading Condition:	Emergency Spillway Elevation 856 ft-msl
Upstream Slope:	3H:1V
Downstream Slope:	3.5H:1V
Upstream Berm:	50 ft Wide (Top Elevation 810 ft-msl)
Analysis Type:	Steady-State Seepage

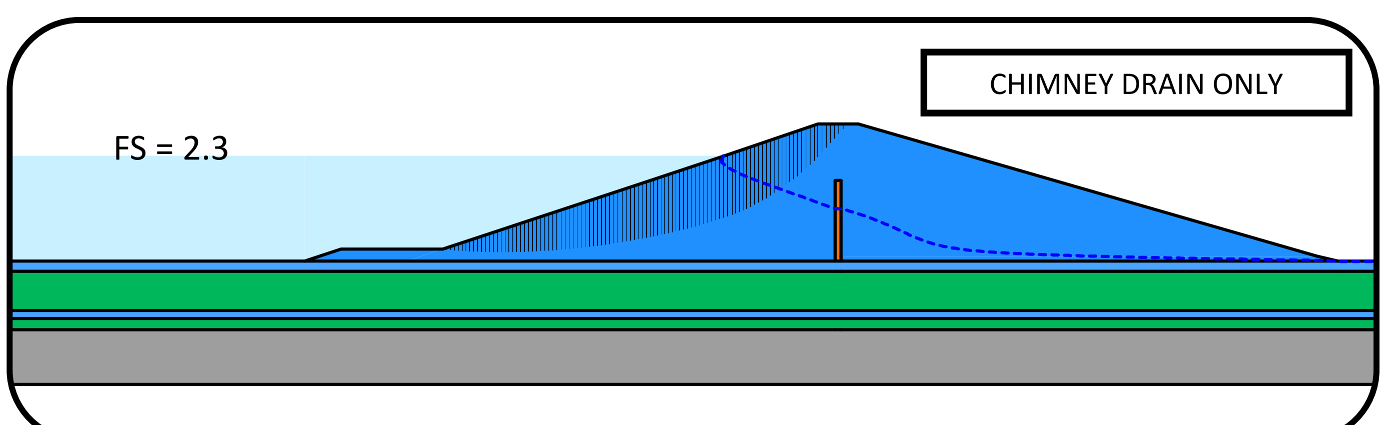


SSS RESULTS (UPSTREAM BERM)

SSS RESULTS (UPSTREAM BERM)







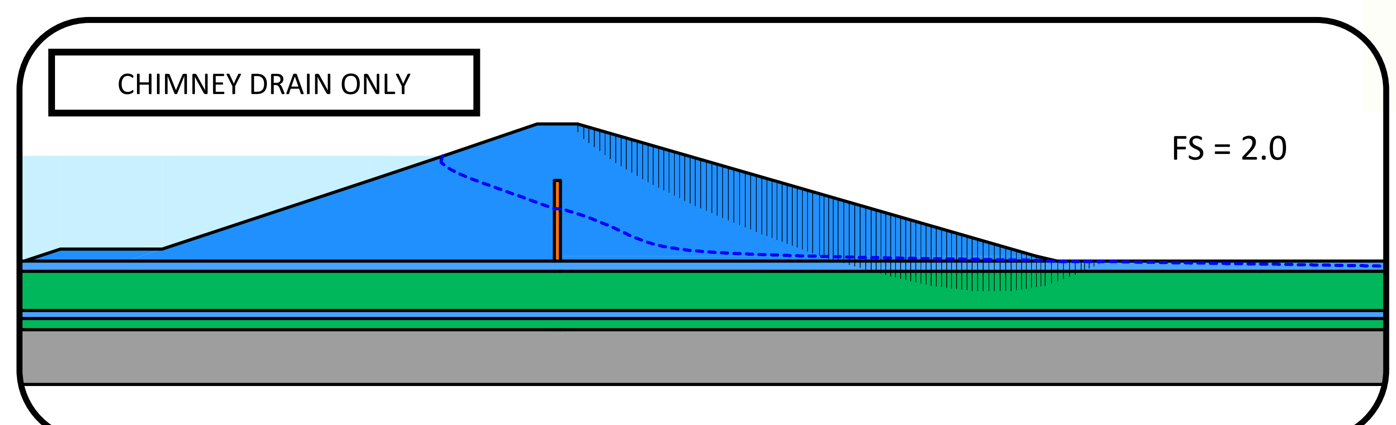


PLATE 11

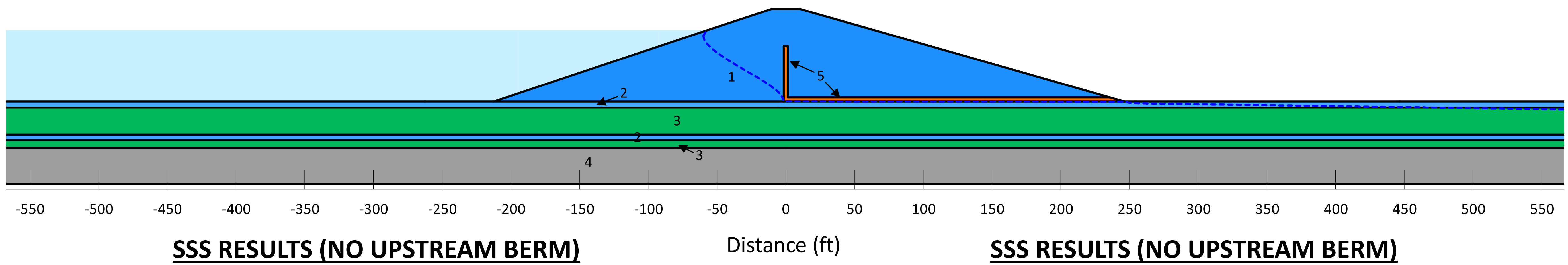
CITY OF WICHITA FALLS
Proposed Lake Ringgold
SLOPE STABILITY ANALYSIS—SECTION B-B

FREESE NICHOLS
4055 International Plaza Suite 200
Fort Worth, TX 76109

FNI PROJECT: WCH12407
FILE: T:\Geotech\Stability Models
DATE: May 30, 2013
PREPARED: MAI

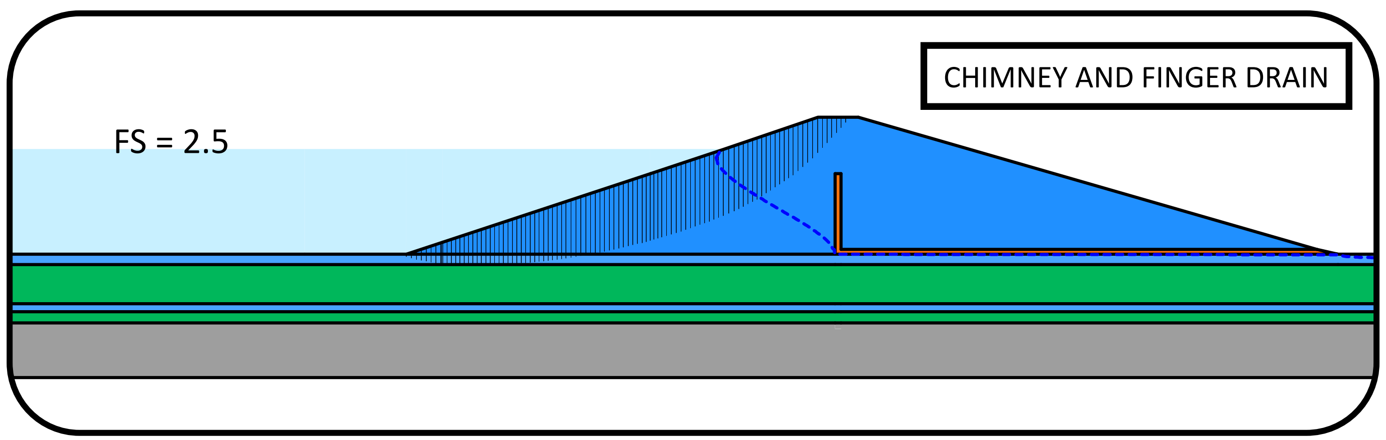
Material		Unit Weight	Effective/Drained		Total CU		Total UU		K_{sat}	K_{sat}	Conductivity Ratio
		(pcf)	c'	ϕ'	c	ϕ	c	ϕ	(cm/sec)	(ft/sec)	(K_v/K_h)
1	CL—Embankment	126	150	27	300	22	1500	0	5.0E-07	1.6E-08	0.25
2	CL—Foundation	124	150	27	300	22	1500	0	2.0E-06	6.6E-08	0.25
3	SM—Silty Sand	125	0	31	-	-	-	-	3.0E-04	9.8E-06	0.33
4	Mudstone	139	3100	20	-	-	-	-	1.0E-05	3.3E-07	0.1
5	Sand Drain	110	0	36	-	-	-	-	2.0E-02	6.6E-04	1
6	Slurry Trench	-	-	-	-	-	-	-	1.0E-08	3.3E-10	1

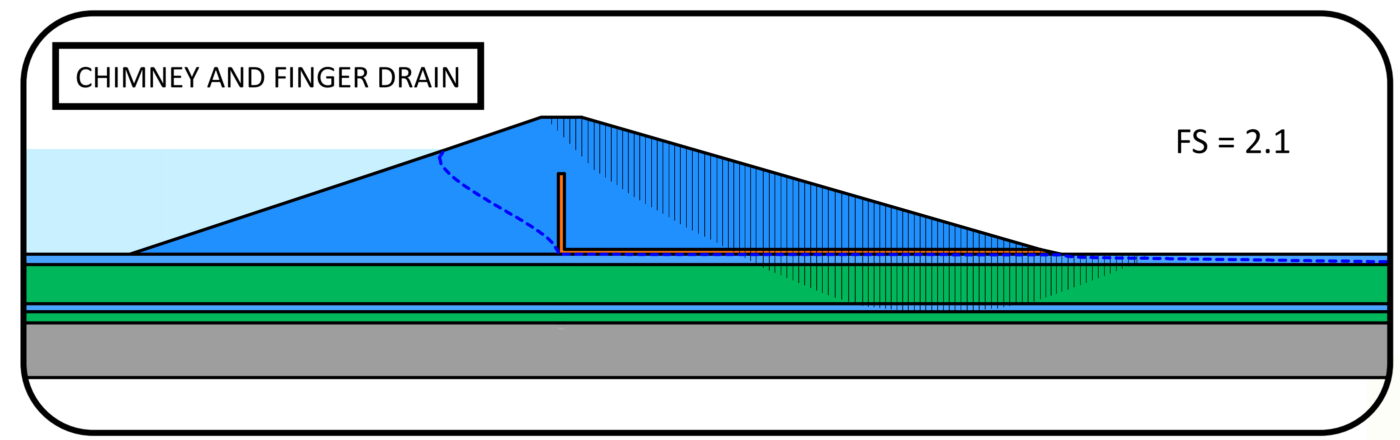
Cross Section Location:	B-B (Left Valley Section)
Loading Condition:	Emergency Spillway Elevation 856 ft-msl
Upstream Slope:	3H:1V
Downstream Slope:	3.5H:1V
Upstream Berm:	None
Analysis Type:	Steady-State Seepage

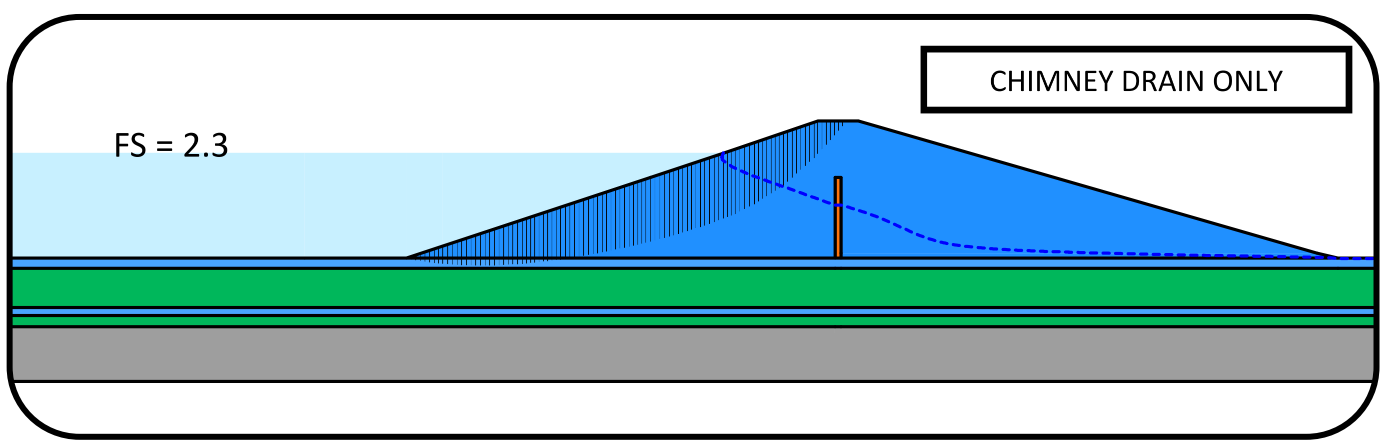


SSS RESULTS (NO UPSTREAM BERM)

SSS RESULTS (NO UPSTREAM BERM)







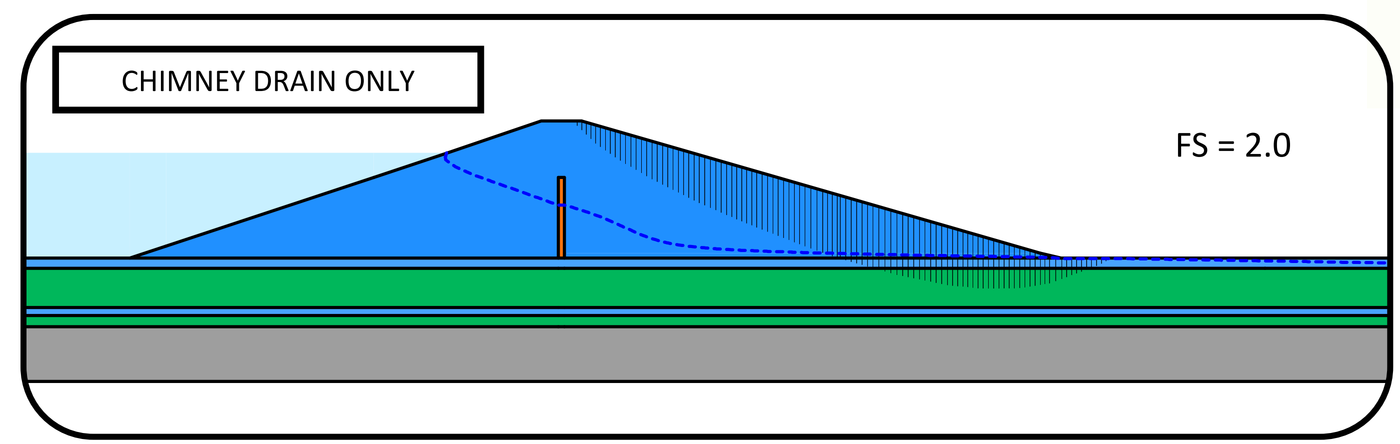


PLATE 12

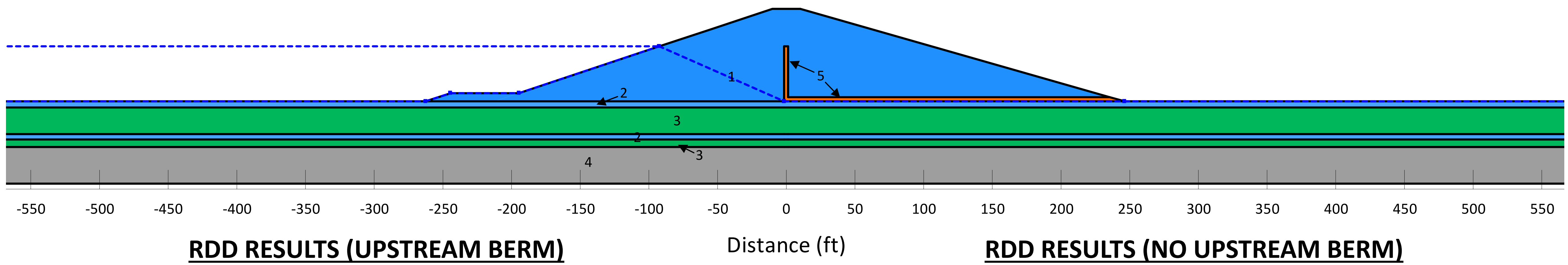
CITY OF WICHITA FALLS
Proposed Lake Ringgold
SLOPE STABILITY ANALYSIS—SECTION B-B

FREESE NICHOLS
4055 International Plaza Suite 200
Fort Worth, TX 76109

FNI PROJECT: WCH12407
FILE: T:\Geotech\Stability Models
DATE: May 30, 2013
PREPARED: MAI

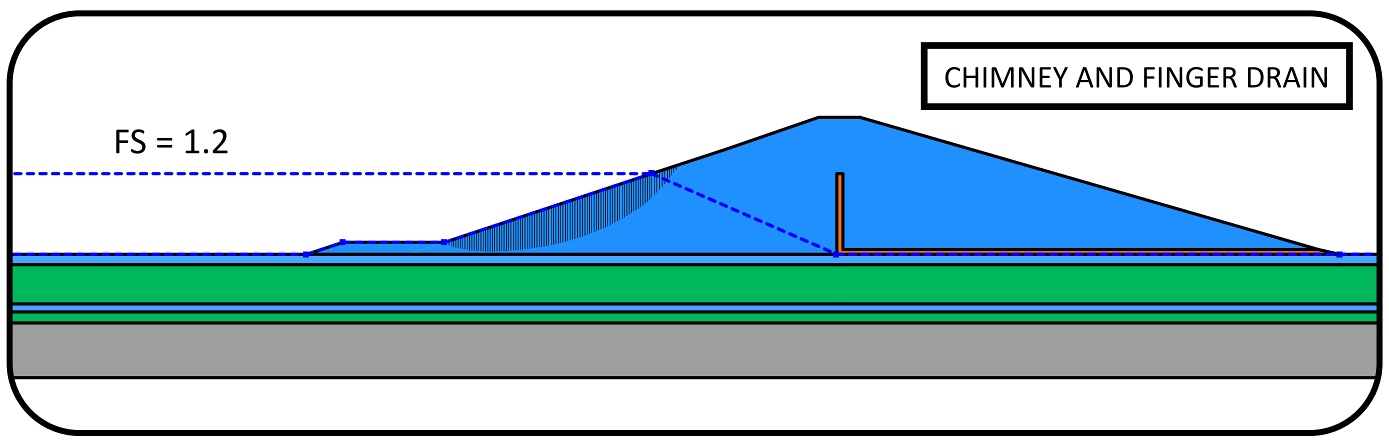
Material		Unit Weight	Effective/Drained		Total CU		Total UU		K_{sat}	K_{sat}	Conductivity Ratio
		(pcf)	c'	ϕ'	c	ϕ	c	ϕ	(cm/sec)	(ft/sec)	(K_v/K_h)
1	CL—Embankment	126	150	27	300	22	1500	0	5.0E-07	1.6E-08	0.25
2	CL—Foundation	124	150	27	300	22	1500	0	2.0E-06	6.6E-08	0.25
3	SM—Silty Sand	125	0	31	-	-	-	-	3.0E-04	9.8E-06	0.33
4	Mudstone	139	3100	20	-	-	-	-	1.0E-05	3.3E-07	0.1
5	Sand Drain	110	0	36	-	-	-	-	2.0E-02	6.6E-04	1
6	Slurry Trench	-	-	-	-	-	-	-	1.0E-08	3.3E-10	1

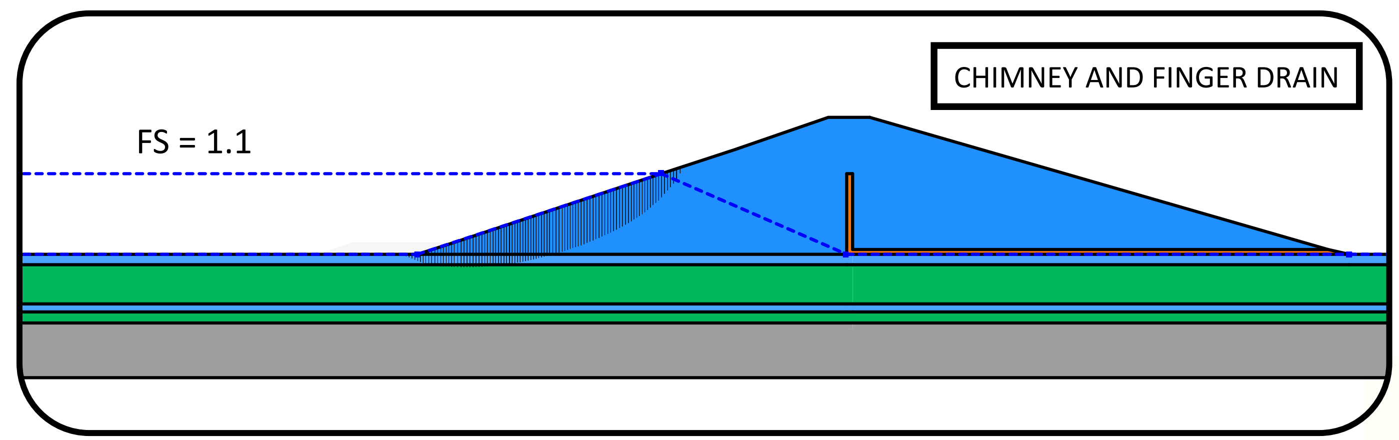
Cross Section Location:	B-B (Left Valley Section)
Loading Condition:	Elevation 844 ft-msl to Empty
Upstream Slope:	3H:1V
Downstream Slope:	3.5H:1V
Upstream Berm:	Varies
Analysis Type:	Multi-stage Rapid Drawdown

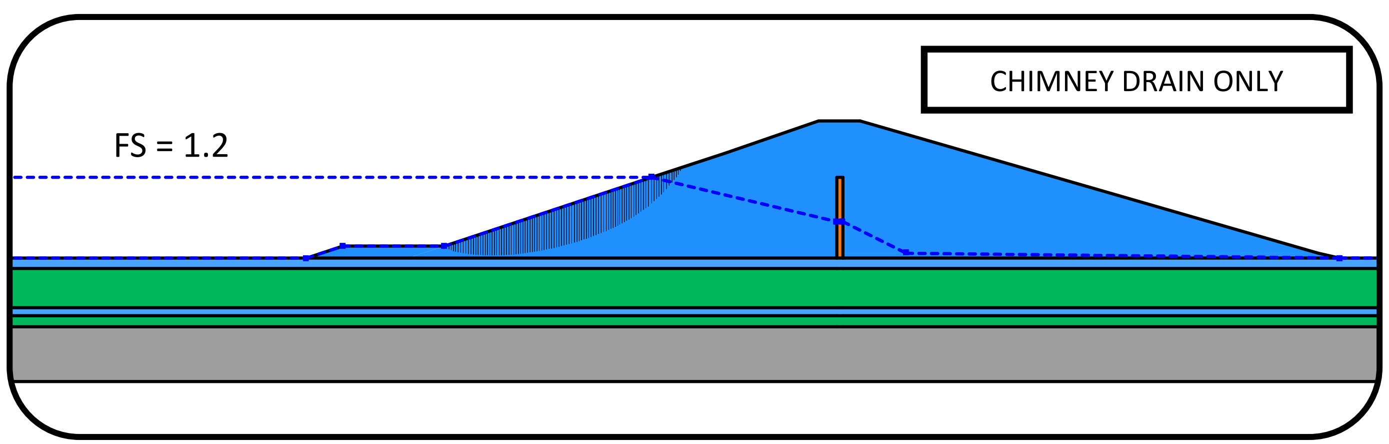


RDD RESULTS (UPSTREAM BERM)

RDD RESULTS (NO UPSTREAM BERM)







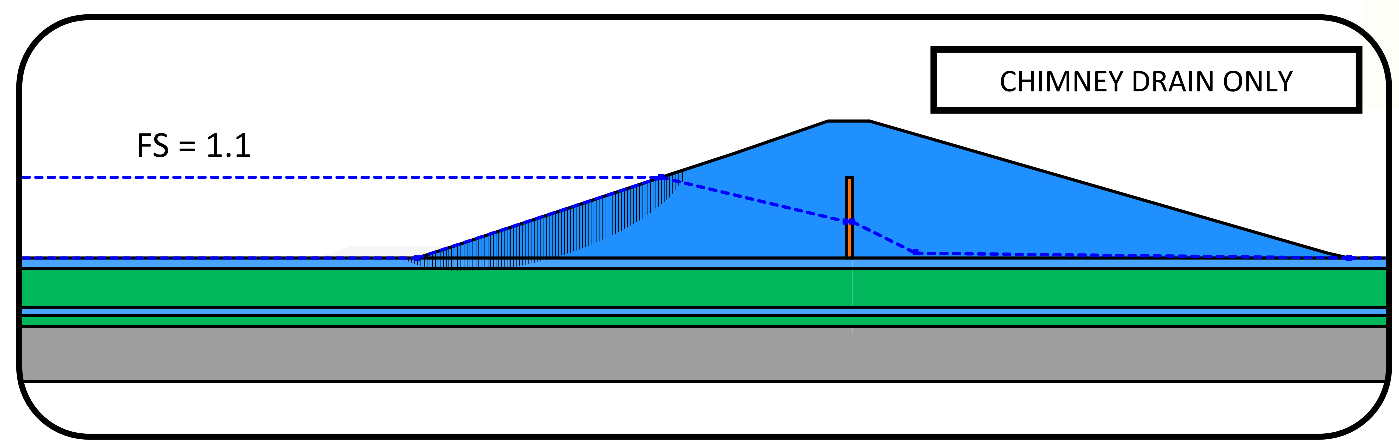


PLATE 13

CITY OF WICHITA FALLS

Proposed Lake Ringgold

SLOPE STABILITY ANALYSIS—SECTION B-B

FREESE NICHOLS
4055 International Plaza Suite 200
Fort Worth, TX 76109

FNI PROJECT: WCH12407

FILE: T:\Geotech\Stability Models

DATE: May 30, 2013

PREPARED: MAI

212 N. Main
PO Box 46
Muenster, TX 76252
940-759-2915 Fax: 940-759-2916
www.gehriginc.com

Geophysical Exploration Report for Proposed Ringgold Dam

January 11, 2013

Prepared for:

FREESE AND NICHOLS

Prepared by:

GEHRIG inc

Michael D. Gehrig, P.G., P.E.
President

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REPORT INDEX

APPENDIX

APPENDIX A – GEOPHYSICAL DATA

Proposed Ringgold Dam
Clay County, Texas

A. INTRODUCTION

The proposed Ringgold Reservoir is will be located on the Little Wichita River northeast of Henrietta, just upstream of the confluence with the Red River in Clay County. The proposed conservation pool will be at an elevation of 844 feet with a conservation capacity of 271,600 acre-feet. The inundated area at the top of the conservation pool will be 14,980 acres.

Freese and Nichols requested 2-D exploratory geophysical methods, specifically electrical resistivity tomography and induced polarization, to provide a more detailed subsurface model across the centerline of the proposed dam. A 10-channel, IRIS Syscal resistivity meter was used to collect geo-electrical measurements.

B. DOCUMENTATION REVIEW

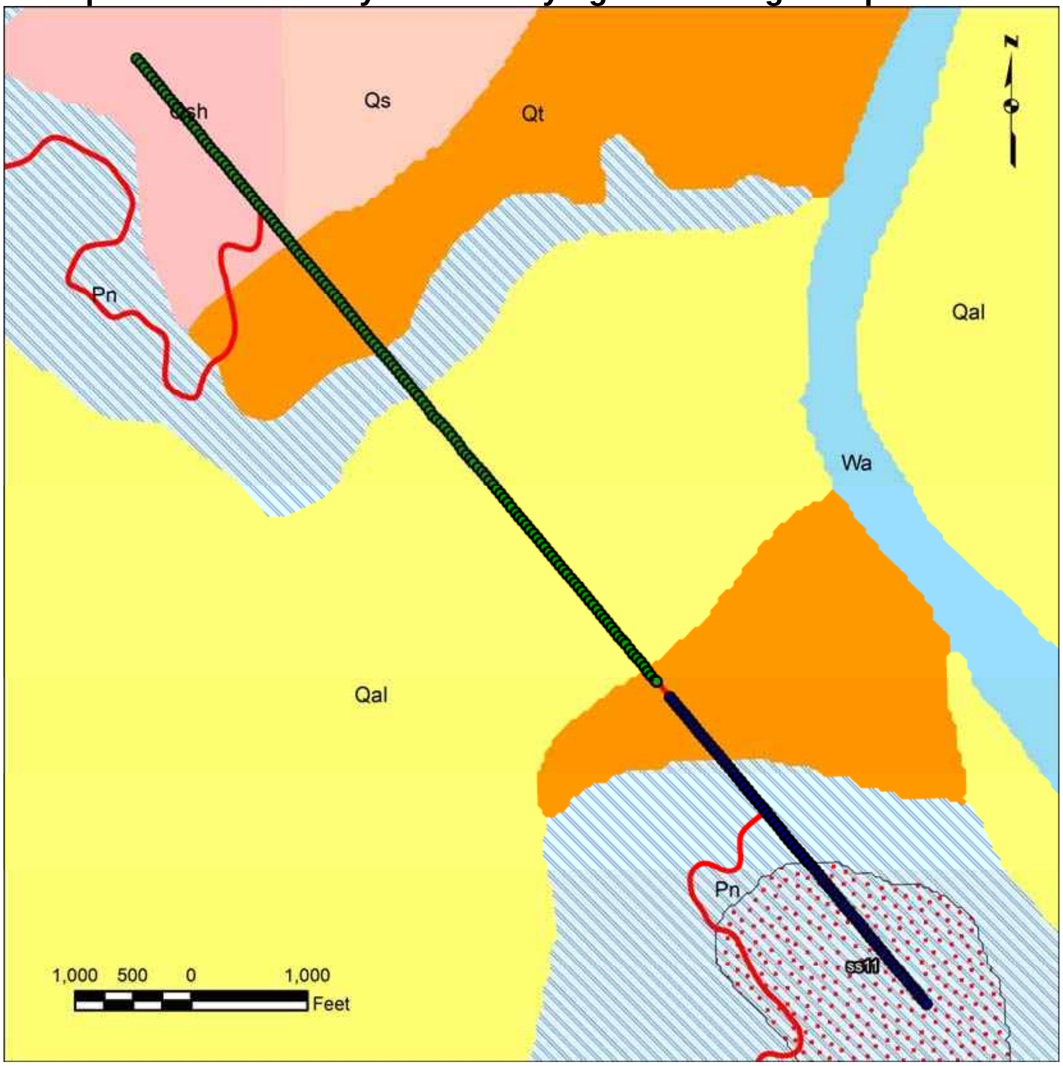
I. Regional Geologic Conditions

Based on the Geologic Atlas of Texas, Wichita Falls - Lawton and Sherman Sheets [1, 2], the geophysical survey crosses multiple geologic units. Map 1 consists of the geophysical survey lines overlain on the geologic map. The northwest portion of the survey crosses the Windblown silts, sheet deposits (Qs-Qsh), of Pleistocene age. This unit consists of silt, sand, and clay; it is massive with crude vertical joints and buried soils. Subdued dune topography is present. Thickness of sheet deposits increases up to 20 feet.

Fluviatile terrace deposits of Pleistocene age (Qt) are also variable in material type containing gravel, sand, and silt. Surrounding the Little Wichita River, the Holocene age Alluvium deposits (Qal) are present. These are flood plain deposits including indistinct low terrace deposits of gravel, sand, silt, and clay.

Outcropping an older geologic unit, the Nocona Formation (Pn, ss11) of Permian age, is exposed on both sides of the Little Wichita River. The Nocona Formation consists of mudstone, shale, sandstone, siltstone, and conglomerates. Exposed sandstone of the Nocona Formation is mapped separately (ss11). Sandstone units are fine-grained to coarse-grained and large scale cross beds are common. In Clay County, individual members locally exhibit multistory configuration of sandstone beds with thickness of sandstone members 5 to 40 feet. Overall thickness of Nocona Formation is 280 to 350 feet.

Map 1. ERT/IP Survey Line Overlying the Geologic Map of Texas



C. NEAR SURFACE GEOPHYSICAL EXPLORATION TECHNIQUES

Near surface geophysical exploration techniques are typically defined as exploratory techniques for the upper 100+ feet. Geophysical testing provides relatively non-destructive means of assessing subsurface conditions below ground level. There are several near surface geophysical techniques which can be implemented, namely seismic reflection and refraction, multi-channel analysis of surface waves (MASW), ground penetrating radar, electrical resistivity tomography (ERT) and induced polarization (IP), electromagnetic mapping, gravity and magnetic surveying. Each technique has its pros and cons based on given subsurface geologic conditions, project scope, economics, etc. Further, geophysical techniques can be used to better identify points or areas of further interest for further evasive testing, i.e. test pits, geotechnical borings, etc.

Pertinent information regarding moisture and material differences of various sites was obtained using the geo-electrical methods, namely electrical resistivity (ERT) and induced polarization (IP). Time domain induced polarization surveys were performed concurrently with the direct current (DC) electrical resistivity surveys. Induced polarization surveys compliment the electrical resistivity surveys in providing additional information on the electrical characteristics of a given soil/rock matrix.

I. Electrical Resistivity

Soil composition for a given soil/rock mass is the primary influence of the electrical resistivity property. In saturated conditions, the more saline the free water within the soil pore spaced, the lower the overall electrical resistivity values. Therefore, the relative ease or difficulty that the electrical current passes through these soils and/or rock can provide information regarding the soil/rock types both laterally and vertically. Due to the natural physical properties of clays or clay based rocks (i.e. shales, marl, etc.), the higher concentration of clay in a given soil mass results in lower electrical resistance of that soil mass. The higher concentration of granular soils such as sand or gravel, or lower concentration of clay soils, results in higher electrical resistivity properties of a given soil mass.

II. Induced Polarization and Chargeability (M)

Induced polarization imaging evaluates the capability for the soil/rock matrix to store an electrical charge, much like a capacitor. This polarization occurs at the interface between a metal and fluid (electrode polarization) and a non-metal (e.g. clay minerals) and a fluid (membrane polarization). The time domain, induced polarization measures the magnitude of this polarization over the course of an approximate one to two second window. Fundamentally, the induced polarization responses depend on microgeometry and mineralogy, pore fluid chemistry, and saturation. The chargeability (*M*), or magnitude of the induced polarization response, is proportional to the ratio of surface resistance to the bulk (or electrolytic) resistance.

D. FIELD INVESTIGATION

On December 10 to 12, 2013, Gehrig, Inc. conducted a geo-electrical profile across the centerline of the proposed Ringgold dam. Two separate lines were conducted at this site. ERT/IP Lines #1 and #2 was conducted across the west side of the FM 2332 covering 7,016 linear feet. This survey also crossed the Little Wichita River. ERT/IP Line #3 was conducted east of FM 2332 covering 3,454 linear feet. The combined survey coverage length was 10,470 linear feet, or 1.98 miles.

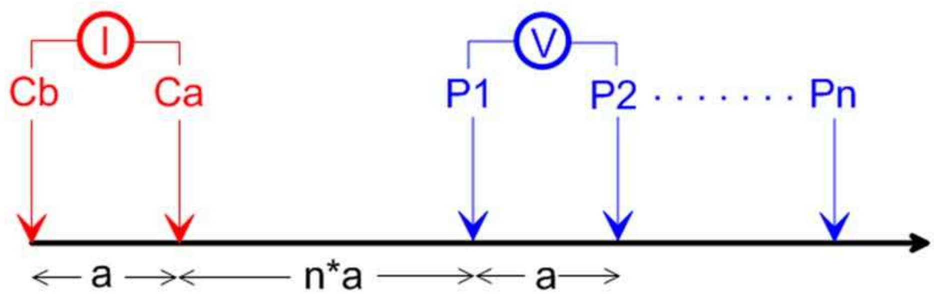
I. Equipment

The resistivity meter is a 10-channel, Syscal Pro designed and manufactured by IRIS Instruments. This resistivity meter is designed to collect time domain, induced polarization and direct current (DC) electrical measurements. Although it possesses an internal power source, it is typically powered by a 12 volt (V) external battery. In the time domain IP mode, the programmable mode offers 20 fully independent IP windows collecting in arithmetic, semi-logarithmic, logarithmic and Cole-Cole modes. It measures the voltage between the receiving electrodes and displays the apparent resistivity and the chargeability values. The measurement is made fully automatically through the control of a microprocessor that does the automatic self potential correction, the digital stacking for signal enhancement and the measurement error display. Real time IP decay curves can be viewed during the data collection process.

II. Instrument Settings

A dipole to dipole array was used to measure both the electrical resistivity and 20 induced polarization windows. Dipole dipole array takes advantage of the multi-channel meter allowing up to 10 measurements per injection sequence. Equally important, dipole to dipole array minimizes electrode polarization influences since the current electrodes would not be subsequently used to measure the primary or secondary voltages. Diagram 1 shows a dipole dipole array geometry used for this site:

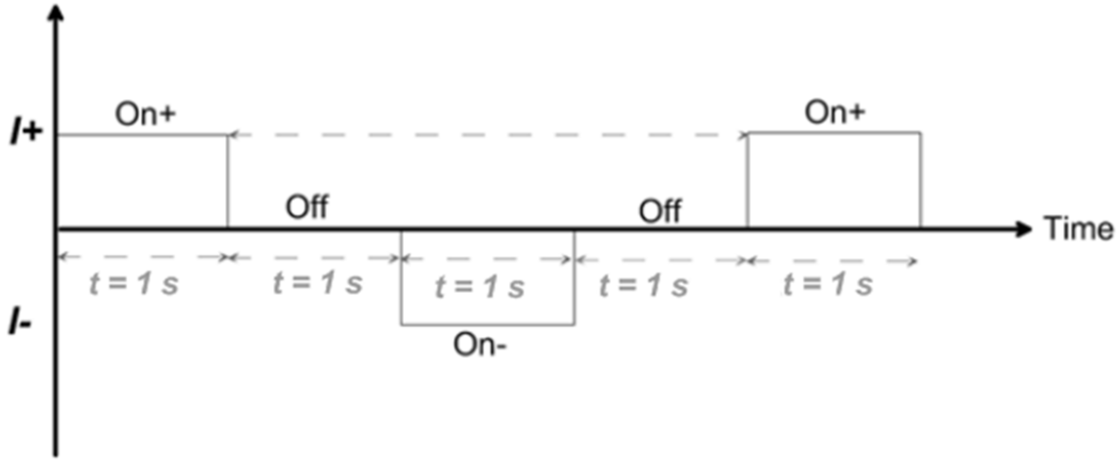
Diagram 1 – Dipole to dipole array geometry



C_a and C_b are the current electrodes and P_1, P_2 to P_n are the potential electrodes during measurements. The distance between the current electrode C_a and the potential electrode P1 is an integer multiple, n, of the distance between the current or potential electrode pair. For this study, n ranges from 1 to 6.

Diagram 2 graphically displays the transmitted waveform for each measurement. Electrical resistivity (*ER*) measurements are collected during the current injection time interval (On+, On-) and induced polarization (*M*) measurements are collected when the current is shut off. As shown in Diagram 2, the polarity is automatically switched between each measurement. For each measurement, the *ER* and *M* measurements are stacked at least two times to improve the signal to noise ratio over the course of the measurement cycle. In noisier or more conductive geologic conditions where signal strength is reduced, the stacking is typically increased to a maximum of three measurements.

Diagram 2 – Transmitted electrical resistivity and time domain waveform



During induced polarization measurements, 20 IP windows were used to define the decay curve in the semi logarithmic mode when the current is shut off. In semi logarithmic mode, the first eight windows span a 20 millisecond (ms) interval per window. The following six measurement windows span 40 ms per window. The last six windows span 80 ms each. The time delay between current shut off and the beginning of the decay curve is 40 milliseconds.

III. Field Setup

Stainless steel electrodes were inserted approximately 4 to 6 inches into the ground at 3 meter on center spacing intervals. Shallower penetrations occurred where shallow sandstone rock was present. The Syscal Pro meter connects to a 96 electrode cable.

IV. Ground Positioning System (GPS)

The geo-electrical lines were surveyed using a 220 channel GNSS receiver capable of tracking GPS and GLONASS satellites together with an integrated dual-frequency GNSS antenna. The GPS handheld uses Trimble H-Star™ technology to deliver decimeter spatial accuracy in the field. Figures 1 to 11 graphically displays the geo-electrical profile positions on 1000 foot increments.

E. DATA PROCESSING

I. Pre processing

Pre-processing electrical resistivity data and induced polarization surveys include the removal of unacceptable induced polarization and/or electrical resistivity values within the datasets. Although high quality electrical resistivity measurements are relatively simple to collect, induced polarization measurement quality should be thoroughly reviewed and noisy and/or errant data removed prior to inversion. First cut through the raw IP dataset includes the removal of repeatable measurement errors exceeding 2 percent. Further, IP data with very low primary signal strength less than 2 millivolts where also rejected. A visual inspection of the remaining induced polarization measurements were also conducted prior to inversion.

Data quality of electrical resistivity measurements were assessed separately from the IP measurements for profile. This allows for a tighter and deeper measurement grid during the inversion process for the electrical resistivity profile. Topographic corrections were applied during preprocessing for each dataset.

II. Inversion

After the removal of unacceptable electrical resistivity and/or induced polarization data points, the corresponding data files were inverted using Res2dinvx64 v. 4.01.29 software by Geotomo Software. The inversion routine used by the program is based on the smoothness constrained least squares method. The inversion process basically tries to reduce the difference between the calculated and measured apparent resistivity values by adjusting the resistivity of the model blocks. A measure of this difference is given by the absolute root-mean-squared (RMS) error. However, it should be noted that the model with the lowest possible absolute RMS error can sometimes show large and unrealistic variations in the model resistivity values and might not be the most representative model from a geological perspective. The more prudent approach is to select the model at the iteration after which the RMS error does not change significantly. This usually occurs between the 2^{nd} and 5^{th} iterations.

The inversion of the resistivity and IP data are carried out concurrently. Immediately after an iteration of the inversion of the resistivity data, an iteration of the IP inversion is carried out.

III. Post Processing

The inverted datasets are exported in a compatible format with topographic corrections applied. During exportation, all linear units are converted into feet, but the true resistivity value is still reported in ohm-meters. Chargeability is reported in millivolt per volt (mV/V). Resistivity data grids were calculated using the kriging method in Surfer v.9 from Golden Software, Inc., and plotted as 2D image maps ranging from 0 to 600 ohm-m. Chargeability data grids were also calculated using the kriging method in Surfer and plotted as 2D image maps ranging from 0 and 30 mV/V.

Figures 1 to 11 plots the electrical resistivity tomographic survey and induced polarization survey along with its spatial position. The red line represents the centerline of the dam structure. Each figure presents 1000 feet of geophysical data, with the exception of the end.

F. ANALYSIS

By the very nature of geophysical exploration techniques, acquired data has an inherit depth uncertainty in comparison to more destructive exploration techniques such as geotechnical borings or test pit excavation. *It should be stated that estimated depths with geophysical exploration techniques cannot be construed as exact depth measurements.* Based on our experience, if the geo-electrical data is acquired, preprocessed, analyzed, and interpreted correctly, depth measurement accuracies up to 5% of the true measured depth is possible, but this estimation does increase with depth due to inherit resolution issues.

Electrical resistivity tomography and induced polarization imaging methods are noninvasive techniques. The main advantage of these techniques is the relatively rapid characterization of the subsurface in a 2D or 3D survey area, albeit at a resolution in comparison to invasive characterized 1D points (i.e. exploratory borings). Any geophysical exploration survey method, including electrical resistivity tomography and induced polarization methods, should be used in conjunction with invasive techniques, which are standard for most engineering projects requiring subsurface information.

I. Geophysical Interpretation

In Figure 1 to 11, a cursory interpretation was provided for the electrical resistivity tomography image below the electrical resistivity color scale bar. The low resistive zones, as represented by the blue colors, are indicative of fine grained soils (i.e. clay) along with fine grained rock (i.e. shales/marls) at deeper depths. As shown in the figures, shale units typically underlie the more electrical resistive sand to sandstone units. However, clay and shale units dominate the entire depth of the survey between stations 1875 and 1975 in ERT/IP Lines #1 and #2 as shown in Figure 2.

Moderate resistivity zones are reflected by the green, yellow, and orange colors. These zones are likely reflective of intermixed soil types, such as sandy clays, clayey sands, silty sands, etc. It is possible that interbedded sandstone layers may also be present within these zones. Several deeper moderate zones were encountered between stations 1150 and 1350, 3100 and 3200, and 3400 to 3550 in ERT/IP Lines #1 and #2. Deeper zones were also recorded between stations 150 and 500 and 1025 and 1075 in ERT/IP Line #3.

Sand and sandstone units presumably associated with the Nocona Formation were detected in the upper part of the geophysical survey. High to very high resistivity values are represented by the red, purple, and brown colors. These high to very high zones reflect coarse grained soils (sands) or sandstone. Clean sands can have a similar electrical resistivity response to sandstone. Sandstone outcroppings were visually evident near station 1400 in ERT/IP Line #3 in Figure 9, which comports well with the high electrical resistivity response. The largest very high resistivity zone represented by the brown color (600+ ohm-m) was documented between stations 2900 and 3100 in ERT/IP Lines #1 and #3 shown in Figures 2 and 3.

Based on documentation review [3, 4, 5] and our experience with IP surveys, for groundwater investigations, chargeability decreases with lower pore water resistivity (or more saline water). Hence, in a saturated state, fresh water will have a higher IP response in comparison to saline water within an alluvial setting. In fresh water saturated sandstone or alluvium, IP appears when the surfaces of the sand and gravel are partially coated with a film clay. Water bearing, clean quartz sand void of clays shows almost no chargeability effect. At this site, it is likely that higher IP responses, such as that indicated by the blue and purple colors, are either related to the presence of shallow sandstone units and/or to shallow groundwater influences within intermixed soils (or rock). Higher IP responses in proximity to the Little Wichita River are more likely relative to saturated intermixed soils within alluvium soils. Water seepage within the sandstone units should also be anticipated where a well-defined horizontal IP response has been documented (i.e. between stations 2725 and 3350 in ERT/IP Lines #1 and #2).

G. REFERENCES

1. Bureau of Economic Geology, *Geologic Atlas of Texas, Wichita Falls - Lawton Sheet*. Reprinted 1987.

2. Bureau of Economic Geology, *Geologic Atlas of Texas, Sherman Sheet*. Reprinted 1991.

3. Vacquier, V., Homes, C.R., Kintzinger, P.R., and Lavergne, M., 1957, Prospecting for groundwater by induced electrical polarization, Geophysics, v. 22, 660-687.

4. Sumi, F., 1965, Prospecting for non-metallic minerals by induced polarization, Geophysical Prospecting, v. 13, no. 4, 603-616.

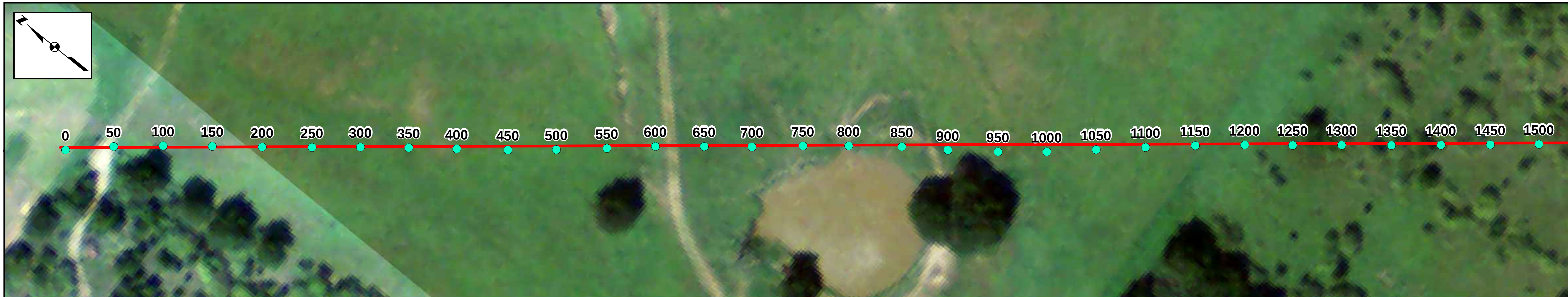
5. Bodmer, R., Ward, S.H., Morrison, H.F., On induced Electrical polarization and groundwater, Geophysics, Vol. 33, No. 5, 805-821.

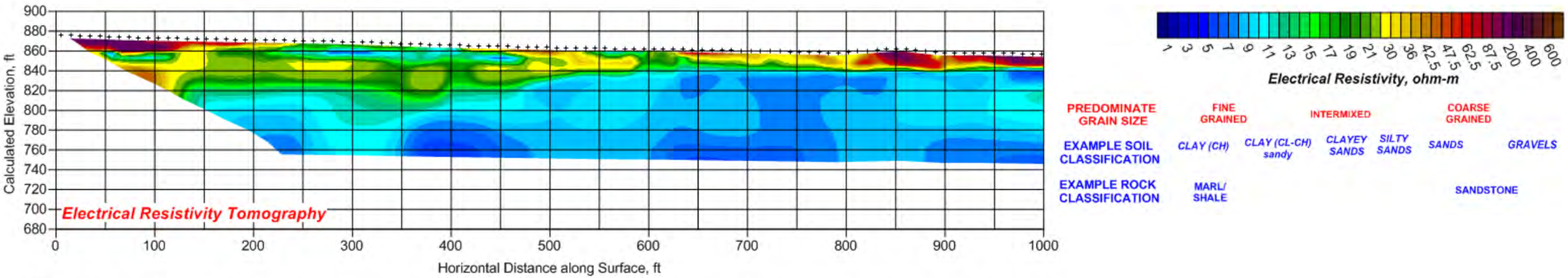
H. LIMITATIONS

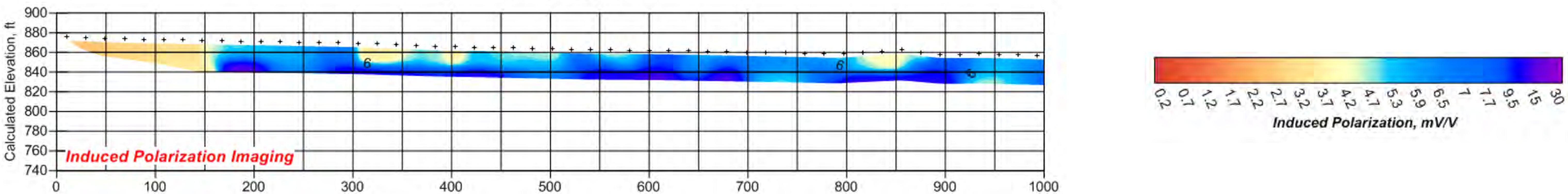
This investigation was performed in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. Gehrig, Inc. analyses are based on geophysical data collection completed at the time of our investigation. There is no warrant, expressed or implied, with regards to this geophysical report. This report does not constitute a guarantee or warranty as to future life, performance, future need for repair or suitability, but for informational purposes only and is not intended to be a rigorous technical evaluation of this property and the underlying subsurface conditions. This report is prepared for the exclusive use of our client. Gehrig, Inc denies permission for use of this report by any other persons for any purpose or by the client for any other purpose unless otherwise obtained and stated in writing.

If any additional information becomes available, then Gehrig, Inc. reserves the right to evaluate the impact of this information on our analysis and to revise our analysis if necessary and warranted after review of the new information.

Any use made of this investigation and any reliance thereon shall be specifically subject to the following limitation of liability: In recognition of the relative risk and benefits of the project to user and Gehrig, Inc., the risks have been allocated such that user agrees, to the fullest extent permitted by law, to limit the liability of Gehrig, Inc. to user for any and all claims, losses, costs, damages of any nature whatsoever or claims expenses from any cause or causes, including attorney's fees and costs and expert witness fees and costs, so that the total aggregate liability of the Gehrig, Inc. to user shall not exceed our billing fee, unless otherwise specifically agreed to in writing. It is intended that this limitation apply to any and all liability or causes of action however alleged or arising, unless otherwise prohibited by law. For the purpose of this provision, Gehrig, Inc. shall include the officers, directors, shareholders, partners, and employees of Gehrig, Inc. This limitation is applicable to Gehrig, Inc. negligence or other fault in whole or in part.







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ERT/IP Lines No. 1 and 2

Proposed Ringgold Dam
Clay County, Texas

Survey Dates: 12/10 to 12/12/2012
Project #: 12-07-001

100 50 0 100
Horizontal Scale: 1 inch = 100 feet

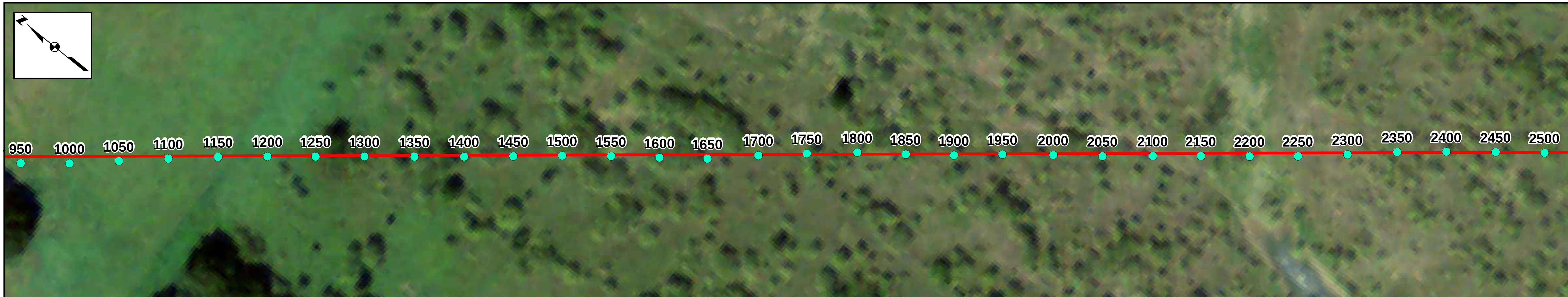
100 50 0 100
Vertical Scale: 1 inch = 100 feet

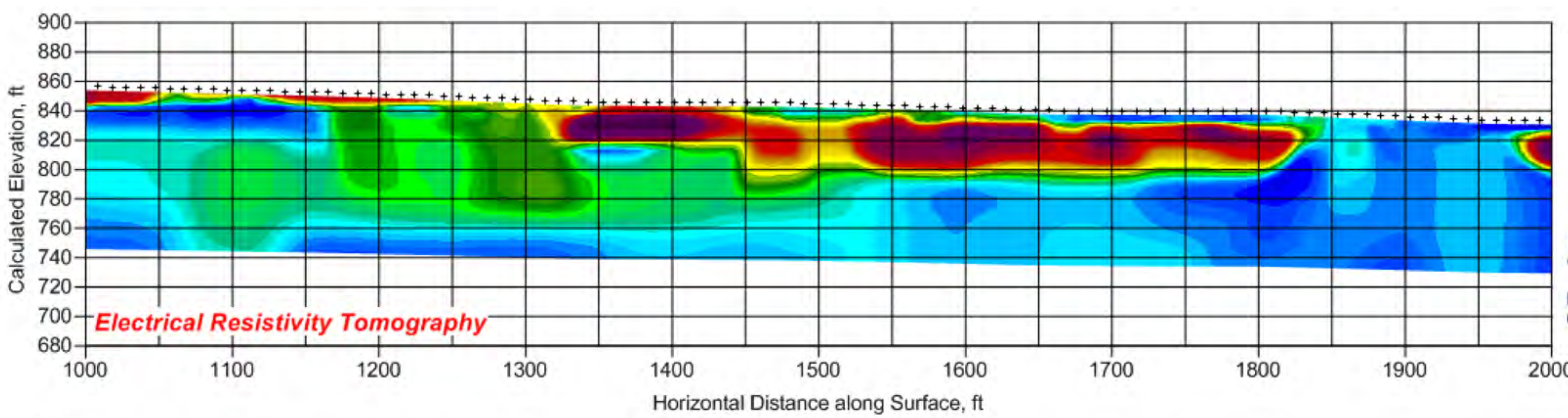
Notes:

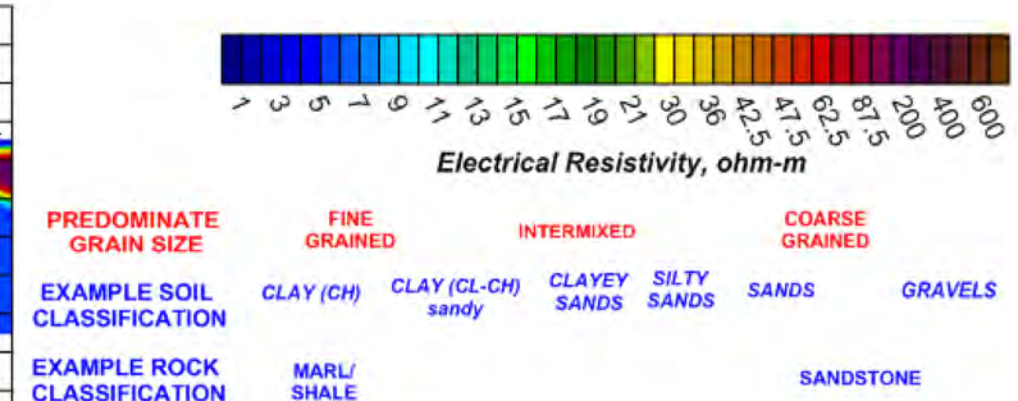
1. Electrical array geometry is dipole dipole with 3 meter electrode spacing.
2. Resistivity inversion conducted with RES2DINV.
3. Aerial: Texas Natural Resources Information System, 2010
4. Red line in aerial indicates proposed centerline of dam.

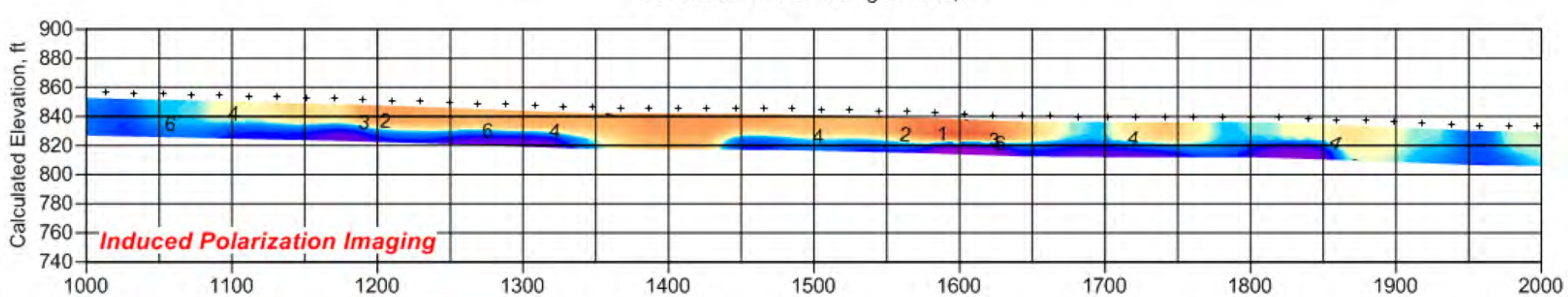
Figure No.

1 of 11









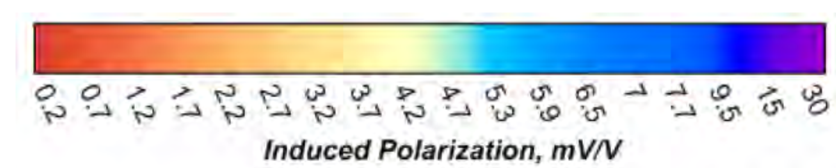


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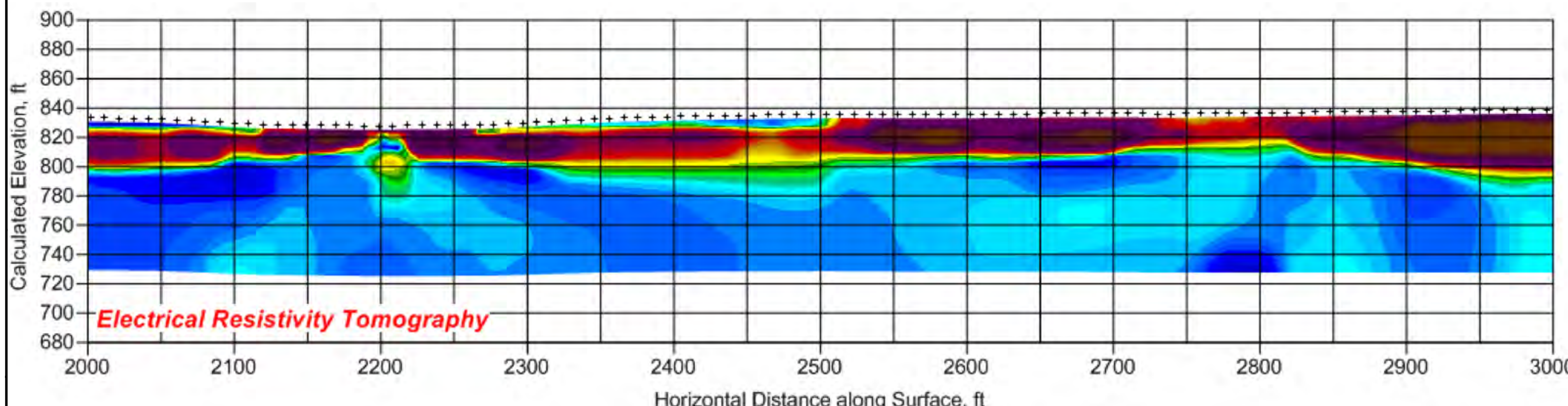
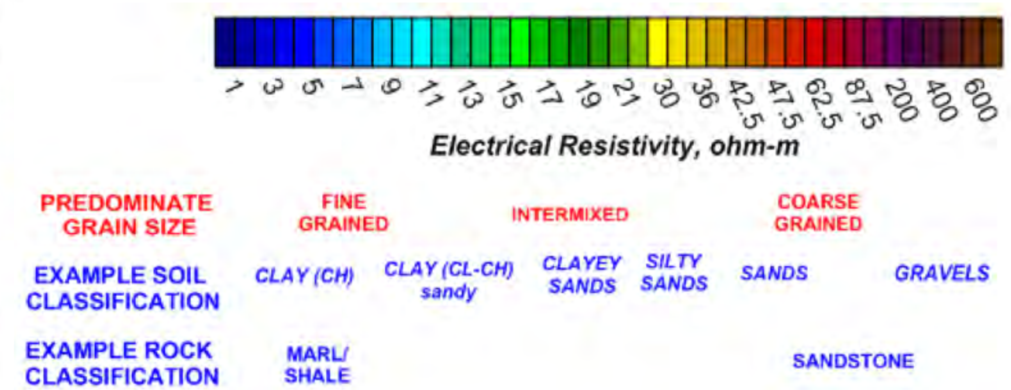
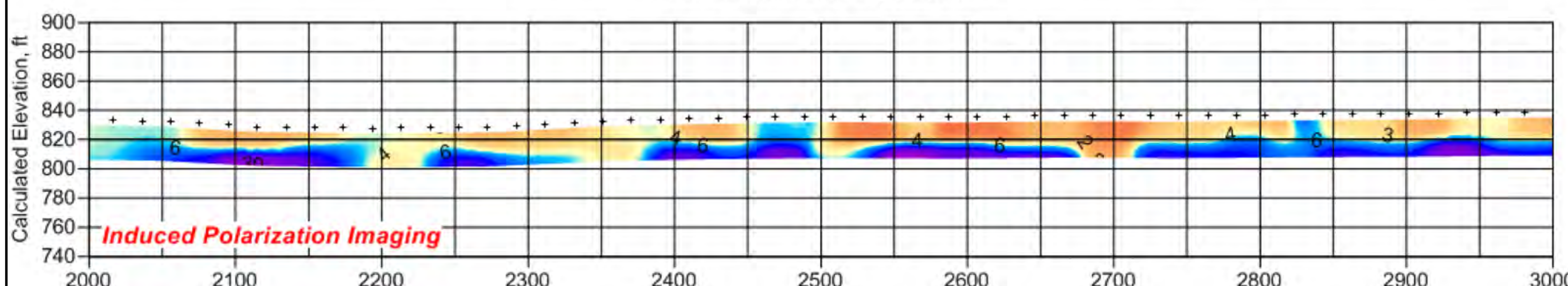
Figure No.

2 of 11







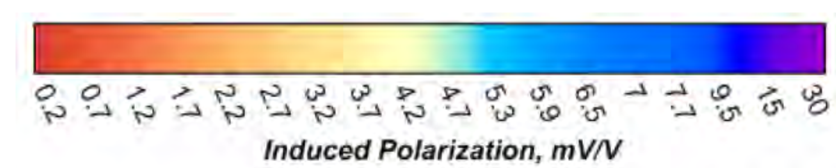


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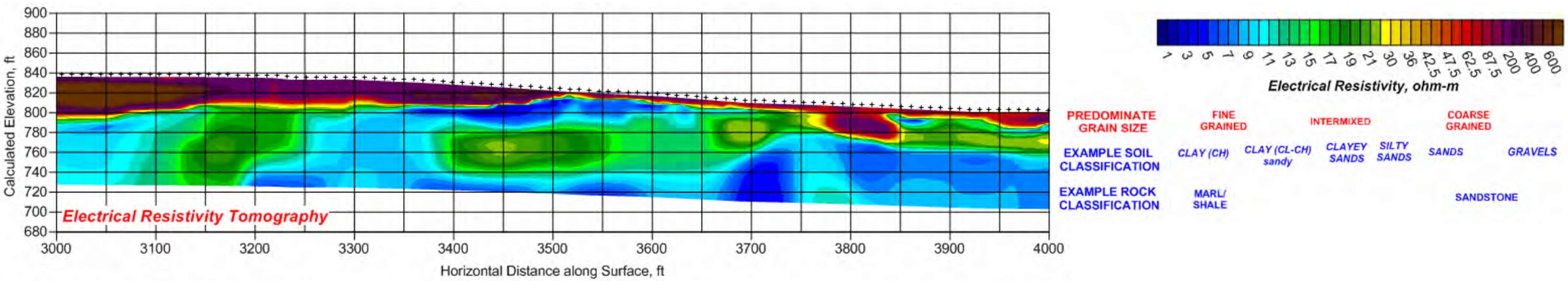
Figure No.
3 of 11



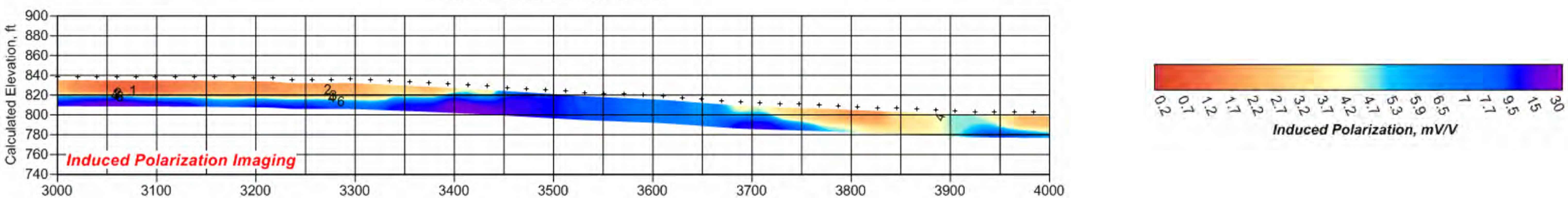


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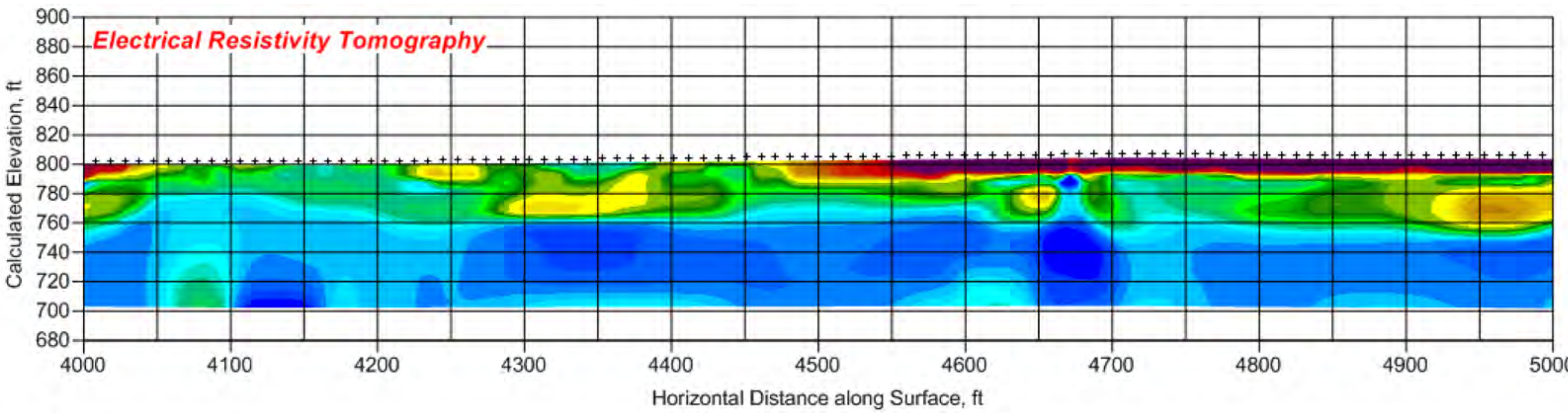
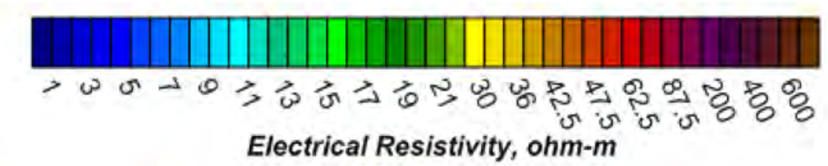
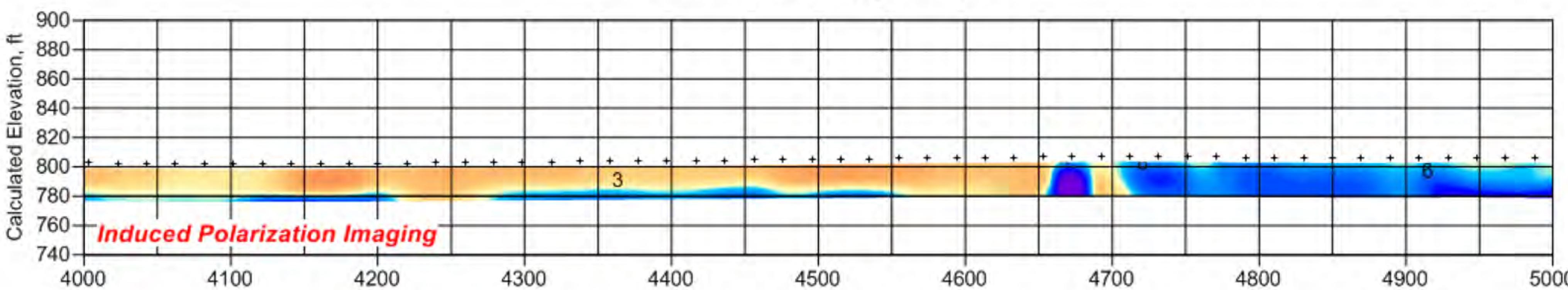
Figure No.
4 of 11





PREDOMINATE GRAIN SIZE	FINE GRAINED		INTERMIXED			COARSE GRAINED
EXAMPLE SOIL CLASSIFICATION	CLAY (CH)	CLAY (CL-CH) sandy	CLAYEY SANDS	SILTY SANDS	SANDS	GRAVELS
EXAMPLE ROCK CLASSIFICATION	MARL/ SHALE				SANDSTONE	



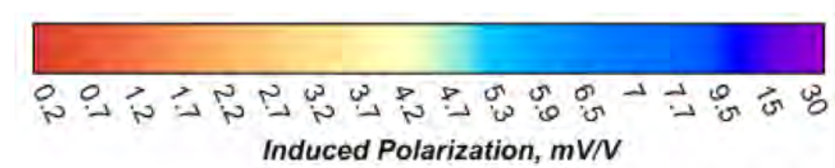


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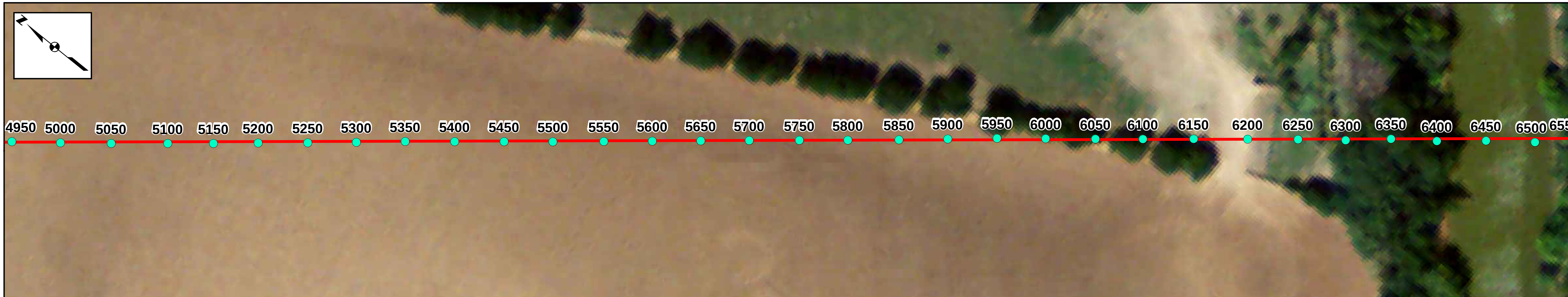
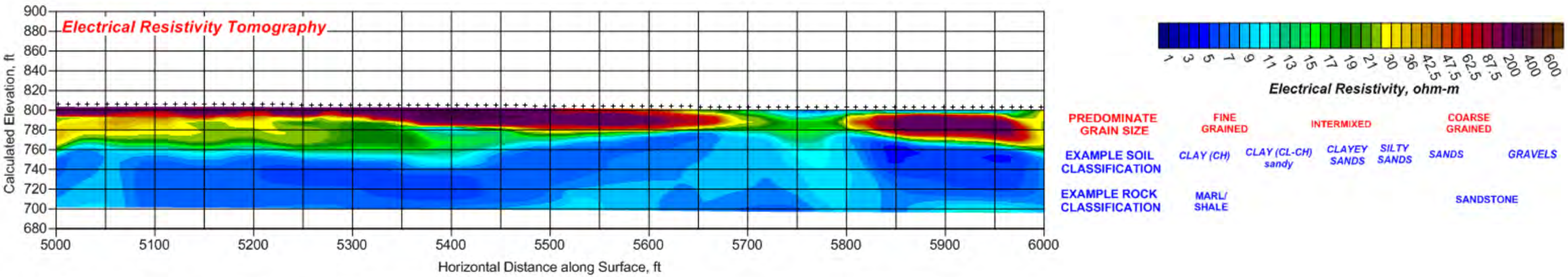
Figure No.
5 of 11





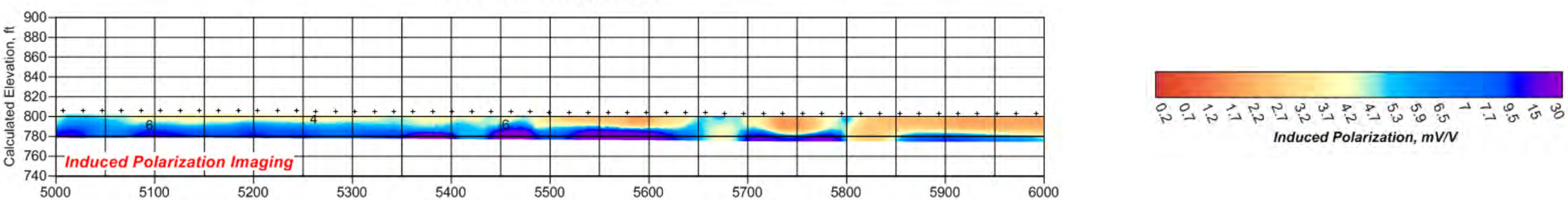


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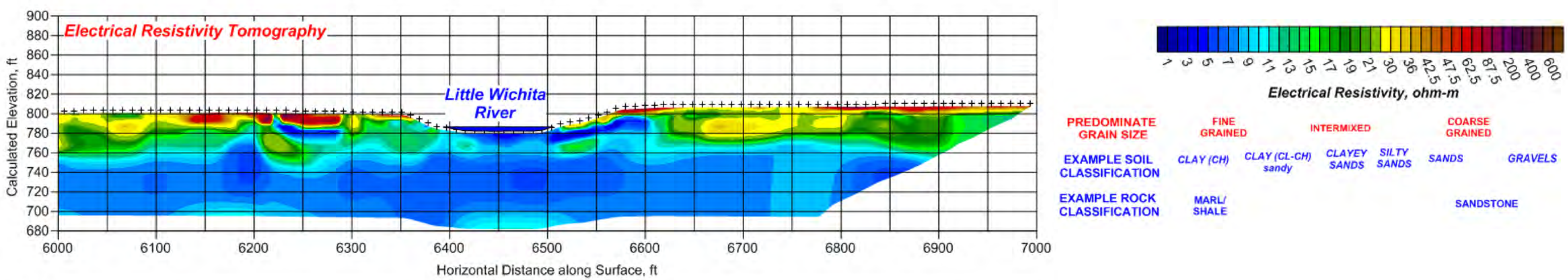
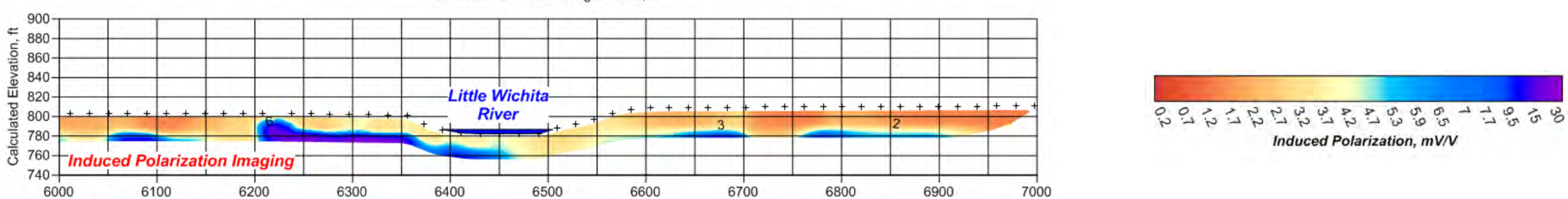
Figure No.
6 of 11





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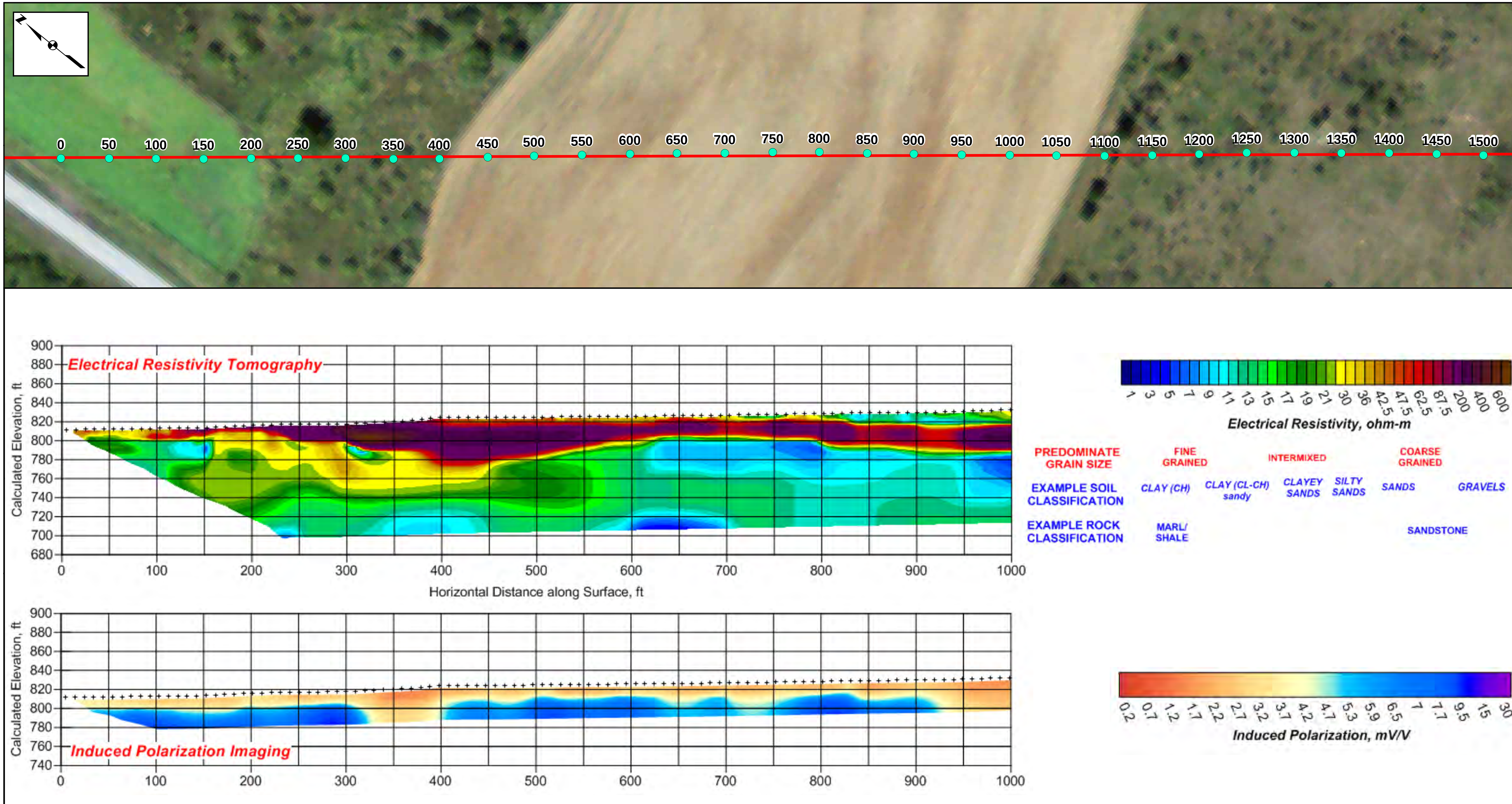
Horizontal Scale: 1 inch = 100 feet

Vertical Scale: 1 inch = 100 feet

Notes:

1. Electrical array geometry is dipole dipole with 3 meter electrode spacing.
2. Resistivity inversion conducted with RES2DINV.
3. Aerial: Texas Natural Resources Information System, 2010
4. Red line in aerial indicates proposed centerline of dam.

Figure No.
7 of 11



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www.gehriginc.com
212 N. Main
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Muenster, TX 76252
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Fax: (940) 759-2916

ERT/IP Line No. 3
Proposed Ringgold Dam
Clay County, Texas
Survey Dates: 12/10 to 12/12/2012
Project #: 12-07-001

100 50 0 100
Horizontal Scale: 1 inch = 100 feet
100 50 0 100
Vertical Scale: 1 inch = 100 feet

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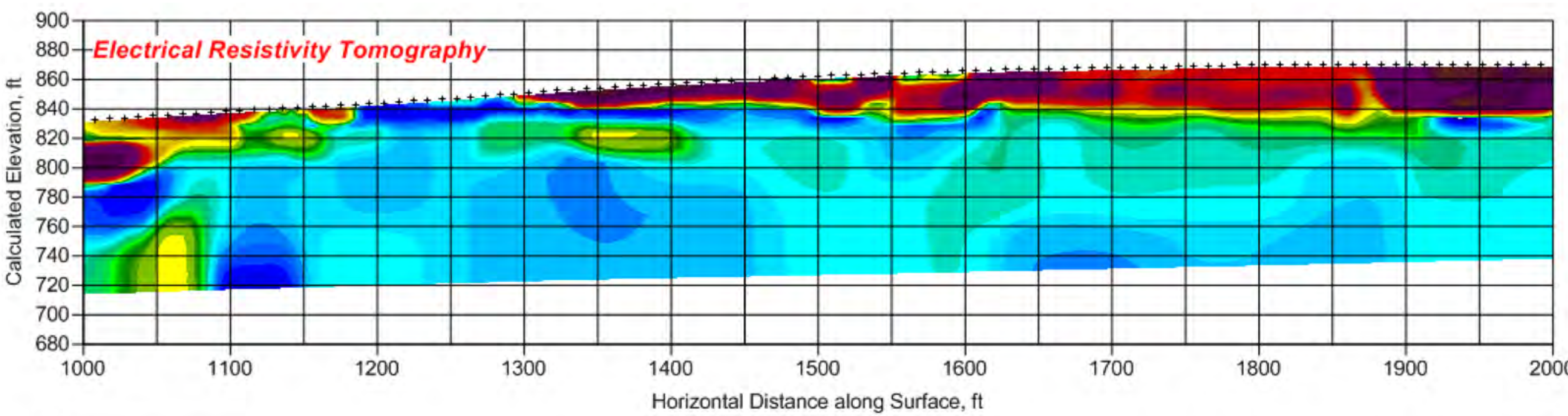
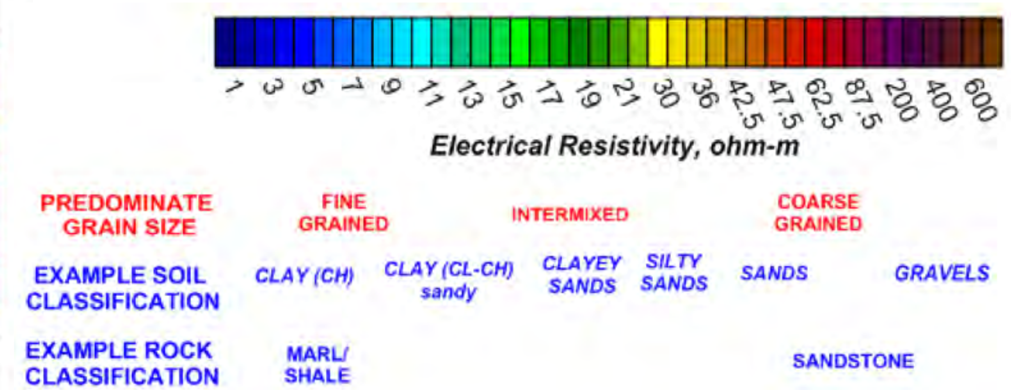
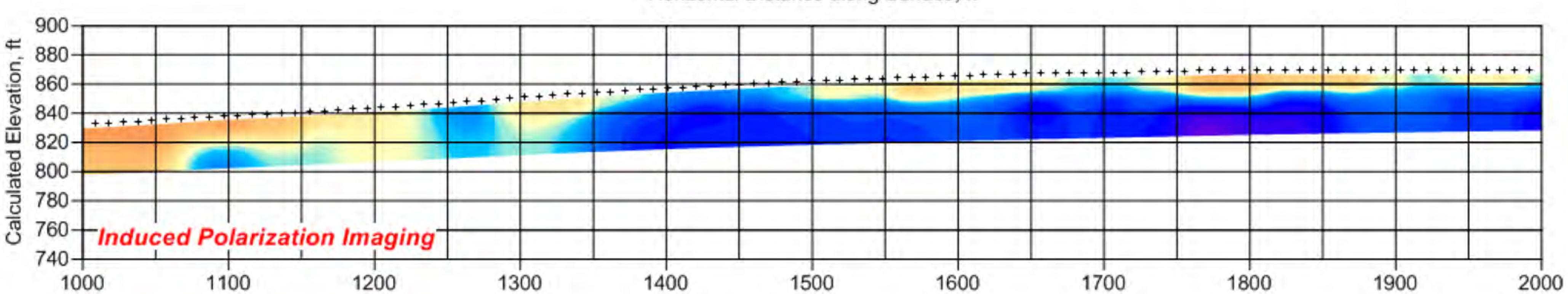
Figure No.
8 of 11







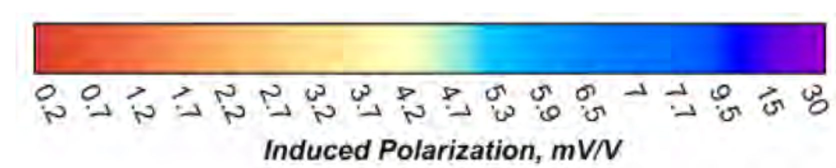


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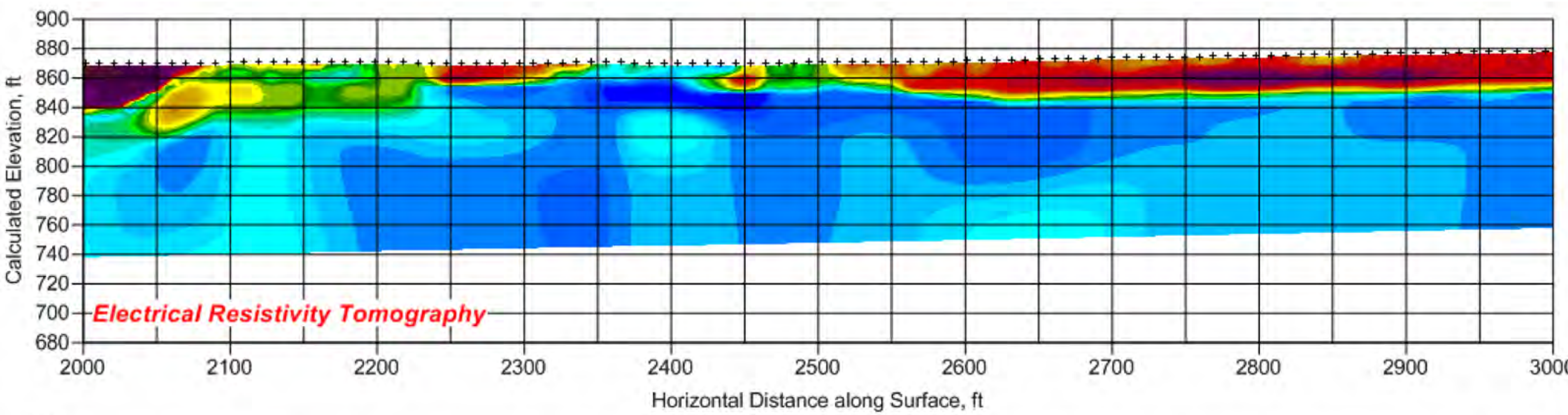
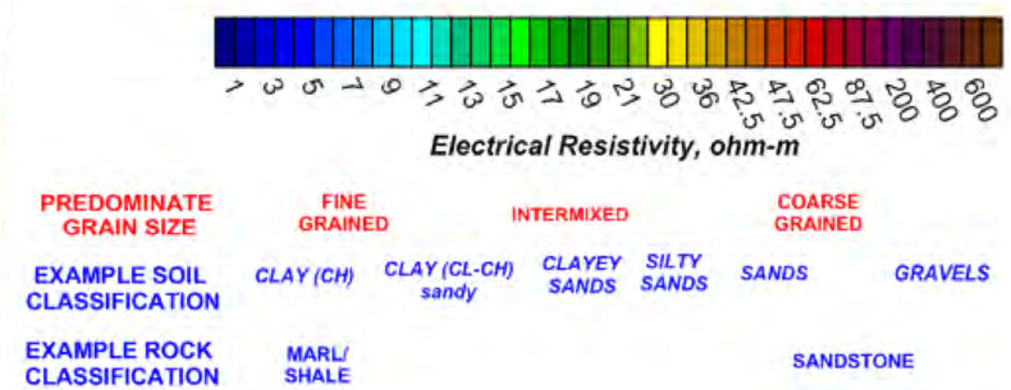
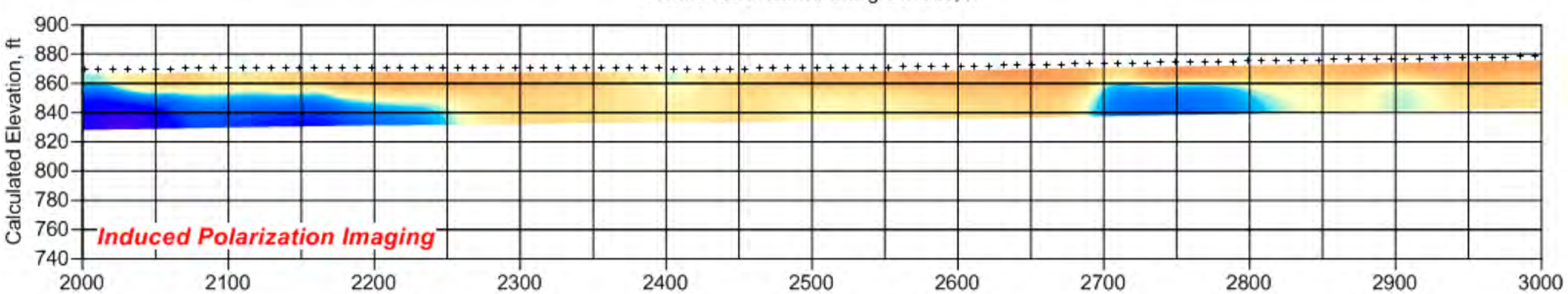
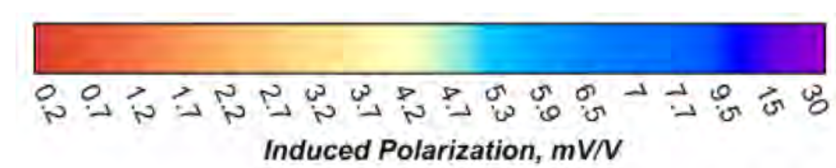
Figure No.
9 of 11









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Project #: 12-07-001

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100 50 0 100
Vertical Scale: 1 inch = 100 feet

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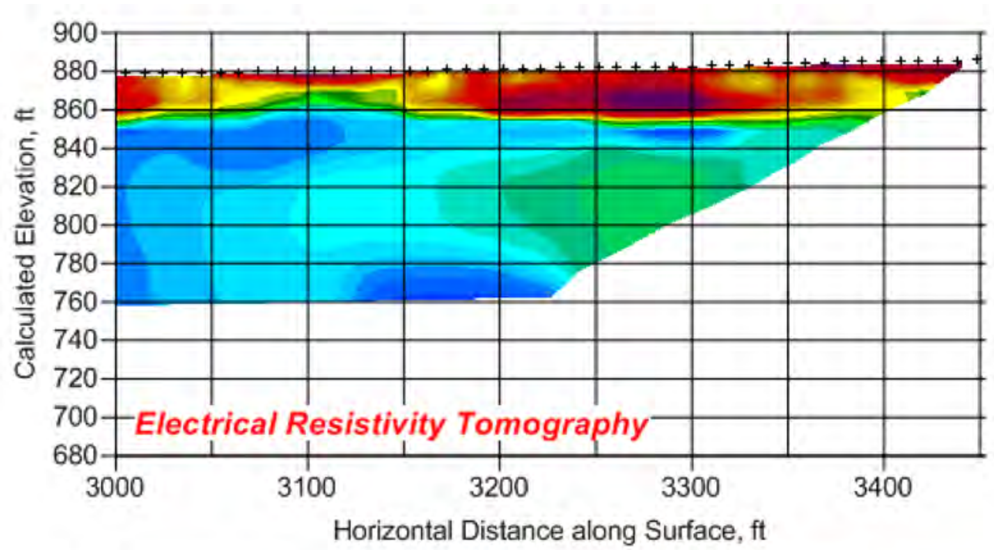
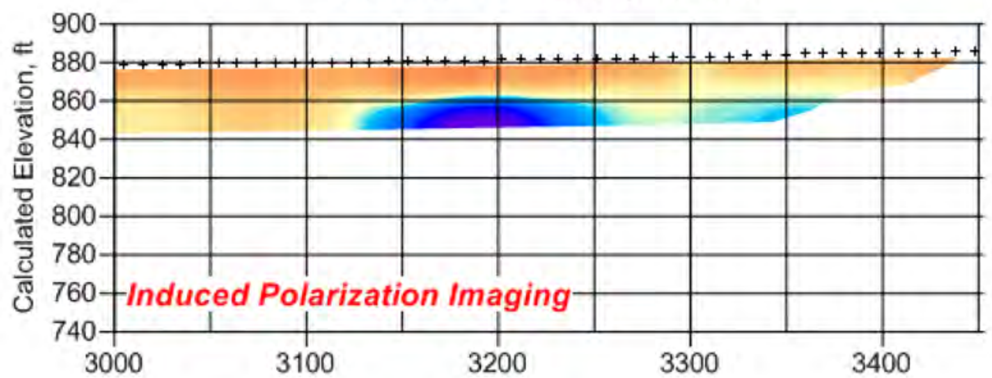
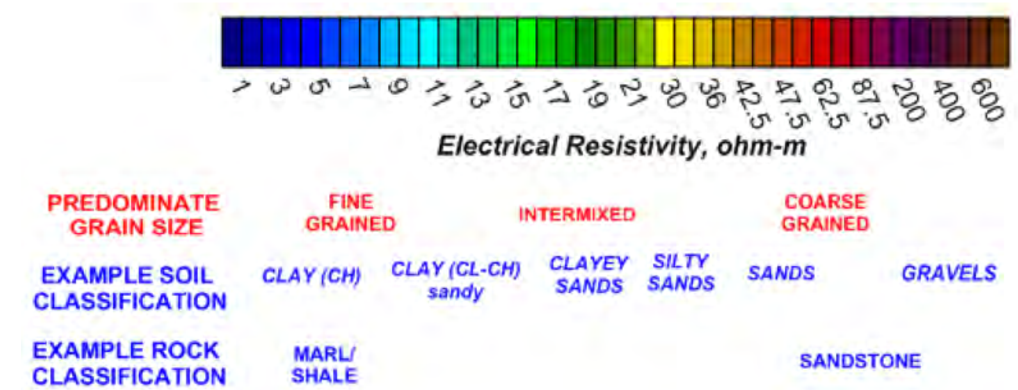
Figure No.
10 of 11







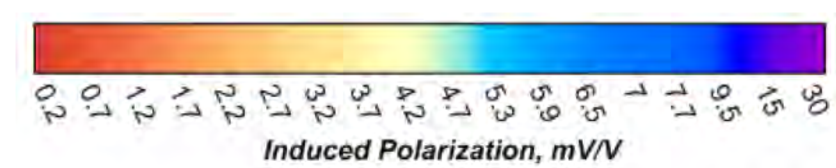


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Figure No.
11 of 11

APPENDIX E

DESIGN STORM ANALYSIS

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TO: Simone Kiel (FNI)

FROM: John Rutledge, P.E.

SUBJECT: Lake Ringgold Dam – Conceptual Dam Design

DATE: April 14, 2017

PROJECT: WCH12407: Lake Ringgold Study

STATE OF TEXAS
JOHN LEE RUTLEDGE
65045
REGISTERED
PROFESSIONAL ENGINEER

04/14/2017

FREESE AND NICHOLS, INC.
TEXAS REGISTERED
ENGINEERING FIRM
F-2144

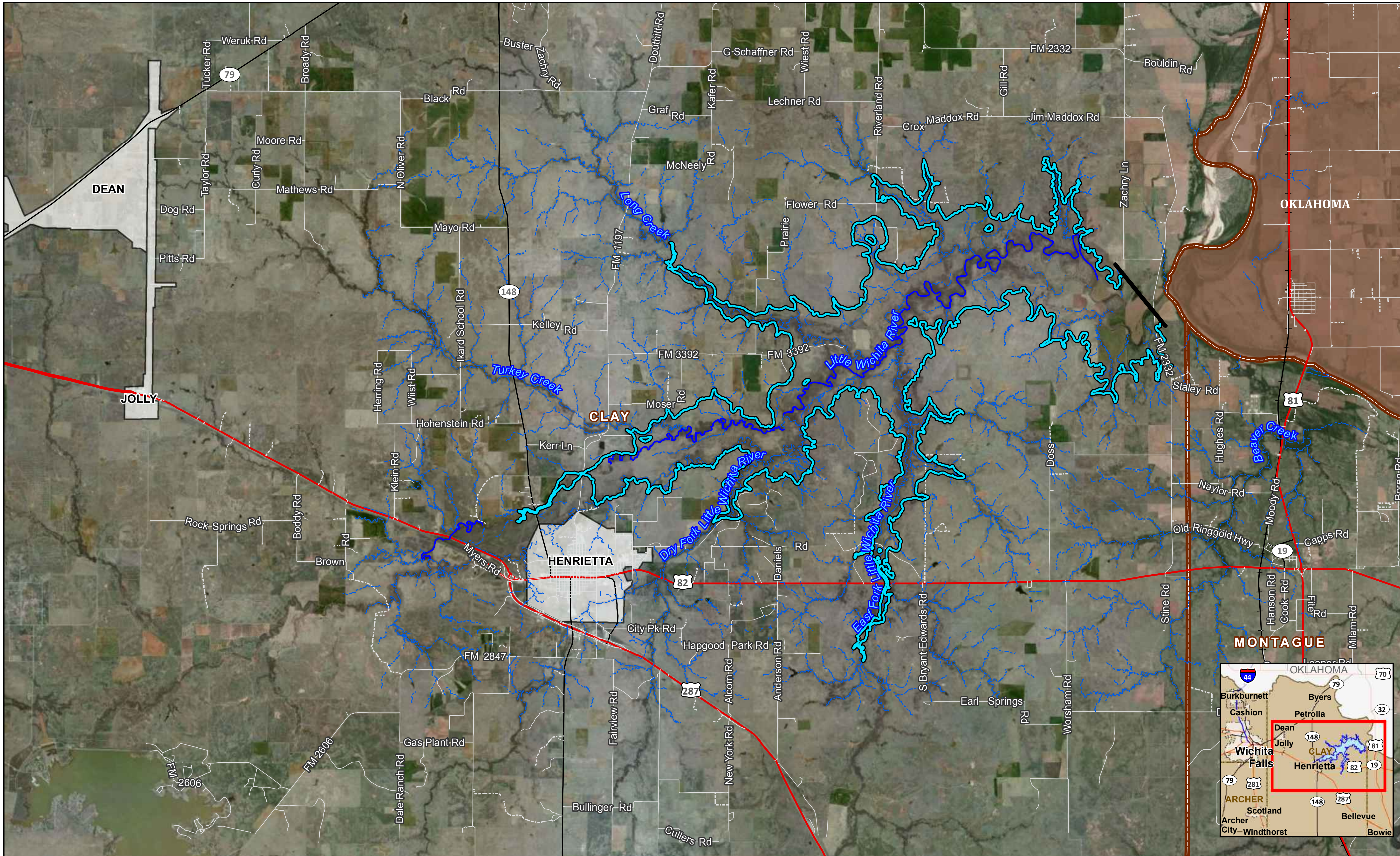
1.0 INTRODUCTION

Lake Ringgold is a proposed reservoir located at the mouth of the Little Wichita River, southwest of the Oklahoma – Texas state border. The proposed reservoir site would impound water along the Little Wichita which would serve as a source of water for both the City of Wichita Falls as well as the Tarrant Regional Water District (TRWD). This technical memorandum documents the hydrologic analysis and conceptual dam design for Lake Ringgold Dam.

1.1 LAKE RINGGOLD – PROJECT HISTORY

The proposed site for Lake Ringgold, shown in Figure 1, is located on the mouth of the Little Wichita River, just upstream of the confluence with the Red River. The reservoir will be located northeast of the town of Henrietta, in Clay County. The location for Lake Ringgold has been studied previously as a potential reservoir location. In 1958 Freese and Nichols, Inc. (FNI) performed a water supply study for the proposed Ringgold Reservoir site. The water supply study stated at that time that the City of Wichita Falls would be in need of an additional water supply source in the future and determined that the Ringgold Reservoir site was a feasible location to meet the projected future water demands for the City of Wichita Falls. In 1979 FNI performed an investigation of potential water supplies for the City of Wichita Falls to determine the most feasible reservoir location and its project yield. Based on the Phase I information, the Ringgold Reservoir site was identified as the most suitable location based on proximity, water quality, and yield. Phase II of the 1979 project provided a more detailed analysis of the Ringgold site included the drilling of six borings and preliminary design estimates for the dam and spillway. The Phase II report proposed a controlled spillway structure which would consist of five tainter gates and a large emergency spillway.

The current study utilized information from the previous studies as well as current topographic and geographic data and available aerial imagery.



FN PROJECT NO. WCH12407
DATE CREATED 8/26/2013
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central
FILE NAME Fig1_LocationMap
PREPARED BY ERN

CITY OF WICHITA FALLS
Proposed Lake Ringgold
Location Map

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4500 International Plaza Suite 200
Fort Worth, Texas 76109-4895
(817) 735-7300

Proposed Lake Ringgold
Dam Centerline
Intermittent/Ephemeral Stream
Perennial Stream
County Boundary
City Boundary

0 10,000 20,000
Feet

1
FIGURE

Path:H:\WR_DESIGN\FIGURES\Fig1_LocationMap.mxd

2.0 HYDROLOGIC MODEL DEVELOPMENT

The hydrologic model for the Lake Ringgold Dam was developed using ArcGIS and HEC-HMS. ArcGIS was used to delineate the drainage areas, flow paths, and soils and landuse for each drainage area contributing to Lake Ringgold. HEC—HMS was then used to model the runoff from each drainage area and route the runoff to Lake Ringgold.

The total drainage area for Lake Ringgold is approximately 1,480 square miles. The total drainage area includes two existing upstream reservoirs: Lake Kickapoo and Lake Arrowhead. The drainage areas and reservoir surface areas for the existing lakes were included in the hydrologic model. The drainage area downstream of Lake Arrowhead will contribute directly to Lake Ringgold. The surface area for Lake Ringgold was also modeled.

The runoff from each drainage area was computed using the Initial and Constant Loss method which uses the soil types in each basin to compute a uniform infiltration rate. As shown in Table 1, uniform loss rates were associated with each hydrologic soil group. In order to determine the uniform loss rate for each basin, the average loss rate was assumed for each soil type, and a weighted average of the loss rates was calculated for each basin. For frequent storm events, an initial loss was computed as 10 times the constant loss. For the Probable Maximum Flood (PMF) analysis TCEQ guidelines require saturated antecedent moisture conditions to be assumed for each basin, thus the initial loss was assumed to be zero inches. This represents a “worst case” scenario in which runoff from each basin would be the greatest. In addition to uniform losses, a percent imperviousness for each of the basins was also calculated based on land use data for developed areas and areas of open water bodies.

Table 1
Uniform Infiltration Rates

Soil Group	Description	Average Uniform Loss Rate (in/hr)
A	Deep sand, deep loess, aggregated silts	0.350
B	Shallow loess, sandy loam	0.225
C	Clay loams, shallow sandy loam, soils low in organic content, soils usually high in clay	0.100
D	Soils that swell significantly when wet, heavy plastic clays	0.025

The Snyder Unit Hydrograph method was used to develop a unit hydrograph for each drainage area. This method requires two parameters to develop a Snyder Unit Hydrograph which are:

T_L, lag time
C_p, shape factor, also commonly expressed as Cp640

The following equation was used to develop the lag time. This is the current version of the Snyder's equation which includes the basin slope in calculating the lag time.

$$T_L = C_T \left(\frac{L \cdot L_{CA}}{S^{0.5}} \right)^{0.38}$$

T_L = Lag Time (hr)

C_T = Coefficient representing variations in watershed slope and storage

L = Hydraulic length of watershed along the longest flow path (mi)

L_{CA} = Hydraulic length along the longest water course from the point under consideration to a point adjacent to the centroid of the drainage basin (mi)

S = Weighted slope of the basin (ft/mi), measured from the 85 percent to the 10 percent points along the longest stream path in the basin

The C_T and C_P values used were obtained from the 1979 study based on review of the previous design notes and calculations.

The hydrologic parameters used in the HEC-HMS model for the six drainage areas are presented in Table 2. Figure 2 shows the drainage basins.

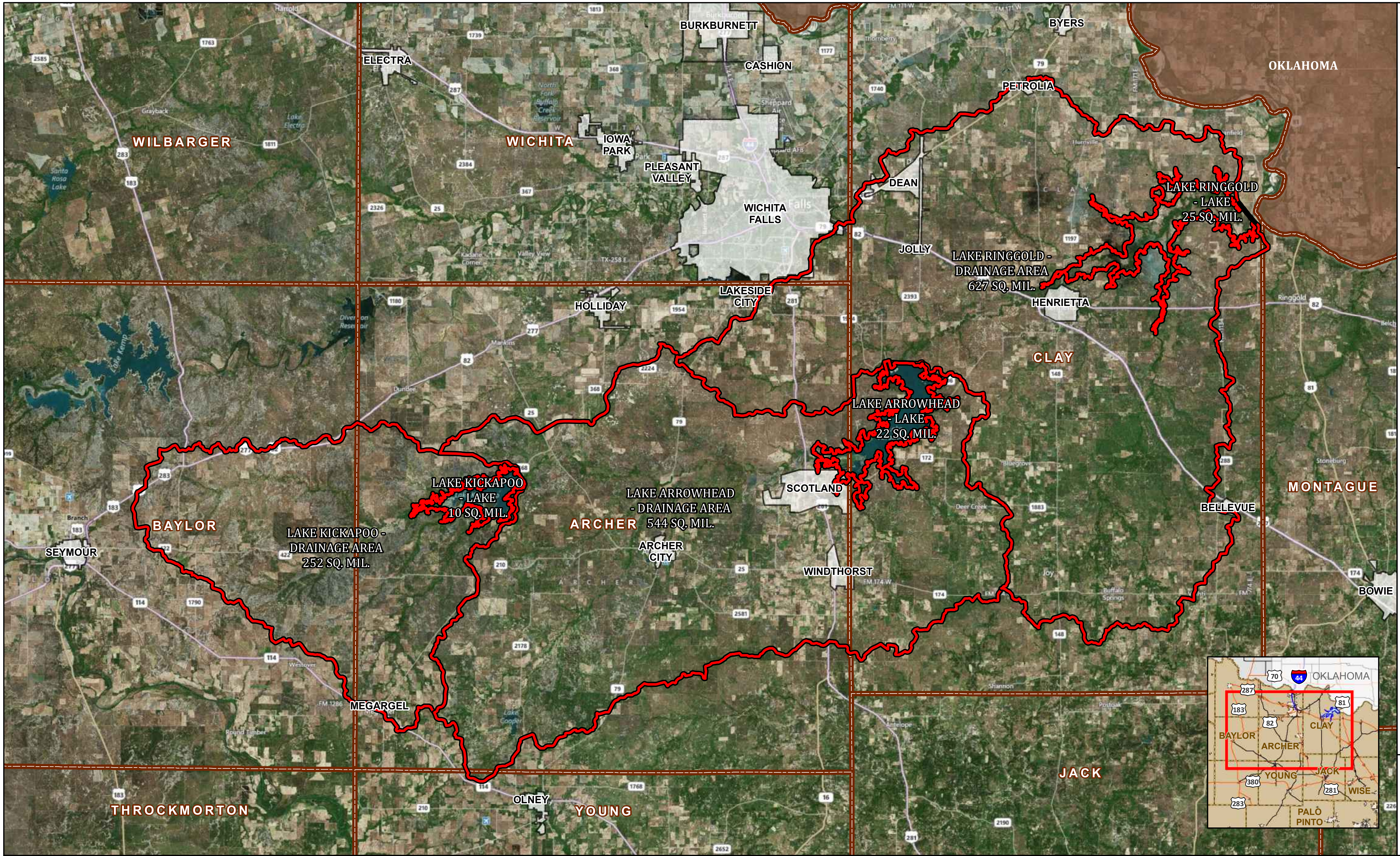
Table 2
Hydrologic Model Parameters

Basin	Area (mi^2)	Initial Loss – Frequency Analysis (in)	Constant Loss (in/hr)	% Impervious	C_T	C_P	Lag Time (hr)
Lake Kickapoo – Drainage Area	252	0.01	0.09	1.1	1.95	0.72	17.8
Lake Kickapoo – Lake	10	-	-	100	-	-	-
Lake Arrowhead – Drainage Area	544	0.01	0.08	1.9	2.40	0.73	36.8
Lake Arrowhead – Lake	22	-	-	100	-	-	-
Lake Ringgold – Drainage Area	627	0.01	0.08	1.7	2.75	0.74	46.0
Lake Ringgold – Lake	25	-	-	100	-	-	-

In addition to runoff from the respective drainage areas, discharges from Lake Kickapoo and Lake Arrowhead will contribute to Lake Ringgold as well. The spillway discharges were routed downstream via two routing reaches using the Muskingum-Cunge routing method. This approach used typical channel cross sections and channel properties such as length, slope and Manning's roughness coefficient, to convey flows from the upstream reservoirs, downstream to Lake Ringgold. Table 3 shows the routing parameters used to model the two routing reaches.

Table 3
Routing Reach Parameters

Reach	Length (ft)	Slope (ft/ft)	Manning's N Value
Reach - 1	276,514	0.00043	0.045
Reach - 2	278,859	0.00029	0.045



FN PROJECT NO.	WCH12407
DATE CREATED	8/26/2013
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas North Central
FILE NAME	Fig2_DrainageBasinMap
PREPARED BY	ERN

CITY OF WICHITA FALLS

Proposed Lake Ringgold

Drainage Basin Map

FREESE AND NICHOLS

4500 International Plaza Suite 200
Fort Worth, Texas 76109-4895
(817) 735-7300

Dam Centerline · Basins · County Boundary · City Boundary

0 30,000 60,000
Feet

2

FIGURE

Path:H:\WR_DESIGN\FIGURES\Fig2_DrainageBasinMap.mxd

2.1 ELEVATION – CAPACITY

The elevation – capacity relationship for Lake Ringgold was developed using available 10-foot USGS contour data. The area for each ten foot elevation increment was digitized using the 10-foot contour data in ArcGIS. The areas derived in ArcGIS were then used to compute the capacity in Lake Ringgold using the Average-End-Area method. The capacity was computed incrementally for each 10-foot elevation increment. The incremental capacity was then summed to develop the elevation-capacity relationship for Lake Ringgold as shown in Table 4. The area and capacity of the proposed normal pool, emergency spillway and top of dam elevations was derived from the elevation-area-capacity curves.

Table 4
Elevation – Area – Capacity for Lake Ringgold

Elevation (ft-msl)	Area (ac)	Capacity (ac-ft)
790	60	0
800	245	1,524
810	1,370	9,597
820	4,260	37,743
830	9,072	104,400
840	13,298	216,246
844*	15,500	275,000
850	19,109	378,279
856**	23,500	505,000
860	27,105	609,351
870	38,017	934,963
875***	44,500	1,145,000

*Proposed Normal Pool Elevation
**Proposed Emergency Spillway Elevation
***Proposed Top of Dam

The elevation – capacity relationship was also required for both Lake Kickapoo and Lake Arrowhead. The 1979 analysis developed the elevation – capacity relationship for both lakes. The Texas Water Development Board (TWDB) performed a volumetric survey for Lake Kickapoo in April 2001 and Lake Arrowhead in June 2001. The volumetric surveys provide elevation – area – capacity data up to the normal pool elevation in each lake. To estimate the capacity above the normal pool, the data obtained from the 1979 study was normalized based on the capacity at the normal pool elevation from the TWDB surveys for Lake Kickapoo and Lake Arrowhead, respectively. The elevation – capacity for Lake Kickapoo is shown in Table 5 and Lake Arrowhead in Table 6. Since both lakes are assumed to be at the normal pool for reservoir routing performed in the HEC-HMS model, Tables 5 and 6 provide the elevation – capacity relationship above the normal pool elevation and up to the top of dam.

Table 5
Elevation – Capacity for Lake Kickapoo

Elevation (ft-msl)	Volume (ac-ft)
1045.0*	85,825
1046.0	92,996
1048.0	104,696
1050.0	118,296
1052.0	134,296
1054.0	150,429
1056.0	167,196
1057.8**	182,456

*Normal Pool Elevation
**Top of Dam

Table 6
Elevation – Capacity for Lake Arrowhead

Elevation (ft-msl)	Volume (ac-ft)
926*	235,997
928	269,897
930	306,397
932	346,897
934	388,564
936	431,897
938	484,397
940**	536,897

*Normal Pool Elevation
**Top of Dam

2.2 DISCHARGE RATING CURVE

Lake Ringgold Dam will consist of a principal spillway and an emergency spillway. Two types of principal spillways were analyzed: a concrete ogee spillway and a concrete labyrinth spillway. The preliminary analysis of the labyrinth weir determined it was not a feasible alternative for the Lake Ringgold site due to the limited hydraulic efficiency gains relative to the additional costs.

The ogee – crested spillway design was optimized to minimize the number of impacted structures within the town of Henrietta while also minimizing the required spillway width. A sensitivity analysis, discussed in Section 2.5, was performed to determine the spillway width in relation to the number of impacted structures that would be located in the town of Henrietta. Based on this analysis, a spillway width of 350 feet, with a crest elevation of 844 feet-msl was chosen for the principal spillway configuration. For preliminary design, a constant discharge coefficient, C, of 3.8, a typical value for an ogee spillway, was used. The discharge through the spillway was calculated using $Q = CLH^{3/2}$, where L is the spillway width and H is the head over the crest.

The emergency spillway will consist of an earthen broad-crested spillway with 3H:1V side slopes. The crest of the emergency spillway was set slightly higher than the 100 year flood elevation in Lake Ringgold. With a crest elevation of 856 feet-msl, the emergency spillway will be 500 feet wide. The discharge rating curve for the emergency spillway was developed using HEC-RAS. Cross sections representing the proposed spillway configuration were modeled. Varying discharges were modeled through the cross sections and the elevation and discharge relationship for the most upstream cross section was used to develop the rating curve.

Table 7 shows the discharge for the principal spillway, emergency spillway, and combined discharge for Lake Ringgold Dam.

Spillway ratings curves were also modeled for Lake Kickapoo and Lake Arrowhead. The 1979 analysis developed discharge rating curves for both spillways using $Q = CLH^{3/2}$. The rating curve for Lake Kickapoo Dam used a crest width of 483 feet with a crest elevation of 1045 feet-msl, and a discharge coefficient of 3.8, a typical value for an ogee-crested spillway. The spillway width and crest elevation were verified in the TCEQ Database of Dams as well as in ArcGIS, based on available aerial imagery. The rating curve for Lake Kickapoo is provided in Table 8.

The discharge rating curve for Lake Arrowhead developed in 1979 used a crest width of 1,581 feet with a crest elevation of 926 feet-msl and a discharge coefficient of 3.8. The spillway width was adjusted to 1,535 feet based on the TCEQ Database of Dams which was verified in ArcGIS based on available aerial imagery. The rating curve for Lake Arrowhead was recomputed using $Q = CLH^{3/2}$ using the revised crest width and is provided in Table 9.

Table 7
Discharge Rating Curve for Lake Ringgold Dam

Elevation (ft-msl)	Principal Spillway (cfs)	Emergency Spillway (cfs)	Combined Discharge (cfs)
844*	0	0	0
846	3,762	0	3,762
848	10,640	0	10,640
850	19,547	0	19,547
852	30,094	0	30,094
854	42,058	0	42,058
856**	55,287	0	55,287
858	69,670	3,193	72,863
860	85,120	8,405	93,525
862	101,569	17,989	119,558
864	118,959	28,785	147,744
866	137,242	39,582	176,823
868	156,375	50,586	206,962
870	176,324	67,337	243,661
872	197,056	84,087	281,143
874	218,541	101,057	319,598
875***	229,559	111,628	341,187

*Proposed Normal Pool Elevation
**Proposed Emergency Spillway Elevation
***Proposed Top of Dam Elevation

Table 8
Discharge Rating Curve for Lake Kickapoo Dam

Elevation (ft-msl)	Discharge (cfs)
1045.0*	0
1046.0	1,835
1048.0	9,537
1050.0	20,520
1052.0	33,992
1054.0	49,556
1056.0	66,961
1057.8**	84,052

*Normal Pool Elevation
**Top of Dam

Table 9
Discharge Rating Curve for Lake Arrowhead Dam

Elevation (ft-msl)	Discharge (cfs)
926*	0
928	16,498
930	46,664
932	85,727
934	131,986
936	184,456
938	242,473
940**	305,551

*Normal Pool Elevation
**Top of Dam

2.3 FREQUENCY FLOOD ANALYSIS

Lake Ringgold was analyzed for the 100 year and 500 year frequency floods to determine an optimal spillway size for the principal spillway. The precipitation for the 100 year and 500 year storms was obtained from *Atlas of Depth – Duration Frequency of Precipitation Annual Maxima for Texas – Scientific Investigations Report 2004 – 5041* by the U.S. Geological Survey (USGS). HEC-HMS uses precipitation depths for varying durations to develop a hyetograph for each drainage basin. Table 10 shows the precipitation depths and respective durations for the 100 year and 500 year storm events.

Table 10
Frequency Flood Precipitation

Duration	100 yr Precipitation Depth (in)	500 yr Precipitation Depth (in)
15 min	2.0	2.6
1 hr	3.8	5.2
2 hr	4.7	6.5
3 hr	5.3	7.5
6 hr	6.5	9.0
12 hr	7.7	11.0
1 day	9.0	12.0

2.4 PROBABLE MAXIMUM FLOOD

The Probable Maximum Flood (PMF) is defined as the greatest flood to be expected assuming complete coincidence of all factors that would produce the heaviest rainfall and maximum runoff. The Probable Maximum Precipitation (PMP) is theoretically the greatest depth of rainfall for a given duration that is physically possible over a given size storm area at a particular geographic location.

The PMF analysis also assumes that all upstream lakes within the total contributing drainage area are at their normal pool at the beginning of the simulation. This results in flood routing above the normal pool which results in a higher volume of runoff routed to Lake Ringgold due to the PMF storm event.

In order to determine the PMP, rainfall amounts were taken from the PMP GIS geoprocessing tool, which is based on a new study released by TCEQ in January 2017. The new study provides updated PMP depths for the State of Texas and surrounding areas and accounts for the state-specific factors affecting climatic and meteorological factors. This new study and the corresponding GIS tool replace the *Hydrometeorological Report No. 52* (HMR52) values that were previously calculated for the PMP. The TCEQ PMP tool calculates gridded PMP depths for a specified drainage basin. The PMP depths are determined using grid points that are automatically generated with the tool and spaced at 90 arc-second intervals in the drainage basin. Based on these grid points, a basin-average table is calculated that provides PMP depths in inches for the particular drainage basin and the specified storm durations. Since the total drainage area to Lake Ringgold (1,480 square miles) is significant, it was necessary to evaluate Lake Ringgold with six drainage basins. These six drainage basins were evaluated and the critical storm was determined.

In January 2007, TCEQ released its *Hydrologic and Hydraulic Guidelines for Dams in Texas*. The modified analyses remove some of the conservatism associated with the temporal distribution of the rainfall. At that time, no updates were made to the total PMP depths, but the new distribution spreads these depths differently over the storm duration. A designated percentage of the total depth is distributed uniformly over the first portion of the storm, and the remaining rainfall is distributed uniformly over the remainder of the storm duration. The rainfall and time percentages are specified by TCEQ, and vary according to the duration of the storm.

The PMP was derived following both the 2007 guidelines and the 2017 PMP updates, then entered into the hydrologic model. TCEQ guidelines stipulate that for a drainage area greater or equal to 1,000 square miles but less than 10,000 square miles, a minimum duration of 24 hours must be evaluated for the PMF. The hydrologic model was then used to evaluate the PMF events for durations of 24, 48, and 72 hours. Table 11 shows the resulting average precipitation depths after running the TCEQ PMP GIS tool with the various storm durations.

Table 11
Probable Maximum Precipitation

Basin	24 hr Depth (in)	48 hr Depth (in)	72 hr Depth (in)
Lake Kickapoo – Drainage Area	25.39	31.65	31.66
Lake Kickapoo – Lake	24.50	30.40	30.40
Lake Arrowhead – Drainage Area	25.5	31.8	31.8
Lake Arrowhead – Lake	25.5	31.8	31.8
Lake Ringgold – Drainage Area	25.5	31.8	31.8
Lake Ringgold – Lake	25.5	31.8	31.8

The TCEQ requires that a dam be able to pass a required percent of the PMF, based on size and hazard classifications. A large size dam is one in which the maximum capacity is equal to or greater than 50,000 acre feet and/or the maximum height is equal to or greater than 100 feet. With a maximum capacity of 1,145,000 acre-feet and a maximum height of 85.0 feet, Lake Ringgold Dam will be classified as a large size dam. Hazard classification is determined based on the potential loss of life and critical infrastructure in the event of a dam failure. With numerous small towns located downstream of Lake Ringgold Dam along the Red River, Lake Ringgold Dam will be classified as a high hazard dam. As a large size, high hazard dam, Lake Ringgold Dam will be required to pass 100 percent of the critical PMF with suitable freeboard based on wind – wave calculations, which are discussed in Section 2.7.

2.5 FREQUENCY FLOOD RESULTS

The 100 year and 500 year frequency storms were analyzed for Lake Ringgold Dam to size the principal spillway and determine the crest elevation for the emergency spillway. As stated previously in Section 2.2, the frequency results were used to optimize the principal spillway width while minimizing the number of potential impacts in the town of Henrietta.

Henrietta is located at the upstream portion of the proposed Lake Ringgold. During flood conditions, the lake elevation will rise and has the potential to cause flooding within Henrietta. A minimum number of impacted structures was desired during both the 100 year and 500 year storm events. Three scenarios were analyzed to determine the optimal principal spillway width based on the estimated number of impacted structures. It should be noted that structures were determined based on available Bing Aerial Imagery and that without an extensive site visit, it is not possible to ensure that all structures were accounted for. Estimates were based solely on aerial imagery.

The three scenarios used in the analysis of the principal spillway were: Zero Impacts, 1 Impact, and 10 Impacts. These impacts are in relation to the town of Henrietta and nearby area and do not include impacted structures located elsewhere in the reservoir footprint. The objective of the sensitivity analysis was to maintain a similar estimated top of dam elevation by only adjusting the width of the principal and emergency spillway and the crest elevation for the emergency spillway. The results are presented in Table 12.

Table 12
Spillway Sizing and Impacts

Impacted Structures	Principal Spillway Width (ft)	Emergency Spillway Width (ft)
Zero	1500	0
One	**350**	**500**
Ten	80	5000

As shown in Table 12, with one impacted structure within or near Henrietta for flood events up to the 500 year flood event, a principal spillway width of 350 feet and crest elevation of 844 feet-msl and an emergency spillway 500 feet wide with a crest elevation of 856 feet-msl is the most optimal configuration, with respect to the number of impacted structures and spillway size.

With the proposed spillway configuration, the 100 year flood event produces a peak inflow of 90,138 cfs which results in a peak outflow of 52,973 cfs and a peak elevation of 855.66 feet-msl. The emergency spillway crest elevation was set slightly higher than the 100 year peak elevation at 856 feet-msl. The 500 year flood event produced a peak inflow of 143,883 cfs which resulted in a peak outflow of 82,790 cfs and peak elevation of 859.02 feet-msl.

With this configuration, one structure located in north Henrietta off of N Bridge Street, along the original Little Wichita River channel, would be impacted during the 100 year and 500 year flood events. Additional structures which are not located in Henrietta or the nearby area that are within the reservoir footprint could also be impacted.

2.6 PMF RESULTS

As a large size, high hazard dam, Lake Ringgold Dam is required to safely pass 100 percent of the PMF. Table 13 shows the resulting peak elevations for the full PMF.

Table 13
Peak Elevations in Lake Ringgold for Full PMF

Duration (hr)	Peak Elevation (ft-msl)
24	870.0
48	**872.2**
72	871.2

The 24 hour PMF event produces a peak inflow of 357,336 cfs, peak outflow of 243,632 cfs and a peak water surface elevation of 870.0 feet-msl. The critical storm, the 48 hour PMF event, produces a peak inflow of 414,217 cfs, resulting in a peak outflow of 285,578 cfs and a peak water surface elevation of 872.2 feet-msl. The 72 hour PMF event produces a peak inflow of 379,480 cfs, a peak outflow of 265,669 cfs and a peak water surface elevation of 871.2 feet-msl. The critical storm duration for Lake Ringgold Dam is the 48 hour PMF event which produces the highest peak elevation of 872.2 feet-msl.

It should be noted that additional structures located in and near Henrietta will be impacted during a PMF event. However, this will not be solely due to the rise in lake elevation of Lake Ringgold, as flood conditions will already be occurring along the Little Wichita and tributaries. Future analysis would be beneficial to determine the impact in Henrietta with and without Lake Ringgold Dam during a PMF event.

2.7 WAVE RUNUP

A wave run-up analysis was performed for Lake Ringgold using the U.S. Army Corps of Engineers (USACE) methodology. Two pool elevations were analyzed for Lake Ringgold: normal pool and PMF. The maximum fetch length which represents the longest distance across the reservoir over which wind would move was determined for both cases. Wind speeds and duration were estimated using *Wave Runup and Wind Setup on Reservoir Embankments* by Bruce McCartney of the USACE in 1976. From the estimated wind speed and wind duration, a design wind speed was determined. For the normal pool analysis, 100 percent of the maximum wind speed and duration was used and for the PMF analysis the maximum wind speed was ratioed down to 20 percent of the maximum wind speed as the peak flooding stages would occur well after the primary storm event and much lower wind values would be expected. The calculations for the wave runup assumed a smooth interior slope of soil cement with 3 horizontal to 1 vertical (3H:1V) side slopes. Table 14 provides the wave runup parameters used for both analyses.

Table 14
Wave Runup Parameters

Parameter	Normal Pool Elevation	PMF Elevation
Water Surface (ft-msl)	844.0	872.2
Effective Fetch (mi)	2.4	3.8
Sustained Wind Velocity (mph)	73.5	15.7
Wave Height (ft)	5	1.2
Wave Period (sec)	4.2	2.4
Wave Runup (ft)*	8.3	2.3
Wind Setup (ft)**	0.6	0.04
Total Wave Runup (ft)	8.9	2.3
Minimum Top of Dam (ft-msl)	852.9	875.0

*Assumes smooth, soil cement surface on upstream face of dam

**Based on preliminary conceptual dam design

Based on the preliminary conceptual dam design and wave runup, a minimum required top of dam elevation would require 2.3 feet above the peak PMF elevation which is a top of dam elevation of approximately 874.5 feet-msl. The proposed top of dam elevation of 875.0 feet-msl provides an additional 0.5 feet of freeboard.

3.0 SUMMARY AND CONCLUSIONS

Based on the conceptual design and analysis, the proposed Lake Ringgold Dam will be located at the mouth of the Little Wichita, located approximately 0.5 miles upstream of the Red River confluence. The dam would have a height of approximately 85 feet and a crest elevation of 875 feet-msl. The principal spillway, located on the left end of the dam, will have a crest elevation of 844 feet-msl, equivalent to the normal pool, and a crest width of 350 feet. The ogee spillway will discharge via a concrete spillway and chute into a stilling basin which will then flow through a concrete channel to the existing downstream channel. The emergency spillway will be located on the right abutment and will consist of a 500 foot wide earthen channel with a crest elevation of 856 feet-msl. It will discharge into the Red River, located downstream.

The proposed Lake Ringgold Dam will be classified by TCEQ as a large size, high hazard dam, and will be required to safely pass the full critical PMF. With the current proposed spillway configuration, the critical PMF at Lake Ringgold Dam is the 48 hour PMF with a peak elevation of 872.2 feet-msl. With a minimum required freeboard of 2.3 feet, the minimum top of dam elevation is 874.5 feet-msl. With the proposed top of dam elevation of 875.0 feet-msl, Lake Ringgold Dam is able to safely pass the PMF without overtopping the embankment.

APPENDIX F

HYDROLOGY AND WAM MODELING

This appendix documents the WAM Modeling conducted in support of the water right application for Lake Ringgold. Each section supports this modeling effort with the first section outlining the water rights in the Little Wichita River Watershed. The second section details the WAM modeling modifications to add Lake Ringgold and the modeling results. The third section includes the no injury analysis for Lake Ringgold.

F-1 Water Rights in the Little Wichita River Watershed

The water rights in the Little Wichita River Watershed are shown in Table F-1. There are 14 rights in the watershed, with the majority of the authorized storage and diversions associated with Wichita Falls water rights.

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Table F-1: Water Rights in the Little Wichita Watershed

Water Right	Amend-ment	Owner	Priority Date	Use	Diversion Amount (ac-ft/yr)	Reservoir Capacity (ac-ft)	Reservoir Name	Stream Name	County
P 3965/A 4268		A L Rhodes Et Al	11/22/1982	Irrigation	3,600			Ltl Wichita River	Clay
CA 02-5109		A D Hanna	3/3/1980	Irrigation	200	370		Unnamed Trib Long Crk	Clay
CA 02-5153		Clay County Country Club Inc	7/1/1968	Irrigation	50			Unnamed Trib Dry Frk Ltl Wichita River	Clay
CA 02-5153		Clay County Country Club Inc	7/1/1968	Recreation				Unnamed Trib Dry Frk Ltl Wichita River	Clay
CA 02-5152		City of Henrietta	3/16/1918	Municipal	1,559	743		Ltl Wichita River	Clay
CA 02-5152		City of Henrietta	5/18/1953	Mining	1			Ltl Wichita River	Clay
CA 02-5154		Johnnie H Shaw	5/31/1967	Irrigation	15	10		Unnamed Trib Ltl Wichita River	Clay
CA 02-5151		A R E Prop Owners Assn Inc	10/30/1978	Recreation		44		Unnamed Trib Lake Crk	Clay
CA 02-5150	A	City of Wichita Falls	6/20/1962	Municipal	45,000	228,000	Lake Arrowhead	Ltl Wichita River	Clay
CA 02-5150	A	City of Wichita Falls	6/20/1962	Industrial			Lake Arrowhead	Ltl Wichita River	Clay
CA 02-5150	A	City of Wichita Falls	6/20/1962	Mining			Lake Arrowhead	Ltl Wichita River	Clay
CA 02-5150	A	City of Wichita Falls	6/20/1962	Recreation			Lake Arrowhead	Ltl Wichita River	Clay
CA 02-5149		Windthorst Water Supply Corp	2/14/1963	Municipal	100	690	Lake Windthorst	E Ltl Post Oak	Clay
P 5904/A 5904		Natural Pork Production II LLP	8/29/2005	Industrial	150	151		Unnamed Trib Ltl Onion Crk	Archer
P 5904/A 5904		Natural Pork Production II LLP	8/29/2005	Irrigation				Unnamed Trib Ltl Onion Crk	Archer
CA 02-5148		City of Archer City	6/26/1950	Municipal	300	396	Archer City Lake	Carver Crk	Archer

Table F-1 Continued

Water Right	Amend-ment	Owner	Priority Date	Use	Diversion Amount (ac-ft/yr)	Reservoir Capacity (ac-ft)	Reservoir Name	Stream Name	County
CA 02-5148		City of Archer City	4/29/1957	Municipal	506	1		Carver Crk	Archer
CA 02-5147		Joy Graham	3/9/1970	Irrigation	30			Unnamed Trib S Frk Ltl Wichita River	Archer
CA 02-5146		City of Olney	3/26/1953	Municipal	1,260	6,650	Lakes Olney & Cooper	Mesquite Crk	Archer
CA 02-5146		City of Olney	8/11/1980	Irrigation	35			Mesquite Crk	Archer
CA 02-5145		City of Megargel	7/3/1962	Municipal	70	223	Megargel Creek Lake	Megargel Crk	Archer
CA 02-5144	A	City of Wichita Falls	6/21/1944	Municipal	40,000	105,000	Lake Kickapoo	N Frk Ltl Wichita River	Archer
CA 02-5144	A	City of Wichita Falls	6/21/1944	Industrial			Lake Kickapoo	N Frk Ltl Wichita River	Archer
CA 02-5144	A	City of Wichita Falls	6/21/1944	Mining			Lake Kickapoo	N Frk Ltl Wichita River	Archer
CA 02-5144	A	City of Wichita Falls	6/21/1944	Recreation			Lake Kickapoo	N Frk Ltl Wichita River	Archer
				Total	*72,876*	*342,278*			
				Total Excluding Wichita Falls	*7,876*	*9,278*			

A - Application
CA - Certificate of Adjudication
P - Permit

F-2 WAM Modeling Modifications

The analyses for the Lake Ringgold water right application are based on the July 2016 version of the Red River WAM, full authorization scenario, obtained directly from TCEQ. The August 2015 version of WRAP-SIM was used to execute the model. (WRAP-SIM is the computer program used to run the WAM.)

Modifications were made to the TCEQ Red River WAM Run 3 to incorporate Lake Ringgold. The modeling setup for Lake Ringgold is based on the approach used for the 2008 Texas Water Development Board's Site Protection Study [1], which was subsequently modified and adopted for the 2013 Lake Ringgold Feasibility Study [2]. Consistent with the water rights permit application, no instream flow requirements are included in the model. The following sections detail the changes to the input files for Lake Ringgold. These changes include:

- A new primary control associated with Lake Ringgold, with associated CP, WP, FD, IN, and EV records
- WR and WS records with the diversion and storage amounts
- SV and SA records with the reservoir storage and area relationships

Primary control point CPU10021 was added for Lake Ringgold in order to properly calculate the naturalized flows at the dam site. It has been our experience that flows from a large river, like the Red, do not do a good job of estimating flows from a smaller tributary like the Little Wichita. We recommend only using gages within the watershed to estimate flows at the Ringgold site. There are two upstream primary control points in the Little Wichita watershed. At this time WRAP does not have the capability to estimate flows downstream of two primary control points, so it was necessary to add a new primary control point at the Ringgold site. The primary control point was added to both the .DAT and the .DIS file and the upstream secondary control points were adjusted. The naturalized flows were developed using the total naturalized flows from the Little Wichita above Henrietta (control point S10000, drainage area 1,040 square miles) and the East Fork Little Wichita River near Henrietta (control point T10000, drainage area 178 square miles), to develop incremental flows between these two upstream gages and the dam site (1,480 less (1,040 + 178) = 262 square miles). These flows were then added to the naturalized flows from the two gages to obtain the total flows at the dam site. The naturalized flows were entered in the .FLO file as INU10021. Evaporation records were also developed for Lake Ringgold and were entered in the .EVA file as EV10021. The evaporation is uses Texas Water Development Board evaporation and precipitation quadrangles 409 and 410, with weighting factors 0.53125 and 0.46875, respectively. The weighting factors are from the Site Protection Study. Effective runoff is from the East Fork of the Little Wichita near Henrietta gage (USGS 07315200). The calculated inflows and evaporation are shown below in Table F-2 and Table F-3.

[1] Texas Water Development Board. Report 370 Reservoir Site Protection Study, July 2008. Print

[2] Freese and Nichols, Inc. Proposed Lake Ringgold, Clay County, Texas Feasibility Study. Rep. Wichita Falls, October 2013. Print.

Table F-2: Calculated Naturalized Flows at Ringgold Dam Site (CP U10021)
(Values in Acre-feet per Month)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1948	8,874	7,023	4,129	727	7,632	41,536	10,355	3,576	0	0	52	1,270
1949	7,503	9,626	5,224	868	48,260	50,502	248	3,034	16,152	16,555	0	1,433
1950	3,391	0	0	19,707	75,481	10,580	125,632	207,781	32,889	0	0	0
1951	0	0	6,305	2,942	37,755	14,930	2,256	0	7,130	237	0	0
1952	736	0	311	5,124	15,126	1,094	1,558	820	0	0	0	2,489
1953	0	0	10,807	1,440	4,366	0	15,935	7,502	0	133,967	7,336	954
1954	670	868	0	13,932	108,114	34,443	0	0	505	0	0	3,413
1955	2,994	5,142	2,915	8,451	50,399	74,951	1,800	448	89,925	50,609	0	0
1956	22	475	993	413	24,742	5,622	2,264	772	719	12,047	2,783	2,725
1957	0	6,625	11,300	107,586	304,927	60,263	2,903	0	16	18,656	81,734	0
1958	0	865	2,430	3,802	38,406	886	19,630	2,791	4,124	0	0	0
1959	0	0	56	9	7,254	41,675	6,133	211	4,158	50,451	57	12,169
1960	4,318	13,256	1,030	270	4,631	3,148	1,456	0	1,575	32,411	0	9,570
1961	1,028	3,863	11,864	842	13,407	12,082	4,832	0	15,084	689	10,091	2,092
1962	0	24	1,175	5,555	7,845	55,727	6,936	0	84,333	18,852	32,059	48,785
1963	0	0	4,921	9,575	5,692	14,281	0	1,467	1,219	787	4,930	328
1964	1,320	7,745	3,352	4,886	12,066	16,802	58	4,158	37,097	741	12,070	1,085
1965	1,820	2,135	597	6,274	27,206	15,165	1,080	7,305	4,864	8,344	928	1,237
1966	0	1,806	3,704	93,173	76,062	1,515	8,455	29,601	69,058	5,170	750	1
1967	2,100	0	1,348	15,627	3,691	25,684	6,146	0	8,432	0	639	620
1968	33,639	930	50,234	14,202	40,758	9,080	15,391	1,904	61	2	5,965	2,283
1969	605	12,175	53,056	9,484	83,800	8,841	2,668	1,340	42,905	236	275	8,128
1970	6,259	5,302	30,214	11,207	23,800	10,478	2,845	0	1,186	94	91	0
1971	3,943	0	3,266	2,394	2,214	4,570	1,887	57,414	18,225	13,062	0	20,375
1972	0	3,798	1,589	9,882	101,782	9,333	4,632	484	3,831	20,561	39,112	331
1973	23,017	7,599	20,605	27,519	5,086	18,088	21,653	11,285	6,212	5,713	17,648	157
1974	29	6,294	3,425	2,685	12,028	12,777	0	3,596	58,049	14,567	21,888	1,564
1975	3,446	11,474	3,925	7,953	132,326	50,389	24,396	9,931	11,766	4,877	733	22

Table F-2 (Continued) – Calculated Naturalized Flows at the Ringgold Dam Site in Acre-Feet per Month

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	326	2,883	1,013	2,945	14,699	14,915	4,065	8,167	28,686	28,231	14,293	22
1977	5,543	9,349	24,746	24,173	21,842	11,071	1,975	2,708	4,321	0	0	0
1978	0	248	11,082	6,582	4,853	13,081	5,118	21,368	175	0	0	0
1979	4,342	2,322	12,692	4,745	19,786	9,054	6,747	12,143	2,819	0	0	0
1980	558	5,498	1,016	264	17,257	5,282	0	3,916	66,521	24,015	3,900	12,252
1981	786	7,460	48,399	9,506	7,782	21,319	1,930	0	11,666	261,575	180	392
1982	2,021	1,289	6,603	3,852	228,251	111,934	18,041	4,998	4,562	5,695	129	637
1983	1,388	13,007	5,890	12,236	7,477	16,781	3,387	7,201	700	20,467	4	1
1984	2,196	1,898	6,229	3,594	181	4,897	0	1,948	887	37,193	5,858	51,529
1985	30,251	44,032	92,222	97,219	24,793	98,990	7,118	4,067	478	16,325	35	1,542
1986	1,798	3,741	5,148	8,539	24,978	58,312	9,794	3,092	98,900	12,700	16,361	13,435
1987	12,992	28,039	59,315	2,128	28,753	32,302	4,719	4,717	3,395	7,067	2,133	45,950
1988	36	1,321	7,400	7,647	5,762	4,702	6	2,133	5,809	11	6	4
1989	1,888	9,259	4,797	1,736	187,350	109,767	242	11,033	72,153	4,713	26	6
1990	10,980	17,501	105,037	226,113	189,259	50,552	9,011	4,998	1,078	9	3,896	7
1991	11,446	3,082	6,297	2,060	17,617	20,072	1,349	1,589	12,641	13,124	682	124,369
1992	28,809	34,606	24,861	1,781	47,924	163,258	48,404	41	5,037	7	10,867	6,967
1993	3,778	35,830	45,187	9,300	95,804	39,552	6,336	829	11,580	11	4	5,538
1994	2,566	4,842	5,830	6,157	27,527	3,956	1,943	5,542	651	31,001	8,785	5,569
1995	2,526	3,328	11,461	9,305	85,078	48,410	52	26,256	15	3,253	1	755
1996	1,281	2,445	8,704	2,784	2,614	5,681	0	2,876	12,946	1,638	6,830	11,819
1997	3,549	65,348	763	9,382	68,836	19,756	28	9,944	0	0	0	10,017
1998	6,024	14,443	78,197	7,153	8,608	10,434	2,278	4,758	3,486	0	5,052	0

Table F-3: Net Evaporation Rates at Lake Ringgold (CP U10021)
(Values in feet)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1948	0.134	-0.113	0.16	0.404	0.011	0.36	0.616	0.869	0.824	0.482	0.46	0.253
1949	-0.162	-0.013	0.143	0.226	-0.149	0.363	0.717	0.618	0.26	0.068	0.348	0.108
1950	0.01	0.133	0.427	0.133	-0.031	0.311	0.09	0.481	0.126	0.573	0.466	0.255
1951	0.202	0.017	0.29	0.284	0.132	0.029	0.613	0.832	0.558	0.357	0.217	0.25
1952	0.187	0.194	0.169	0.113	0.195	0.673	0.798	1.11	0.855	0.745	0.247	0.115
1953	0.178	0.161	0.109	0.186	0.328	0.777	0.633	0.7	0.764	0.217	0.203	0.268
1954	0.003	0.259	0.343	0.035	-0.082	0.376	0.546	0.707	0.516	0.21	0.169	0.043
1955	0.015	0.043	0.127	0.25	0.059	0.228	0.525	0.561	0.109	0.408	0.289	0.149
1956	0.039	0.025	0.351	0.344	0.164	0.639	0.618	0.725	0.687	0.171	0.146	-0.023
1957	0.021	-0.111	0.008	-0.541	-0.302	0.208	0.478	0.513	0.192	0.005	-0.229	0.087
1958	-0.039	0.075	-0.107	-0.061	0.053	0.299	0.367	0.37	0.174	0.209	0.126	0.066
1959	0.093	0.102	0.256	0.246	0.107	-0.146	0.127	0.402	0.271	-0.266	0.152	-0.077
1960	-0.074	0.031	0.112	0.175	0.11	0.324	0.142	0.418	0.128	-0.022	0.247	-0.127
1961	-0.033	-0.016	-0.016	0.311	0.218	0.082	0.197	0.378	0.001	0.147	-0.056	0.006
1962	0.107	0.13	0.157	-0.015	0.329	-0.145	0.064	0.363	-0.362	0.109	-0.057	0.086
1963	0.082	0.08	0.173	0.031	0.028	0.325	0.281	0.364	0.196	0.241	0.045	0.024
1964	0.002	0.053	0.203	0.218	0.018	0.55	0.804	0.364	-0.038	0.351	-0.187	0.135
1965	0.007	0.034	0.188	0.215	-0.083	0.319	0.783	0.413	0.268	0.186	0.223	0.143
1966	-0.002	-0.036	0.315	-0.158	0.375	0.44	0.601	0.069	-0.02	0.375	0.306	0.103
1967	0.224	0.216	0.377	0.11	0.035	0.443	0.451	0.669	-0.041	0.28	0.159	0.028
1968	-0.255	0.007	-0.046	0.162	0.007	0.301	0.249	0.491	0.238	0.235	-0.057	0.115
1969	0.06	-0.021	-0.041	0.153	0.06	0.389	0.674	0.405	0.086	-0.012	0.186	-0.105
1970	0.129	-0.034	0.011	-0.011	0.27	0.501	0.661	0.563	-0.033	0.112	0.291	0.212
1971	0.179	0.148	0.447	0.436	0.338	0.51	0.534	0.122	0.074	-0.054	0.13	-0.186
1972	0.133	0.185	0.384	0.216	0.222	0.454	0.628	0.339	0.231	-0.119	0.062	0.116
1973	-0.109	0.023	0.106	-0.009	0.228	0.078	0.172	0.549	-0.09	0	0.081	0.201
1974	0.123	0.182	0.312	0.199	0.375	0.498	0.631	0.224	-0.221	-0.132	0.098	0.028
1975	0.076	-0.056	0.101	0.194	-0.206	0.331	0.245	0.321	0.2	0.423	0.173	0.077

Table F-3 (Continued) - Net Evaporation Rates at Lake Ringgold in Feet

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	0.239	0.365	0.288	0.022	0.057	0.397	0.342	0.55	-0.036	-0.094	0.185	0.091
1977	-0.077	0.149	0.107	0.216	0.167	0.515	0.63	0.344	0.481	0.343	0.211	0.271
1978	0.034	-0.078	0.175	0.348	0.119	0.425	0.824	0.357	0.352	0.339	-0.066	0.163
1979	-0.037	0.038	0.013	0.127	0.036	0.319	0.444	0.32	0.417	0.388	0.168	-0.009
1980	0.052	0.101	0.296	0.393	-0.076	0.672	0.901	0.818	0.005	0.297	0.126	0.053
1981	0.171	0.047	0.118	0.132	-0.074	0.24	0.576	0.468	0.277	-0.589	0.113	0.164
1982	0.083	0.071	0.158	0.203	-0.349	0.07	0.46	0.563	0.429	0.251	-0.02	-0.041
1983	0.045	0.017	0.064	0.285	0.031	0.188	0.58	0.597	0.611	0.038	0.101	0.029
1984	0.173	0.159	0.132	0.429	0.316	0.565	0.663	0.445	0.427	-0.262	0.043	-0.188
1985	0.075	-0.036	-0.029	0.19	0.23	0.183	0.538	0.64	0.356	-0.124	0.062	0.134
1986	0.275	0.031	0.288	0.085	-0.129	0.14	0.648	0.436	0.149	-0.106	-0.046	-0.029
1987	0.033	-0.219	0.212	0.397	-0.143	0.17	0.483	0.46	0.226	0.414	0.06	-0.228
1988	0.092	0.149	0.165	0.255	0.421	0.244	0.429	0.598	0.001	0.272	0.157	0.065
1989	0.02	-0.111	0.11	0.404	-0.188	-0.089	0.428	0.355	0.161	0.382	0.297	0.228
1990	0.015	-0.122	-0.112	-0.121	0.17	0.546	0.379	0.433	0.158	0.292	-0.047	0.031
1991	-0.078	0.178	0.285	0.291	0.148	0.251	0.623	0.29	0.154	0.062	0.186	-0.137
1992	-0.064	0.063	0.157	0.259	-0.056	0.149	0.488	0.413	0.214	0.39	-0.048	-0.074
1993	0.011	-0.09	0.118	0.146	0.2	0.328	0.98	0.676	0.22	0.016	0.211	-0.013
1994	0.057	-0.052	0.198	0.144	-0.013	0.62	0.394	0.685	0.198	-0.17	-0.06	0.035
1995	0.003	0.004	-0.008	0.119	-0.11	0.268	0.394	0.295	0.146	0.466	0.279	0.106
1996	0.167	0.333	0.188	0.366	0.543	0.366	0.481	0.057	-0.085	0.164	-0.438	0.135
1997	0.205	-0.197	0.234	-0.019	0.061	0.227	0.532	0.387	0.459	0.105	0.163	-0.236
1998	-0.103	0.037	0.152	0.343	0.461	0.608	0.83	0.663	0.566	0.159	0.088	-0.001

The proposed diversion amount was added as a WR record with a 2018 priority date and using the municipal pattern. The WS record storage corresponds to elevation 844 feet, the proposed normal pool elevation. The storage volume (SV) to surface area (SA) relationship for Lake Ringgold is based on the Feasibility Study. Table F-4 shows the elevation, area and capacity relationships for the reservoir.

Table F-4: Elevation-Area-Capacity Relationship for Lake Ringgold

Elevation (ft-msl)	Area (acres)	Capacity (acre-feet)
790	60	0
800	245	1,524
810	1,370	9,597
820	4,260	37,743
830	9,072	104,400
840	13,298	216,246
844*	15,500	275,000
850	19,109	378,279
856**	23,500	505,000
860	27,105	609,351
870	38,017	934,963
875***	44,500	1,145,000

*Proposed Normal Pool Elevation
**Proposed Emergency Spillway Elevation
***Proposed Top of Dam

Changes to .DAT File

```
** Ringgold Change:
** Add control point U10021 for Lake Ringgold. This CP is primary and has evaporation.
**CPU10020  U10010                       6            NONE         0.
CPU10020  U10021                       2  U10021    NONE         0.
CPU10021  U10010                       0                         0.
**

** Ringgold change: add Reservoir to WAM
WRU10021   65000     MUN20180101                                        RINGGOLD
WSRIGOLD  275000
PX     3
**

** Ringgold Change:
** Area-Capacity for new reservoir based on Feasibility Study:
**ELEV       790      800      810      820      830      840      844
SVRIGOLD       0     1524     9597    37743   104400   216246   275000
SARIGOLD      60      245     1370     4260     9072    13298    15500
```

Changes to .DIS File

```
**  <<
**  Ringgold Reservoir:
**  Control Point Added:
**  Ringgold modeled as a primary control point. Naturalized flow are calculated outside the WRAP Model
**  and entered in the FLO file. The source gages are two primary control point (S10000 and T10000) located
**  upstream of Ringgold (There is no downstream gage for FD). But if there is not a downstream gage to calculate
**  incremental flows, the WRAP Model allows only one source gage upstream of an ungaged location.
**  WRAP can not calculate the flow using two upstream gages and cannot calculate the flows the way we want.
**  Therefore, model Ringgold as primary CP. Change also distribution of other CPs in the Little Wichita.
WPU10021  1480.0
** >>

  ** Ringgold change:
  ** Use gages on the Little Wichita to estimate flow in the watershed.
  **FDU10010  U10000       4  S10000  T10000  Q10000  H10000
  FDU10010  U10000       3  U10021  Q10000  H10000
  ** Ringgold change:
  ** Use gages on the Little Wichita to estimate flow in the watershed.
  **FDU10020  U10000       2  S10000  T10000  Q10000  H10000
  FDU10020  U10021       2  S10000  T10000
  **
  ** Ringgold change:
  ** Use gages on the Little Wichita to estimate flow in the watershed.
  **FDU10030  U10000       0  S10000  T10000  Q10000  H10000
  FDU10030  U10021       0  S10000  T10000
  **
  ** Ringgold change:
  ** Use gages on the Little Wichita to estimate flow in the watershed.
  **FDU10040  U10000       0  S10000  T10000  Q10000  H10000
  FDU10040  U10021       0  S10000  T10000
  **
  ** Ringgold change:
  ** Use gages on the Little Wichita to estimate flow in the watershed.
  **FDU10050  U10000       0  S10000  T10000  Q10000  H10000
  FDU10050  U10021       0  S10000  T10000
  **
  ** Ringgold change:
  ** Use gages on the Little Wichita to estimate flow in the watershed.
  **FDU10060  U10000       1  S10000  T10000  Q10000  H10000
  FDU10060  U10021       1  S10000  T10000
  **
```

F-3 No Injury Analysis

The no injury analysis for the proposed Lake Ringgold, modeled as described above, shows very small changes to the mean shortage for three water rights in the Red River WAM. Table F-5 shows the difference between the model with the Lake Ringgold primary control point but without Lake Ringgold (i.e. “without project”) and the modified WAM with Lake Ringgold (i.e. “with project”) for all water rights in the July 2016 version of the Red River WAM. Three water rights are shown to have minor impacts with the mean shortage increased by less 0.1 acre-feet per year: 60205233003, 60205150301, and 60205123001. The change in the mean shortage is not even large enough to register a change in the period and volume reliabilities. This change is well within the accuracy of the model and is not significant. Thus the model shows no impact of the Ringgold project. The difference between the ‘with project’ and ‘without project’ scenarios is zero for the other water rights in the Red River WAM. The model shows no injury to other water rights.

Table F-5: No Injury Analysis

NAME	Without Project				With Project				Difference			
	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)
60205122002	7,289	726.95	79	90	7,289	726.95	79	90	0	0	0	0
60205122301	727	62.92	92	91	727	62.92	92	91	0	0	0	0
60205230301	16	0.06	100	100	16	0.06	100	100	0	0	0	0
60205230302	600	33.91	91	94	600	33.91	91	94	0	0	0	0
60205122003	672	455.84	32	32	672	455.84	32	32	0	0	0	0
60205122302	456	10.21	97	98	456	10.21	97	98	0	0	0	0
60205152301	100	0.14	100	100	100	0.14	100	100	0	0	0	0
60205123304	25,150	557.95	94	98	25,150	557.95	94	98	0	0	0	0
60205123305	558	9.00	97	98	558	9.00	97	98	0	0	0	0
60205123306	5,850	112.62	98	98	5,850	112.62	98	98	0	0	0	0
60205123307	113	54.92	46	51	113	54.92	46	51	0	0	0	0
60205123308	40,000	5,066.15	80	87	40,000	5,066.15	80	87	0	0	0	0
60205123309	5,066	552.56	85	89	5,066	552.56	85	89	0	0	0	0
60205123310	2,000	435.44	79	78	2,000	435.44	79	78	0	0	0	0
60205123311	435	61.40	84	86	435	61.40	84	86	0	0	0	0
60205123312	103,340	32,334.83	64	69	103,340	32,334.83	64	69	0	0	0	0
60205123313	32,335	5,825.33	79	82	32,335	5,825.33	79	82	0	0	0	0
60204943301	12,000	0.00	100	100	12,000	0.00	100	100	0	0	0	0
60205127001	30	0.00	100	100	30	0.00	100	100	0	0	0	0
60205127003	55	0.00	100	100	55	0.00	100	100	0	0	0	0
60205124101	75	0.00	100	100	75	0.00	100	100	0	0	0	0
60205126301	61	0.00	100	100	61	0.00	100	100	0	0	0	0
60204961301	1,920	0.00	100	100	1,920	0.00	100	100	0	0	0	0
60204961302	300	0.00	100	100	300	0.00	100	100	0	0	0	0
60205124301	3,000	0.00	100	100	3,000	0.00	100	100	0	0	0	0
60205146301	450	2.03	99	100	450	2.03	99	100	0	0	0	0
60205146303	100	6.60	94	93	100	6.60	94	93	0	0	0	0
60204876301	1,286	106.71	87	92	1,286	106.71	87	92	0	0	0	0
60204921001	109	14.90	90	86	109	14.90	90	86	0	0	0	0
60204921002	15	14.75	0	1	15	14.75	0	1	0	0	0	0
60205133301	300	37.97	79	87	300	37.97	79	87	0	0	0	0
60205137301	125	21.16	75	83	125	21.16	75	83	0	0	0	0
60204875301	133	100.71	18	24	133	100.71	18	24	0	0	0	0
60204875302	101	80.04	18	21	101	80.04	18	21	0	0	0	0
60204875303	9	8.00	17	11	9	8.00	17	11	0	0	0	0
60204875304	8	6.94	18	13	8	6.94	18	13	0	0	0	0
60205144303	1,120	53.70	95	95	1,120	53.70	95	95	0	0	0	0

Table F-5 Continued – No Injury Analysis

NAME	Without Project				With Project				Difference			
	TARGET DIVERSION (AC-FT/YR	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)
60205144301	38,880	7,215.46	74	81	38,880	7,215.46	74	81	0	0	0	0
60205230304	3,000	460.60	80	85	3,000	460.60	80	85	0	0	0	0
60205230001	461	175.94	49	62	461	175.94	49	62	0	0	0	0
60205228001	63	7.40	89	88	63	7.40	89	88	0	0	0	0
60205232001	200	45.38	78	77	200	45.38	78	77	0	0	0	0
60204895001	208	33.88	76	84	208	33.88	76	84	0	0	0	0
60204895003	34	33.88	0	0	34	33.88	0	0	0	0	0	0
60205221301	397	5.83	98	99	397	5.83	98	99	0	0	0	0
60205226001	60	7.46	89	88	60	7.46	89	88	0	0	0	0
60205227001	100	12.64	88	87	100	12.64	88	87	0	0	0	0
60205128301	600	0.00	100	100	600	0.00	100	100	0	0	0	0
60205132301	500	0.00	100	100	500	0.00	100	100	0	0	0	0
60205121101	2,153	2,119.95	2	2	2,153	2,119.95	2	2	0	0	0	0
60205181301	80	1.21	97	98	80	1.21	97	98	0	0	0	0
60205229301	30	2.84	90	91	30	2.84	90	91	0	0	0	0
60205148301	300	88.19	58	71	300	88.19	58	71	0	0	0	0
60204960301	160	19.05	87	88	160	19.05	87	88	0	0	0	0
60204955301	381	0.00	100	100	381	0.00	100	100	0	0	0	0
60205259001	34	3.70	87	89	34	3.70	87	89	0	0	0	0
60205259301	4	0.22	84	94	4	0.22	84	94	0	0	0	0
60205236001	130	0.50	100	100	130	0.50	100	100	0	0	0	0
60205236301	1	0.00	100	100	1	0.00	100	100	0	0	0	0
OKSHARETEXO	168,000	0.00	100	100	168,000	0.00	100	100	0	0	0	0
60204901301	5,280	3,351.99	12	37	5,280	3,351.99	12	37	0	0	0	0
60204901303	24,400	23,894.98	0	2	24,400	23,894.98	0	2	0	0	0	0
60204901302	23,895	0.00	100	100	23,895	0.00	100	100	0	0	0	0
60205258001	140	10.91	91	92	140	10.91	91	92	0	0	0	0
60204954002	1,875	1.73	100	100	1,875	1.73	100	100	0	0	0	0
60205225001	96	17.40	82	82	96	17.40	82	82	0	0	0	0
60204907001	200	30.80	84	85	200	30.80	84	85	0	0	0	0
60205234001	184	18.41	89	90	184	18.41	89	90	0	0	0	0
60205257101	70	6.75	89	90	70	6.75	89	90	0	0	0	0
60205146302	810	101.10	82	88	810	101.10	82	88	0	0	0	0
60205235001	108	8.95	91	92	108	8.95	91	92	0	0	0	0
60205152303	1,459	7.67	99	99	1,459	7.67	99	99	0	0	0	0
60205152304	1	0.00	99	100	1	0.00	99	100	0	0	0	0

Table F-5 Continued – No Injury Analysis

NAME	Without Project				With Project				Difference			
	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)
60204945001	110	6.80	91	94	110	6.80	91	94	0	0	0	0
60204953002	750	1.97	99	100	750	1.97	99	100	0	0	0	0
60204952002	100	6.58	91	93	100	6.58	91	93	0	0	0	0
60204949002	550	36.67	91	93	550	36.67	91	93	0	0	0	0
60205260002	100	13.38	84	87	100	13.38	84	87	0	0	0	0
60204962001	80	3.12	97	96	80	3.12	97	96	0	0	0	0
60205135003	357	27.84	92	92	357	27.84	92	92	0	0	0	0
60205223001	39	3.00	92	92	39	3.00	92	92	0	0	0	0
60205236003	43	3.61	91	92	43	3.61	91	92	0	0	0	0
60205236302	4	0.00	100	100	4	0.00	100	100	0	0	0	0
60205125002	675	335.55	53	50	675	335.55	53	50	0	0	0	0
60204957003	67	0.06	100	100	67	0.06	100	100	0	0	0	0
60205250002	33	4.51	84	86	33	4.51	84	86	0	0	0	0
60205261102	59	5.84	89	90	59	5.84	89	90	0	0	0	0
60205253002	319	32.50	88	90	319	32.50	88	90	0	0	0	0
60204904003	482	12.46	94	97	482	12.46	94	97	0	0	0	0
60204917003	219	5.33	94	98	219	5.33	94	98	0	0	0	0
60204918101	360	2.01	99	99	360	2.01	99	99	0	0	0	0
60205253302	33	18.24	21	44	33	18.24	21	44	0	0	0	0
60205256001	50	4.52	91	91	50	4.52	91	91	0	0	0	0
60204903001	4,000	3,599.42	0	10	4,000	3,599.42	0	10	0	0	0	0
10202006301	25,000	0.00	100	100	25,000	0.00	100	100	0	0	0	0
60205102301	33	8.81	63	73	33	8.81	63	73	0	0	0	0
60205102302	50	23.58	48	53	50	23.58	48	53	0	0	0	0
60205120301	85	80.75	5	5	85	80.75	5	5	0	0	0	0
60205148001	506	143.23	70	72	506	143.23	70	72	0	0	0	0
60205231001	41	4.08	88	90	41	4.08	88	90	0	0	0	0
60205110302	40	25.20	23	37	40	25.20	23	37	0	0	0	0
60205233301	250	2.91	99	99	250	2.91	99	99	0	0	0	0
60205233302	10,819	1,059.72	83	90	10,819	1,059.72	83	90	0	0	0	0
60205233303	372	61.32	83	84	372	61.32	83	84	0	0	0	0
60205233304	559	92.62	82	83	559	92.62	82	83	0	0	0	0
60205233003	3,711	1,839.09	23	50	3,711	1,839.17	23	50	0	0.08	0	0
60205233004	128	97.77	23	24	128	97.77	23	24	0	0	0	0
60205233005	191	147.26	22	23	191	147.26	22	23	0	0	0	0
60204879301	645	0.00	100	100	645	0.00	100	100	0	0	0	0

Table F-5 Continued – No Injury Analysis

NAME	Without Project				With Project				Difference			
	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)
60204930001	48	0.79	95	98	48	0.79	95	98	0	0	0	0
60204956001	81	0.07	100	100	81	0.07	100	100	0	0	0	0
60204900301	10,000	6,125.39	28	39	10,000	6,125.39	28	39	0	0	0	0
60204896301	21	0.05	100	100	21	0.05	100	100	0	0	0	0
60205137302	100	2.65	96	97	100	2.65	96	97	0	0	0	0
60204900302	6,125	0.00	100	100	6,125	0.00	100	100	0	0	0	0
60205264301	70	0.00	100	100	70	0.00	100	100	0	0	0	0
60205196301	124	115.94	4	7	124	115.94	4	7	0	0	0	0
60205186301	200	129.72	35	35	200	129.72	35	35	0	0	0	0
60205150301	31,918	594.23	99	98	31,918	594.25	99	98	0	0.02	0	0
60205099301	117	15.66	82	87	117	15.66	82	87	0	0	0	0
60205254001	125	13.93	88	89	125	13.93	88	89	0	0	0	0
60205145301	70	56.39	18	19	70	56.39	18	19	0	0	0	0
60204881301	4,500	0.00	100	100	4,500	0.00	100	100	0	0	0	0
60205237301	300	0.00	100	100	300	0.00	100	100	0	0	0	0
60205131301	840	0.00	100	100	840	0.00	100	100	0	0	0	0
60205149301	60	32.67	45	46	60	32.67	45	46	0	0	0	0
60205197302	60	11.21	82	81	60	11.21	82	81	0	0	0	0
60205136002	200	20.92	89	90	200	20.92	89	90	0	0	0	0
60205267301	100	87.18	5	13	100	87.18	5	13	0	0	0	0
60204919001	20	0.51	94	97	20	0.51	94	97	0	0	0	0
60205130002	40	4.29	89	89	40	4.29	89	89	0	0	0	0
60205243301	217	1.23	99	99	217	1.23	99	99	0	0	0	0
60205238301	160	2.29	98	99	160	2.29	98	99	0	0	0	0
60205113302	150	22.02	79	85	150	22.02	79	85	0	0	0	0
60205113301	22	21.96	2	0	22	21.96	2	0	0	0	0	0
60205111001	23	2.28	89	90	23	2.28	89	90	0	0	0	0
60205106301	80	55.95	18	30	80	55.95	18	30	0	0	0	0
60205103301	28	8.42	62	70	28	8.42	62	70	0	0	0	0
60205101301	37	1.16	96	97	37	1.16	96	97	0	0	0	0
60205105301	30	2.46	88	92	30	2.46	88	92	0	0	0	0
60205104301	17	9.81	39	42	17	9.81	39	42	0	0	0	0
60205134102	125	89.08	27	29	125	89.08	27	29	0	0	0	0
60205182101	37	34.34	6	7	37	34.34	6	7	0	0	0	0
60205182301	34	31.45	10	8	34	31.45	10	8	0	0	0	0
60205183101	13	12.06	6	7	13	12.06	6	7	0	0	0	0

Table F-5 Continued – No Injury Analysis

NAME	Without Project				With Project				Difference			
	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)
60205183301	12	9.82	19	19	12	9.82	19	19	0	0	0	0
60205184101	54	50.11	6	7	54	50.11	6	7	0	0	0	0
60205184301	50	43.21	13	14	50	43.21	13	14	0	0	0	0
60205100301	19	1.21	91	94	19	1.21	91	94	0	0	0	0
60204940301	23,885	36.90	100	100	23,885	36.90	100	100	0	0	0	0
60204940302	1,115	3.00	100	100	1,115	3.00	100	100	0	0	0	0
60204940303	16,610	33.83	100	100	16,610	33.83	100	100	0	0	0	0
60204940304	20,000	64.22	99	100	20,000	64.22	99	100	0	0	0	0
60205185301	125	114.57	7	8	125	114.57	7	8	0	0	0	0
60204914301	30	4.15	85	86	30	4.15	85	86	0	0	0	0
60205262101	29	3.20	88	89	29	3.20	88	89	0	0	0	0
60204908001	135	20.75	84	85	135	20.75	84	85	0	0	0	0
60204922301	362	70.28	74	81	362	70.28	74	81	0	0	0	0
60204922001	70	48.23	39	31	70	48.23	39	31	0	0	0	0
60204916001	160	30.53	81	81	160	30.53	81	81	0	0	0	0
60205138401	55	11.84	63	78	55	11.84	63	78	0	0	0	0
60205179001	796	782.91	1	2	796	782.91	1	2	0	0	0	0
60204926101	520	89.50	87	83	520	89.50	87	83	0	0	0	0
60204925301	5,340	0.00	100	100	5,340	0.00	100	100	0	0	0	0
60204913002	30	5.28	83	82	30	5.28	83	82	0	0	0	0
60205245301	129	89.63	18	31	129	89.63	18	31	0	0	0	0
60205212301	107	12.85	86	88	107	12.85	86	88	0	0	0	0
60205154301	15	0.16	98	99	15	0.16	98	99	0	0	0	0
60205140001	270	29.35	89	89	270	29.35	89	89	0	0	0	0
60205211301	2,000	30.76	98	98	2,000	30.76	98	98	0	0	0	0
60205211302	600	11.57	98	98	600	11.57	98	98	0	0	0	0
60204899301	250	0.00	100	100	250	0.00	100	100	0	0	0	0
60205139003	30	3.13	89	90	30	3.13	89	90	0	0	0	0
60204884302	56	26.34	46	53	56	26.34	46	53	0	0	0	0
60204884303	26	25.13	3	5	26	25.13	3	5	0	0	0	0
60204884304	25	14.03	41	44	25	14.03	41	44	0	0	0	0
60204886301	33	6.46	76	81	33	6.46	76	81	0	0	0	0
60205187401	40	35.42	11	11	40	35.42	11	11	0	0	0	0
60205248301	30	0.00	100	100	30	0.00	100	100	0	0	0	0
60205251301	60	58.71	2	2	60	58.71	2	2	0	0	0	0
60204883301	80	6.02	89	92	80	6.02	89	92	0	0	0	0

Table F-5 Continued – No Injury Analysis

NAME	Without Project				With Project				Difference			
	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)
60204936301	20	9.24	51	54	20	9.24	51	54	0	0	0	0
60205114301	35	31.19	11	11	35	31.19	11	11	0	0	0	0
60204931301	10	0.00	100	100	10	0.00	100	100	0	0	0	0
60205209301	284	260.75	6	8	284	260.75	6	8	0	0	0	0
60204935301	40	19.92	49	50	40	19.92	49	50	0	0	0	0
60205153301	50	23.63	47	53	50	23.63	47	53	0	0	0	0
60205240301	100	0.00	100	100	100	0.00	100	100	0	0	0	0
60205197303	20	12.66	36	37	20	12.66	36	37	0	0	0	0
60204937301	30	26.22	15	13	30	26.22	15	13	0	0	0	0
60205119301	20	17.56	12	12	20	17.56	12	12	0	0	0	0
60205129001	256	27.62	88	89	256	27.62	88	89	0	0	0	0
60205198301	57	41.01	26	28	57	41.01	26	28	0	0	0	0
60205198302	41	40.49	2	1	41	40.49	2	1	0	0	0	0
60205200301	12	7.14	39	40	12	7.14	39	40	0	0	0	0
60205202301	61	41.37	32	32	61	41.37	32	32	0	0	0	0
60205203301	26	18.31	28	30	26	18.31	28	30	0	0	0	0
60205206301	24	19.21	16	20	24	19.21	16	20	0	0	0	0
60205207301	8	5.07	34	37	8	5.07	34	37	0	0	0	0
60205210301	60	58.65	2	2	60	58.65	2	2	0	0	0	0
60204958301	7	0.00	100	100	7	0.00	100	100	0	0	0	0
60204912301	987	917.81	3	7	987	917.81	3	7	0	0	0	0
60205147301	30	23.79	19	21	30	23.79	19	21	0	0	0	0
60205249301	10	0.31	93	97	10	0.31	93	97	0	0	0	0
60205208301	55	53.43	3	3	55	53.43	3	3	0	0	0	0
60205197304	69	44.30	35	36	69	44.30	35	36	0	0	0	0
60205204301	34	17.35	48	49	34	17.35	48	49	0	0	0	0
60204941002	885	12.69	96	99	885	12.69	96	99	0	0	0	0
60204941301	298	0.00	100	100	298	0.00	100	100	0	0	0	0
60205149302	40	22.02	45	45	40	22.02	45	45	0	0	0	0
60205199302	90	57.00	34	37	90	57.00	34	37	0	0	0	0
60205199301	173	109.44	35	37	173	109.44	35	37	0	0	0	0
60204889301	30	0.00	100	100	30	0.00	100	100	0	0	0	0
60204890301	20	0.22	97	99	20	0.22	97	99	0	0	0	0
60204891301	130	1.62	98	99	130	1.62	98	99	0	0	0	0
60204892301	20	0.00	100	100	20	0.00	100	100	0	0	0	0
60204893301	24	19.38	25	19	24	19.38	25	19	0	0	0	0

Table F-5 Continued – No Injury Analysis

NAME	Without Project				With Project				Difference			
	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)
60204893302	19	3.80	70	80	19	3.80	70	80	0	0	0	0
60205107301	101	3.81	95	96	101	3.81	95	96	0	0	0	0
60204884301	30	15.48	73	48	30	15.48	73	48	0	0	0	0
60204884305	16	15.48	0	0	16	15.48	0	0	0	0	0	0
60204884306	16	15.48	0	0	16	15.48	0	0	0	0	0	0
60204884307	16	15.48	1	0	16	15.48	1	0	0	0	0	0
60205252301	20	18.25	8	9	20	18.25	8	9	0	0	0	0
60204874301	30	5.05	79	83	30	5.05	79	83	0	0	0	0
60205142301	200	12.72	91	94	200	12.72	91	94	0	0	0	0
60205142302	13	4.40	67	65	13	4.40	67	65	0	0	0	0
60205142303	4	2.69	56	39	4	2.69	56	39	0	0	0	0
60205143001	200	20.71	89	90	200	20.71	89	90	0	0	0	0
60205242301	9	0.24	94	97	9	0.24	94	97	0	0	0	0
60204947301	225	2.77	97	99	225	2.77	97	99	0	0	0	0
60204948301	150	15.54	86	90	150	15.54	86	90	0	0	0	0
60204950301	102	23.09	75	77	102	23.09	75	77	0	0	0	0
60205112303	45	0.00	100	100	45	0.00	100	100	0	0	0	0
60205195301	400	169.63	42	58	400	169.63	42	58	0	0	0	0
60204898301	250	0.00	100	100	250	0.00	100	100	0	0	0	0
60204898302	1,650	0.00	100	100	1,650	0.00	100	100	0	0	0	0
60204898303	100	0.00	100	100	100	0.00	100	100	0	0	0	0
60204902301	120	116.67	3	3	120	116.67	3	3	0	0	0	0
60204923301	20	0.00	100	100	20	0.00	100	100	0	0	0	0
60204911302	30	8.24	69	73	30	8.24	69	73	0	0	0	0
60204911301	8	2.98	59	64	8	2.98	59	64	0	0	0	0
60205247301	100	2.27	95	98	100	2.27	95	98	0	0	0	0
60205241301	4	0.16	92	96	4	0.16	92	96	0	0	0	0
60205246301	70	0.53	98	99	70	0.53	98	99	0	0	0	0
60205115001	3,050	3,000.17	2	2	3,050	3,000.17	2	2	0	0	0	0
60205117001	1,240	1,217.71	2	2	1,240	1,217.71	2	2	0	0	0	0
60205118001	3,770	3,703.11	2	2	3,770	3,703.11	2	2	0	0	0	0
60205239301	5	0.00	100	100	5	0.00	100	100	0	0	0	0
60205189301	164	80.71	44	51	164	80.71	44	51	0	0	0	0
60205190301	10	5.12	44	49	10	5.12	44	49	0	0	0	0
60205191301	164	86.83	42	47	164	86.83	42	47	0	0	0	0
60205192301	164	94.53	39	42	164	94.53	39	42	0	0	0	0

Table F-5 Continued – No Injury Analysis

NAME	Without Project				With Project				Difference			
	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)
60205129002	148	16.90	88	89	148	16.90	88	89	0	0	0	0
60204959002	2,556	2.36	100	100	2,556	2.36	100	100	0	0	0	0
60205123001	16,660	5,283.71	57	68	16,660	5,283.72	57	68	0	0.01	0	0
60204920001	640	137.22	82	79	640	137.22	82	79	0	0	0	0
60204933301	110	72.97	32	34	110	72.97	32	34	0	0	0	0
60204946002	1,000	4.84	99	100	1,000	4.84	99	100	0	0	0	0
60205109301	200	19.15	90	90	200	19.15	90	90	0	0	0	0
60204934301	50	42.79	16	14	50	42.79	16	14	0	0	0	0
60204934302	43	31.01	21	28	43	31.01	21	28	0	0	0	0
60205146304	35	6.35	81	82	35	6.35	81	82	0	0	0	0
60204938301	220	102.94	50	53	220	102.94	50	53	0	0	0	0
60204939301	78	44.83	38	43	78	44.83	38	43	0	0	0	0
60204939302	45	41.64	12	7	45	41.64	12	7	0	0	0	0
60205220301	20	0.00	100	100	20	0.00	100	100	0	0	0	0
10204130001	132	131.12	1	1	132	131.12	1	1	0	0	0	0
60204941003	2,085	29.89	96	99	2,085	29.89	96	99	0	0	0	0
60204941302	702	0.00	100	100	702	0.00	100	100	0	0	0	0
10204184301	60	5.05	86	92	60	5.05	86	92	0	0	0	0
10204193301	90	4.99	91	94	90	4.99	91	94	0	0	0	0
10204194201	90	32.21	61	64	90	32.21	61	64	0	0	0	0
10204198001	25	3.46	86	86	25	3.46	86	86	0	0	0	0
10204207001	75	12.13	83	84	75	12.13	83	84	0	0	0	0
10204209001	200	38.42	81	81	200	38.42	81	81	0	0	0	0
10204228002	320	79.76	81	75	320	79.76	81	75	0	0	0	0
60205211304	2,000	56.16	96	97	2,000	56.16	96	97	0	0	0	0
60205211305	600	22.01	96	96	600	22.01	96	96	0	0	0	0
10204268101	3,600	1,008.09	69	72	3,600	1,008.09	69	72	0	0	0	0
60204951302	40	0.00	100	100	40	0.00	100	100	0	0	0	0
10204317001	18	0.82	97	95	18	0.82	97	95	0	0	0	0
60205125301	336	255.56	21	24	336	255.56	21	24	0	0	0	0
60205125302	256	0.00	100	100	256	0.00	100	100	0	0	0	0
10204363003	1,379	35.86	94	97	1,379	35.86	94	97	0	0	0	0
10204363002	2,158	56.10	94	97	2,158	56.10	94	97	0	0	0	0
10204371001	500	10.08	95	98	500	10.08	95	98	0	0	0	0
10204392002	500	1.96	99	100	500	1.96	99	100	0	0	0	0
10204397002	360	9.36	94	97	360	9.36	94	97	0	0	0	0

Table F-5 Continued – No Injury Analysis

NAME	Without Project				With Project				Difference			
	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)
10204433101	300	203.74	33	32	300	203.74	33	32	0	0	0	0
60204935302	60	31.09	48	48	60	31.09	48	48	0	0	0	0
60204912401	140	7.85	86	94	140	7.85	86	94	0	0	0	0
60205194302	38	0.00	100	100	38	0.00	100	100	0	0	0	0
10204576301	80	25.66	70	68	80	25.66	70	68	0	0	0	0
10204582301	103	98.20	2	5	103	98.20	2	5	0	0	0	0
10205003301	84,000	0.00	100	100	84,000	0.00	100	100	0	0	0	0
10205022301	2	0.23	88	88	2	0.23	88	88	0	0	0	0
10205078601	8	7.95	0	0	8	7.95	0	0	0	0	0	0
10205113301	125	55.01	52	56	125	55.01	52	56	0	0	0	0
10205129301	92	78.35	16	15	92	78.35	16	15	0	0	0	0
10205152001	2,352	504.85	78	79	2,352	504.85	78	79	0	0	0	0
60204879302	435	0.00	100	100	435	0.00	100	100	0	0	0	0
60204879303	100	0.00	100	100	100	0.00	100	100	0	0	0	0
60204879304	80	0.00	100	100	80	0.00	100	100	0	0	0	0
10204371101	3,728	78.51	94	98	3,728	78.51	94	98	0	0	0	0
10205233002	2,700	192.58	93	93	2,700	192.58	93	93	0	0	0	0
10205233004	250	24.73	93	90	250	24.73	93	90	0	0	0	0
10205233005	650	71.72	92	89	650	71.72	92	89	0	0	0	0
60204946003	350	20.48	95	94	350	20.48	95	94	0	0	0	0
60204946004	250	17.56	94	93	250	17.56	94	93	0	0	0	0
10204363004	3,755	169.38	94	95	3,755	169.38	94	95	0	0	0	0
10205276001	2,535	37.53	96	99	2,535	37.53	96	99	0	0	0	0
10205393301	300	140.35	55	53	300	140.35	55	53	0	0	0	0
10205434302	10	5.42	44	46	10	5.42	44	46	0	0	0	0
10205434303	13	7.96	39	39	13	7.96	39	39	0	0	0	0
10205393302	150	77.74	52	48	150	77.74	52	48	0	0	0	0
10205530001	32	7.42	77	77	32	7.42	77	77	0	0	0	0
10205558401	85	22.51	72	74	85	22.51	72	74	0	0	0	0
10205605001	100	58.24	45	42	100	58.24	45	42	0	0	0	0
10205605301	58	0.00	100	100	58	0.00	100	100	0	0	0	0
10205630001	797	25.49	93	97	797	25.49	93	97	0	0	0	0
10205632001	800	1.43	99	100	800	1.43	99	100	0	0	0	0
60204881302	3,240	4.93	100	100	3,240	4.93	100	100	0	0	0	0
60205194303	53	0.00	100	100	53	0.00	100	100	0	0	0	0
10205904301	120	38.71	56	68	120	38.71	56	68	0	0	0	0

Table F-5 Continued – No Injury Analysis

NAME	Without Project				With Project				Difference			
	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)
10205003002	113,000	0.00	100	100	113,000	0.00	100	100	0	0	0	0
OKSHARETEX5	113,000	0.00	100	100	113,000	0.00	100	100	0	0	0	0
60204900304	6,400	5,195.42	19	19	6,400	5,195.42	19	19	0	0	0	0
60204900305	5,195	0.00	100	100	5,195	0.00	100	100	0	0	0	0
BF-FMB-LP1	329	0.00	100	100	329	0.00	100	100	0	0	0	0
BF-FMB-LP2	11	0.00	100	100	11	0.00	100	100	0	0	0	0
BF-FMB-LP3	648	0.00	100	100	648	0.00	100	100	0	0	0	0
BF-FMB-LP4	277	0.00	100	100	277	0.00	100	100	0	0	0	0
BF-FMB-LP5	9	0.00	100	100	9	0.00	100	100	0	0	0	0
BF-FMB-LP6	2,786	0.00	100	100	2,786	0.00	100	100	0	0	0	0
SUBPULOFF	7	0.00	100	100	7	0.00	100	100	0	0	0	0
FKFMLFRESH	1,476	0.00	100	100	1,476	0.00	100	100	0	0	0	0
BODARCREG	200,334	0.00	100	100	200,334	0.00	100	100	0	0	0	0
BDFREONOFF	603	0.00	100	100	603	0.00	100	100	0	0	0	0
FMFREPREV	81	0.00	100	100	81	0.00	100	100	0	0	0	0
FMFRETRAC1	3	0.00	100	100	3	0.00	100	100	0	0	0	0
FMFRETRAC2	8	0.00	100	100	8	0.00	100	100	0	0	0	0
BDFREONOFFPREV	603	0.00	100	100	603	0.00	100	100	0	0	0	0
SET_REL_TARGET	70	0.00	100	100	70	0.00	100	100	0	0	0	0
FKFMLPULW1	14,786	0.00	100	100	14,786	0.00	100	100	0	0	0	0
FMWINONOFF	100	0.00	100	100	100	0.00	100	100	0	0	0	0
FKFMLPUSP1	45,266	0.00	100	100	45,266	0.00	100	100	0	0	0	0
FMSPRONOFF	33	0.00	100	100	33	0.00	100	100	0	0	0	0
FKFMLPULS1	8,786	0.00	100	100	8,786	0.00	100	100	0	0	0	0
FMSUMONOFF	167	0.00	100	100	167	0.00	100	100	0	0	0	0
P12151_1	175,000	12,262.60	91	93	175,000	12,262.60	91	93	0	0	0	0
FM409_REG	48,391	0.00	100	100	48,391	0.00	100	100	0	0	0	0
FMFREONOFF	81	0.00	100	100	81	0.00	100	100	0	0	0	0
10202006302	56,500	955.24	98	98	56,500	955.24	98	98	0	0	0	0
10202006312	955	955.24	0	0	955	955.24	0	0	0	0	0	0
OKSHARETEX1	56,500	0.00	100	100	56,500	0.00	100	100	0	0	0	0
10212618001	11,991	11,895.54	1	1	11,991	11,895.54	1	1	0	0	0	0
10202006303	1,700	44.09	97	97	1,700	44.09	97	97	0	0	0	0
10202006313	44	40.36	6	8	44	40.36	6	8	0	0	0	0
OKSHARETEX3	1,700	0.00	100	100	1,700	0.00	100	100	0	0	0	0
60205150307	76	0.11	99	100	76	0.11	99	100	0	0	0	0

Table F-5 Continued – No Injury Analysis

NAME	Without Project				With Project				Difference			
	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)	TARGET DIVERSION (AC-FT/YR)	MEAN SHORTAGE (AC-FT/YR)	PERIOD RELIABILITY (%)	VOLUME RELIABILITY (%)
COM001	90,119	0.00	100	100	90,119	0.00	100	100	0	0	0	0
COM002	88,298	0.00	100	100	88,298	0.00	100	100	0	0	0	0
5COETEXOMA	955	0.00	100	100	955	0.00	100	100	0	0	0	0
9COETEXOMA	40	0.00	100	100	40	0.00	100	100	0	0	0	0

APPENDIX G

ACCOUNTING PLAN

4055 International Plaza, Suite 200 • Fort Worth, Texas 76109 • 817-735-7300 • fax 817-735-7492 www.freese.com

TO:	Texas Commission on Environmental Quality
CC:	City of Wichita Falls
FROM:	Lissa Gregg E.I.T., Freese and Nichols
SUBJECT:	City of Wichita Falls Draft Accounting Plan
DATE:	March 10, 2016, Revised June 22, 2016 Revised April 5, 2017
PROJECT:	WCH15215

The City of Wichita Falls (the "City") is authorized to store, divert, and use surface water from Lake Arrowhead pursuant to Certification of Adjudication ("COA") No 02-5150, as amended. The City also has authorization to store, divert, and use surface water from Lake Kickapoo pursuant to COA 02-5144, as amended. Under COA 02-5150 and COA 02-5144, the City may currently use up to 45,000 acre-feet per year from Lake Arrowhead and up to 40,000 acre-feet from Lake Kickapoo. However, the combined diversion from these two reservoirs may not exceed 65,000 acre-feet. The City also has raw water contracts with users that divert directly from Lakes Arrowhead and Kickapoo under their authorizations. These include Windthorst and the Red River Authority from Lake Arrowhead; and Archer City, the City of Olney, and Wichita Valley Water Supply Corporation from Lake Kickapoo. Amendment C to COA 02-5150, which will allow the City to divert, use, and convey (via the bed and banks of Lake Arrowhead) all existing and future return flows associated with TPDES Permit No. WQ0010509001, is assumed to be in place for the purposes of this application version of the Draft Accounting Plan.

As part of the water right application for Lake Ringgold, the City is seeking:

- The right to divert, use, and convey, via the bed and banks of Lake Arrowhead, up to 65,000 acre-feet per year of supply from the proposed Lake Ringgold reservoir.

This draft accounting plan seeks to demonstrate compliance with the request stated above that is associated with the Lake Ringgold water right application, in addition to previous City of Wichita Falls' water right authorizations and requests within the Little Wichita River Basin. Specifically, this accounting plan is developed to demonstrate compliance with the conditions of COA 02-5150, as amended (including the proposed amendment COA 02-5150 C), diversions under COA 02-5144 to demonstrate compliance with the combined maximum diversion of 65,000 acre-feet per year from Lakes Arrowhead and Kickapoo; and to account for diversions from Lake Ringgold that would be conveyed via the bed and banks of Lake Arrowhead.

Elements of the Accounting Plan

Overview & Conversion Factors	Introduction to the accounting plan, including basic information and description.
Table 1 – Daily Data	Includes basic data concerning City of Wichita Falls' diversions from Lakes Arrowhead and Kickapoo, Wastewater Treatment Plant (WWTP) discharges to Lake Arrowhead, and conveyance and use from Lake Ringgold.
Table 2 – Monthly Data	Tracks diversions of all users from Lakes Arrowhead, Kickapoo and

	Ringgold on a monthly basis. Tracks diversions from Lake Arrowhead under the proposed Lake Ringgold water right. Allocates diversions by permit on a monthly basis.
Table 3 – Water Right Summary	Demonstrates compliance with water rights CA 02-5150, CA 02-5150 C, CA 02-5144, and the proposed Lake Ringgold Permit.

These tables are discussed individually in the following sections of the plan. Within the Accounting Plan, light blue shaded cells represent basic data. Grey shaded cells represent user input data. Light green shaded cells represent data brought in from elsewhere in the accounting plan. Unshaded cells represent computations.

Table 1 – Daily Data

Table 1 displays the amount of discharge from the wastewater treatment plant into Lake Arrowhead, and City of Wichita Falls diversions from Lakes Arrowhead and Kickapoo on a daily basis. This table also displays the amount of water used directly from Lake Ringgold and water diverted from Lake Ringgold and transported to Lake Arrowhead daily. This data will be input by the City.

Column	Title	Units	Description
A	Date	Date	This is the date to which the data apply. Determined by input year in cell G4.
B	Numerical Month	No.	Numerical month (1-12) corresponding to the date in column A. Used to sum monthly values.
C	WWTP Discharge to Lake Arrowhead	MGD	This is the amount of water discharged under TPDES Permit No. WQ0010509001 by the City in million gallons per day.
D	WWTP Discharge to Lake Arrowhead	Acre-Feet	This is the amount of water discharged under TPDES Permit No. WQ0010509001 by the City converted to acre-feet.
E	COWF Lake Ringgold Direct Diversions	MGD	This is the amount of water diverted directly from the proposed Lake Ringgold for use in million gallons per day.
F	COWF Lake Ringgold Direct Diversions	Acre-Feet	This is the amount of water diverted directly from the proposed Lake Ringgold for use converted to acre-feet.
G	Lake Ringgold Discharge to Lake Arrowhead	MGD	This is the amount of water diverted from Lake Ringgold and transported to the bed and banks of Lake Arrowhead in million gallons per day.
H	Lake Ringgold Discharge to Lake Arrowhead	Acre-Feet	This is the amount of water diverted from Lake Ringgold and transported to the bed and banks of Lake Arrowhead in converted to acre-feet.
I	COWF Diversions from Lake Arrowhead	MGD	This is the total amount of water diverted from Lake Arrowhead by the City of Wichita Falls (COWF) in million gallons per day.
J	COWF Diversions from Lake Arrowhead	Acre-Feet	This is the total amount of water diverted from Lake Arrowhead by the City of Wichita Falls (COWF) converted to acre-feet.
K	COWF Diversions from Lake Kickapoo	MGD	This is the total amount of water diverted from Lake Kickapoo by the City of Wichita Falls (COWF) in million gallons per day.
L	COWF Diversions from Lake Kickapoo	Acre-Feet	This is the total amount of water diverted from Lake Kickapoo by the City of Wichita Falls (COWF) converted to acre-feet.

Table 2 – Monthly Data

Table 2 collects monthly diversion data from all direct users of Lakes Arrowhead and Kickapoo and assigns diversions by permit.

Column	Title	Units	Description
A	Month	Month	This is the month to which the data apply.
B	Numerical Month	No.	Numerical month (1-12) corresponding to the month in column A.
C	Windthorst	MG	This is the amount of water diverted from Lake Arrowhead by Windthorst in MG.
D	Red River Authority	MG	This is the amount of water diverted from Lake Arrowhead by the Red River Authority in MG.
E	Windthorst	Acre-Feet	This is the amount of water diverted from Lake Arrowhead by Windthorst converted to acre-feet.
F	Red River Authority	Acre-Feet	This is the amount of water diverted from Lake Arrowhead by the Red River Authority converted to acre-feet.
G	Wichita Falls	Acre-Feet	This is the amount of water diverted from Lake Arrowhead by the City of Wichita Falls in acre-feet. This is summed from T1-Daily Data, Column J.
H	Total Diversion from Lake Arrowhead	Acre-Feet	This is the sum of columns E-G. This is total amount of water diverted from Lake Arrowhead by all users.
I	Archer City	MG	This is the amount of water diverted from Lake Kickapoo by Archer City in MG.
J	Olney	MG	This is the amount of water diverted from Lake Kickapoo by Olney in MG.
K	Wichita Valley WSC	MG	This is the amount of water diverted from Lake Kickapoo by Wichita Valley WSC in MG.
L	Archer City	Acre-Feet	This is the amount of water diverted from Lake Kickapoo by Archer City converted to acre-feet.
M	Olney	Acre-Feet	This is the amount of water diverted from Lake Kickapoo by Olney converted to acre-feet.
N	Wichita Valley WSC	Acre-Feet	This is the amount of water diverted from Lake Kickapoo by Wichita Valley WSC converted to acre-feet.
O	Wichita Falls	Acre-Feet	This is the amount of water diverted from Lake Kickapoo by the City of Wichita Falls in acre-feet. This is summed from T1-Daily Data, Column L.
P	Total Diversion from Lake Kickapoo (COA 02-5144B)	Acre-Feet	This is the sum of columns L-O. This is total amount of water diverted from Lake Kickapoo by all users.
Q	WWTP Discharge to Lake Arrowhead	Acre-Feet	This is the amount of water discharged under TPDES Permit No. WQ0010509001 by the City in acre-feet. This is summed from T1- Daily Data, Column D.
R	Direct Diversions from Lake Ringgold	Acre-Feet	This is the amount of water diverted from Lake Ringgold directly for use. This is summed from T1- Daily Data, Column F.
S	Lake Ringgold	Acre-Feet	This is the amount of water diverted from Lake Ringgold and

Column	Title	Units	Description
	Discharge to Lake Arrowhead		transported to and discharged into Lake Arrowhead. This is summed from T1- Daily Data, Column H.
T	Proposed Reuse Amendment COA 02-5150C	Acre-Feet	Amount of diversions from Lake Arrowhead under the proposed reuse amendment COA 02-5150C. Assumes returns flows are used first.
U	Diversions from Lake Arrowhead of Water Imported from Lake Ringgold	Acre-Feet	Amount of diversions from Lake Arrowhead under the proposed Lake Ringgold Permit. Assumes returns flows are used first followed by Lake Ringgold supplies.
V	Lake Arrowhead Permit COA 02-5150	Acre-Feet	Amount of diversions from Lake Arrowhead under the existing permit CA 02-5150. It is the total diversions from Lake Arrowhead (Column H) minus the diversions under the proposed reuse amendment (Column T) minus the diversions from Lake Arrowhead of water imported from Lake Ringgold (Column U), with a minimum of zero.

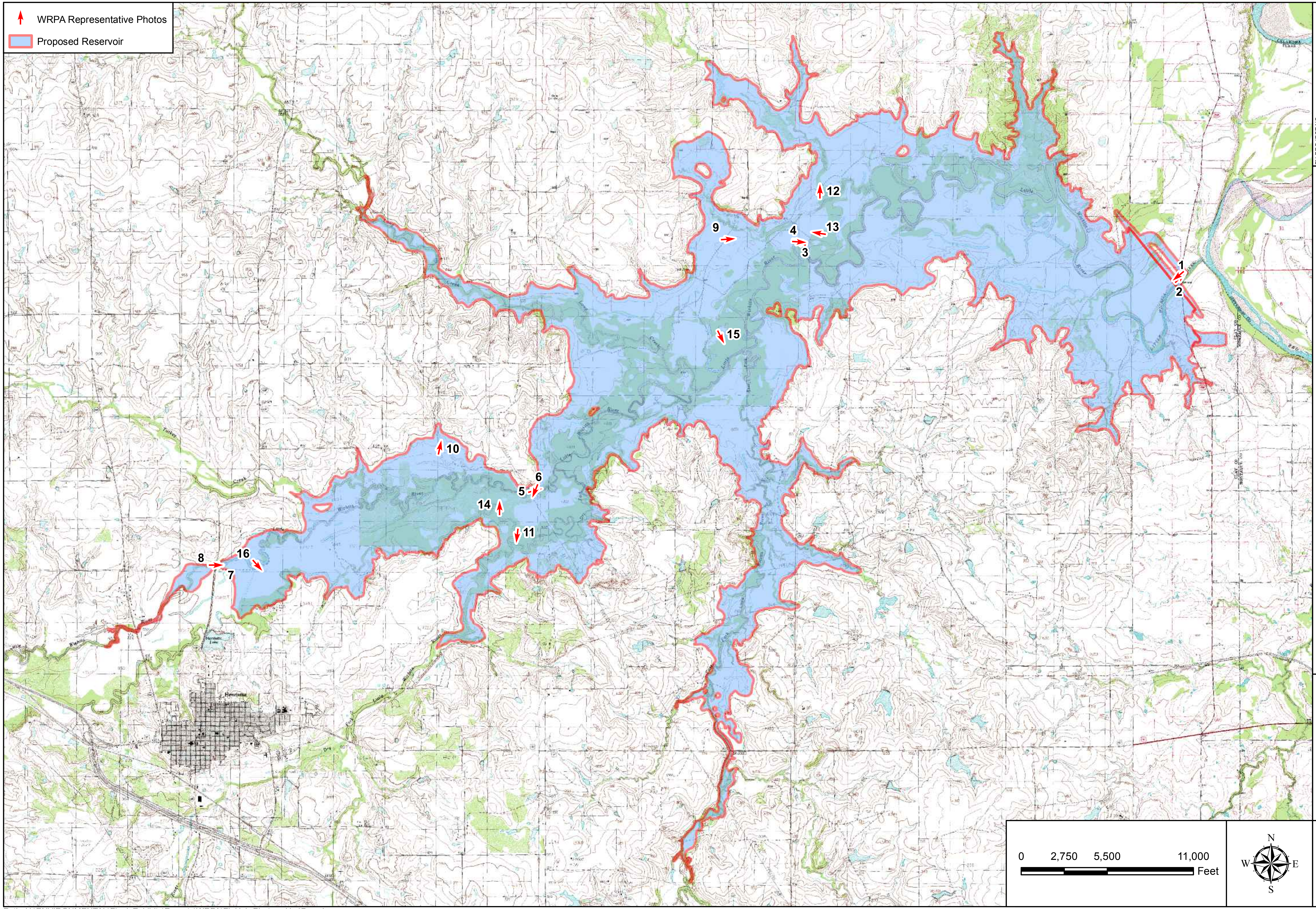
Table 3 – Water Right Summary
Summarizes diversions under each water right and checks for compliance.

Column	Title	Units	Description
A	Month	Month	This is the month to which the data apply.
B	Numeric Month	No.	Numerical month (1-12) corresponding to the month in column A.
C	Diversion from Proposed Lake Arrowhead Reuse Permit COA 02-5150C	Acre-Feet	Return Flow diversions from Lake Arrowhead. From column T on T2-Monthly Data. Checks compliance with requested permit limit of 22,302 acre-feet per year.
D	Diversion from Lake Arrowhead Under COA 02-5150 (Excluding Reuse)	Acre-Feet	Diversions under existing Lake Arrowhead permit, not including reuse. Checks compliance with current permit limit of 45,000 acre-feet per year.
E	Diversion from Lake Kickapoo Under COA 02-5144B	Acre-Feet	Diversions under existing Lake Kickapoo permit, not including reuse. Checks compliance with current permit limit of 40,000 acre-feet per year.
F	Combined Diversion from Lake Arrowhead (02-5150) & Lake Kickapoo (02-5144), Excluding Reuse	Acre-Feet	Sums diversions from Lake Arrowhead (Column D) and Lake Kickapoo (Column E) to demonstrate compliance with 65,000 acre-feet per year system limit.
G	Proposed Lake Ringgold Diversions Imported to Lake Arrowhead	Acre-Feet	Diversions under the proposed Lake Ringgold Permit from Lake Arrowhead. From column S on T2- Monthly Data.
H	Direct Diversions from Lake Ringgold	Acre-Feet	Diversions under the proposed Lake Ringgold Permit directly from Lake Ringgold. From column R on T2- Monthly Data.

Column	Title	Units	Description
I	Total diversion under Proposed Lake Ringgold Permit	Acre-Feet	Sums diversions from Lake Ringgold imported to Lake Arrowhead (Column G) and the direct Lake Ringgold diversions (Column H) to demonstrate compliance with 65,000 acre-feet per year limit.

APPENDIX H

PHOTOGRAPHS OF PROJECT SITE



FN PROJECT NO. WCH15215

DATE CREATED 4/17/2017

DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central

FILE NAME FigH-1_Photos_11x17

PREPARED BY HHM

CITY OF WICHITA FALLS

Proposed Lake Ringgold

PHOTOGRAPH LOCATION MAP

FREESE AND NICHOLS
4055 International Plaza Suite 200
Fort Worth, Texas 76109-4895
(817) 735-7300

H-1

FIGURE

Path: H:\ENVIRONMENTAL\Final_Exhibits\Reports\WRPA\FigH-1_Photos_11x17.mxd


Photo 1. Little Wichita River on FM2332 near the proposed dam site looking upstream.


Photo 2. Little Wichita River on FM2332 near the proposed dam site looking downstream.


Photo 3. Little Wichita River within eastern proposed reservoir pool area looking upstream.


Photo 4. Little Wichita River within eastern proposed reservoir pool area looking downstream.


Photo 5. Little Wichita River within western proposed reservoir pool area looking upstream.


Photo 6. Little Wichita River within western proposed reservoir pool area looking downstream.

Photo 7. Little Wichita River on FM1197 looking upstream.

Photo 8. Little Wichita River on FM1197 looking downstream.

Photo 9. Grassland within north-eastern reservoir pool area looking east.

Photo 10. Grassland within south-western reservoir pool area looking north.

Photo 11. Bottomland hardwood forest within south-western reservoir pool area looking south.

Photo 12. Bottomland hardwood forest within north-eastern reservoir pool area looking north.

Photo 13. Upland deciduous forest within north-eastern reservoir pool area looking west.

Photo 14. Upland deciduous forest within south-western reservoir pool area looking north.


Photo 15. Shrubland within north-eastern reservoir pool area looking south.


Photo 16. Shrubland within western reservoir pool area looking south-west.

APPENDIX I

HABITAT EVALUATION REPORT

4055 International Plaza, Suite 200 • Fort Worth, Texas 76109 • 817-735-7300 • fax 817-735-7492 www.freese.com

TO: Russell Schreiber, P. E.

CC: Simone Kiel, P. E.;

FROM: Wesley Wiegreffe, Michael Votaw, PWS, CWB

SUBJECT: Habitat Evaluation Procedures (HEP) Report for the Proposed Lake Ringgold Project

DATE: May 23, 2017

PROJECT: Lake Ringgold Water Rights Permit

Introduction

The Habitat Evaluation Procedure (HEP) is a habitat-based evaluation methodology developed by the U. S. Fish and Wildlife (USFWS) in 1974 for use as an analytical tool in impact assessments and project planning. Listed as an appropriate habitat evaluation methodology by Rule 297.53 of the Texas Administrative Code, HEP is recommended by the USFWS as their basic tool for evaluating project impacts and developing mitigation recommendations (USFWS 1993). As a species-habitat analysis of the ecological value of a study area, the approach of HEP is to quantify the value of habitat available to a selected set of wildlife species within a specified geographic area of interest. This method is designed to describe wildlife habitat values at baseline and future conditions to allow for comparisons of the relative values of different areas at the same point in time or of the same area at different points in time. Because HEP provides a quantitative method for such comparisons, it may be used in planning applications such as the assessment of current and future wildlife habitat, trade-off analyses, or compensation analyses.

HABITAT VALUE (HU) =
Habitat Quantity (Acres)
×
Habitat Quality (HSI)

HEP appraises a study area by quantifying its Habitat Value, calculated as the product of habitat quantity and habitat quality; this value is expressed in Habitat Units (HU). Habitat quantity is defined as the total area of habitat available within the study area, usually expressed in number of acres. Habitat quality is expressed in terms of a Habitat Suitability Index (HSI) which is determined by comparing the ecological characteristics of the study area to the habitat characteristics that are optimum for the selected evaluation species. The evaluation species are representative wildlife species with known habitat requirements that provide a basis to assess habitat suitability.

HABITAT SUITABILITY INDEX

1.0 = optimal habitat

0.0 = unsuitable habitat

HSI values are based on two components: the habitat characteristics that provide ideal conditions for an evaluation species, and the habitat characteristics existing in the study area. These characteristics are described by a set of measurable habitat variables that are obtained from documented habitat suitability models for each evaluation species. These models describe the species' life requisites (i.e., its habitat requirements for food, cover and reproduction), the relationship between the habitat variables' values and the suitability of the area to meet its life requisites, and the method to integrate these suitability relationships into an HSI value. HSI values range from 0.0 to 1.0, with a ranking of 0.0 being unsuitable and 1.0 being optimum conditions.

Habitat values may be calculated for each evaluation species within all its available habitat or for each cover type within the study area. Calculations based on existing ecological conditions can be used to describe baseline conditions and serve as a reference point for resource monitoring or for comparison to predicted future habitat values with or without proposed actions or mitigation measures. HEP provides a consistent means of assessing project impacts by demonstrating, in HUs gained or lost, the beneficial or adverse impacts anticipated as a result of various courses of action. Furthermore, HEP aids mitigation analyses by identifying which factors positively impact habitat values in various scenarios, e.g., habitat variables resulting in high HSI values, thus suggesting means for improving habitat or selecting mitigation lands.

The generalized process for conducting a HEP study involves the following components (USFWS 1980a):

- Determine the applicability of HEP and define the study area;
- Delineate habitat or vegetation cover types;
- Select the relevant evaluation species;
- Determine each species' life requisites and measure habitat variables;
- Determine baseline and future habitat units; and
- Develop compensation/mitigation plans for the proposed project.

Approach and Methods

The Lake Ringgold HEP team included members from the Texas Commission on Environmental Quality (TCEQ) and Freese and Nichols, Inc. The HEP team had oversight for the tasks that were required for the analysis, including defining the study area, delineating cover types, field sampling, and selecting evaluation species. Utilizing both desktop analysis and field verification, the HEP team developed the data necessary to evaluate the existing habitat quality within the Lake Ringgold project area.

Study Limits

The proposed study area for the Lake Ringgold project is the approximately 16,174-acre project area. This includes the area that will be inundated at the normal pool elevation of 844 ft mean sea level (msl), as well as the footprints of the dam, principal spillway, and emergency spillway.

Cover Type Determination and Delineation

Cover types were delineated prior to field work using 2014 National Agriculture Imagery Program (NAIP) imagery and were adjusted after field verification to accurately document habitat quantities. Eight cover types were identified for the HEP analysis within the Lake Ringgold project area. The cover types identified were *Emergent / Herbaceous Wetland, Grassland / Old Field, Riparian Woodland / Bottomland Hardwood* (including forested wetland habitat), *Shrubland, Shrub Savanna, Shrub Wetland*, *Tree Savanna,* and *Upland Deciduous Forest*. In addition, the project area included *Cropland*, *Lacustrine,* and *Riverine* cover types. These cover types were not assessed in the HEP analysis due to a lack of ecological need for mitigation of these habitats. Table 1 provides the number of acres for each identified cover type.

COVER TYPES

Emergent / Herbaceous Wetland

Grassland / Old Field

Riparian Woodland / Bottomland Hardwood

Shrubland

Shrub Wetland

Shrub Savanna

Tree Savanna

Upland Deciduous Forest

Table 1. Cover Types and Associated Acreages Identified within the Proposed Lake Ringgold Project Area.

Cover Type	Area (acres)
Cropland	589
Emergent / Herbaceous Wetland	102
Grassland / Old Field	5,162
Lacustrine	100
Riparian Woodland / Bottomland Hardwood	4,298
Riverine	254
Shrubland	2,243
Shrub Savanna	1,402
Shrub Wetland	38
Tree Savanna	791
Upland Deciduous Forest	1,195
Total	**16,174**

Evaluation Species Selection and Descriptions

Fifteen evaluation species were selected by the HEP team based on their ecological significance, presence within the study area, and the availability of applicable HSI models. The species models used in this study included the American Kestrel, Barred Owl, Brown Thrasher, Carolina Chickadee, Downy Woodpecker, Eastern Cottontail, Eastern Meadowlark, Field Sparrow, Fox Squirrel, Great Blue Heron, Green Heron, Northern Bobwhite, Raccoon, Racer, and Scissor-tailed Flycatcher. Table 2 displays the model species utilized in the HEP study and the cover types to which each species model was applied.

Table 2. Species Models and Associated Cover Types used for the Proposed Lake Ringgold Project HEP Assessment.

Cover Type / Species	Emergent / Herbaceous Wetland	Grassland / Old Field	Riparian Woodland / Bottomland Hardwood	Shrubland	Shrub Savanna	Shrub Wetland	Tree Savanna	Upland / Deciduous Forest
American Kestrel	X	X			X		X	
Barred Owl			X					X
Brown Thrasher				X				X
Carolina Chickadee			X					X
Downy Woodpecker			X					X
Eastern Cottontail		X		X	X			
Eastern Meadowlark		X						
Field Sparrow				X	X			
Fox Squirrel			X				X	X
Great Blue Heron	X					X		
Green Heron	X					X		
Northern Bobwhite				X	X		X	
Racoon	X		X			X		
Racer		X		X	X		X	
Scissor-tailed Flycatcher		X					X	

EVALUATION SPECIES

American Kestrel
Barred Owl
Brown Thrasher
Carolina Chickadee
Downy Woodpecker
Eastern Cottontail
Eastern Meadowlark
Field Sparrow
Fox Squirrel
Great Blue Heron
Green Heron
Northern Bobwhite
Raccoon
Racer
Scissor-tailed Flycatcher

The following are descriptions of the habitat preferences and life requisites for the evaluation species, along with the cover types that make up their available habitat.

American Kestrel (*Falco sparverius*)

The American Kestrel is associated with open prairies and agricultural lands as well as where these areas border forested habitats. This raptor hunts insects, birds, small mammals and reptiles in areas of low, open vegetation from adjacent perch sites such as fence posts, trees, and utility lines. Nest sites are found near their hunting habitat, often in mature trees with cavities excavated by other species, as well as in cliffs and on the roofs of old buildings (Author Unknown 1980a).

AMERICAN KESTREL

COVER TYPES:
Emergent / Herbaceous Wetland
Grassland / Old Field
Shrub Savanna
Tree Savanna

LIFE REQUISITES:
Open fields with perches
Cavities in lone trees or cliffs

Barred Owl (*Strix varia*)

Barred Owls are forest-dwelling birds that prefer expansive, mature forests with open sub-canopies allowing for the flying space needed for hunting small game. The species shows no marked preference between upland and bottomland forests. However, since upland forests are more accessible to logging/timber harvest, bottomland sites are currently more likely to provide for their needs. Specifically, barred owl habitat must provide large, decadent trees with adequate numbers of nesting cavities, although nesting has been recorded in abandoned raptor nests. Due to the foliage cover, live trees provide superior nesting sites compared to snags (Allen 1987).

BARRED OWL

COVER TYPES:
Riparian Woodland / Bottomland Hardwood
Upland Deciduous Forest

LIFE REQUISITES:
Large, living trees
Adequate nesting cavities

Brown Thrasher (*Toxostoma rufum*)

The Brown Thrasher is often associated with thickets, hedgerows, mid-successional forests, and habitats that provide trees in low density and support dense understory growth of shrubs. They primarily forage in the deep leaf litter, using bill sweeps to locate insects and other arthropods, but will also feed in shrubs for seeds and berries. Shrubs are most often used as nest sites, but the presence of

BROWN TRASHER

COVER TYPE:
Shrubland
Upland Deciduous Forest

LIFE REQUISITES:
Available but sparse trees
Dense understory & leaf litter

evergreen and deciduous trees increases nesting success and provides alternative nest sites (Cade 1986).

Carolina Chickadee (*Poecile carolinensis*)

CAROLINA CHICKADEE

COVER TYPE:
Riparian Woodland / Bottomland Hardwood
Upland Deciduous Forest

LIFE REQUISITES:
Forests with deciduous / evergreen mix
Closed canopies and open understories

Carolina Chickadees are residents of forests and forest boundaries, preferring the well-developed canopies and open understories of these habitats, but also utilizing shrub layers. This bird captures moths, caterpillars, and other arthropods from the bark and foliage of the trees within these habitats as well as exploiting shrubs for berries and seeds. Carolina chickadees are cavity nesters that utilize natural and excavated sites in tree limbs, snags, and fence posts (Author Unknown 1980b).

Downy Woodpecker (*Picoides pubescens*)

Downy Woodpeckers show a preference for open woodlots, but the species is found across North America wherever there are trees that they can drill and glean for the insects they eat. They inhabit both coniferous and deciduous forests. These woodpeckers are not strong excavators, so their nest cavity placement is limited by the availability of soft snags, often with both surface sap rot and fungal heart rot. Living trees with broken crowns are also chosen as nesting sites (Schroeder 1983).

DOWNY WOODPECKER

COVER TYPE:
Riparian Woodland / Bottomland Hardwood
Upland Deciduous Forest

LIFE REQUISITES:
Open woodlots
Soft snags

Eastern Cottontail (*Sylvilagus floridanus*)

Eastern Cottontails are habitat generalists within a wide range of early to mid-succession habitats. They require an abundance of both well-distributed escape cover and open areas for nocturnal browsing; this combination often consists of old-field bordered by shrubby edge habitat. Eastern cottontails also need dense thickets or hedgerows for resting and daytime shelter. Nests are usually located in areas of thick grass cover, such as hayfields and fallow fields that lie near escape cover (Allen 1984).

EASTERN COTTONTAIL

COVER TYPE:
Grassland / Old Field
Shrubland
Shrub Savanna

LIFE REQUISITES:
Fields with shrubby edges
Dense thickets or hedgerows
Thick grass or hayfields

Eastern Meadowlark (*Sturnella magna*)

Eastern Meadowlarks inhabit grasslands, meadows, pastures, and fallow fields in the south and central United States. While they do need numerous perch sites, such as tall forbs, shrubs, small trees and fences, their preferred habitat consists of relatively open grasslands with low shrub and forb coverage. The eastern meadowlark is a ground-nesting species, so groundcover must be thick for nest concealment (Schroeder and Sousa 1982).

EASTERN MEADOWLARK

COVER TYPE:
Grassland / Old Field

LIFE REQUISITES:
Herbaceous or grassy canopy
Nearby perch sites

Field Sparrow (*Spizella pusilla*)

The Field Sparrow prefers brushy fencerows and old fields with scattered woody vegetation, and can also be found in grasslands and forested areas. The diet of this ground-foraging species is dominated by vegetative plant material in the spring and summer and by seeds in the fall, but they also forage for insects, especially for the feeding of nestlings. Small trees and shrubby vegetation are used for roosting and winter cover, while a mix of herbaceous vegetation with short, sparse shrubs provides ideal breeding and ground-nesting cover (Sousa 1983).

FIELD SPARROW

COVER TYPE:
Shrubland
Shrub Savanna

LIFE REQUISITES:
Short, sparse shrubs
Small trees
Thick grass cover in Spring

Fox Squirrel (*Sciurus niger*)

While Fox Squirrels prefer open forest stands with little understory vegetation, they will inhabit a wide variety of forest types. Upland and well-drained bottomland forest habitats are used more often than poorly-drained lowland areas. Small stands of large trees situated in agricultural areas allow fox squirrels to supplement their diet, which consists of mast and a variety of other plant and animal foods, with grains as needed. Mature mast trees provide both food and nesting sites. Fox squirrels will nest in tree cavities, but also build leaf nests; therefore, quality habitat is not limited by the availability of nesting cavities (Allen 1982).

FOX SQUIRREL

COVER TYPE:
Riparian Woodland /
Bottomland Hardwood
Tree Savanna
Upland Deciduous Forest

LIFE REQUISITES:
Open forests
Little understory
Nearby grain

Great Blue Heron *(Ardea herodias)*

The Great Blue Heron utilizes a variety of aquatic habitats throughout the United States, from freshwater lakes and rivers, to marshes, lagoons, mangroves, and coastal wetlands. Foraging habitats for this species are primarily found in disturbance-free areas with shallow water bodies and a suitable population of fish, frogs, or other aquatic animals. Shrubby and herbaceous wetlands may provide foraging resources for this species, but lack sturdy trees for nesting. Therefore, foraging areas are usually found within commuting distance of reproductive sites, including forested wetlands or tree lands alongside rivers and lakes (Short 1985).

GREAT BLUE HERON

COVER TYPE:
Emergent / Herbaceous Wetland
Shrub Wetland

LIFE REQUISITES:
Nearby nesting trees
Shallow water with prey
Disturbance-free area

Green Heron (*Butorides virescens*)

Green Herons wade in or perch above the shallow waters of rivers, lakes, ponds, lagoons, ditches, marshes and swamps, where they hunt for fish, frogs, crawfish and other aquatic animals. They are adaptable generalists within these aquatic environments and inhabit both freshwater and saltwater ecosystems. Their preferred feeding habitat consists of open, permanent, shallow waters that are free of emergent aquatic vegetation. Ideally, adequate cover such as dense stands of reeds and cattails, which also provide nesting areas, are available in proximity to hunting sites. More often, nests are built in shrubs or small trees near the shoreline (Author Unknown 1980c).

GREEN HERON

COVER TYPE:
Emergent / Herbaceous Wetland
Shrub Wetland

LIFE REQUISITES:
Shallow, open water
Nearby shrubs or small trees

Northern Bobwhite (*Colinus virginianus*)

The Northern Bobwhite is a small gamebird which inhabits grassy areas interspersed with brush throughout the eastern half of North America. This species subsists primarily on a wide variety of herbaceous plant seeds, such as annual and perennial legumes, asters, and cultivated grains. Local diets of Northern Bobwhite vary greatly, and areas of bare ground and light litter are essential to provide access to different foraging areas. Within forested habitats, Northern Bobwhite diets are even further supplemented with mast, such as pine nuts and acorns. In order to escape from predators, this species relies on the availability of cover from small, woody vegetation throughout its habitat. Bobwhites

NORTHERN BOBWHITE

COVER TYPE:
Shrubland
Shrub Savanna
Tree Savanna

LIFE REQUISITES:
Moderately dense herbaceous/mast food plants
Short, sparse shrubs
Dry, grassy nesting areas

construct nests consisting mostly of dead grass stems in open areas on dry, only partially covered ground (Schroeder 1985).

Raccoon (*Procyon lotor*)

Coastal swamps, marshes, and bottomland hardwood forests maintain the greatest numbers of Raccoons by supplying their daily need for water and cover. Upland populations are limited by their access to water, preferring hardwood forests near rivers, streams, or swamps. Raccoons forage nocturnally on a limitless variety of food, including fruits, insects, aquatic animals, small mammals, and reptiles; access to open areas increases the availability of many of their food sources. These solitary mammals prefer to locate their dens in overmature hardwood trees, especially for raising their young, but will also utilize rock crevices, caves, and brush piles (Author Unknown 1980d).

RACCOON

COVER TYPE:
Emergent / Herbaceous Wetland
Riparian Woodland / Bottomland Hardwood
Shrub Wetland

LIFE REQUISITES:
Daily access to water
Mature forests

Racer (*Coluber constrictor*)

Racers are snakes that live in grasslands, open woods, and brushy areas. Tallgrass prairie is ideal summer habitat, but pastureland, brushy ravines, hay or grain fields, and open woodlands with adequate cover are widely used by this species. Eggs are often laid in the tunnels of burrowing mammals as well as in rotten logs and stumps. In the fall, racers migrate to rocky outcroppings and ledges with southern exposures where they hibernate in deep crevices (Author Unknown 1980e).

RACER

COVER TYPE:
Grassland / Old Field
Shrubland
Shrub Savanna
Tree Savanna

LIFE REQUISITES:
Herbaceous canopy cover
Tunnels or other refuge sites

Scissor-tailed Flycatcher (*Tyrannus forficatus*)

Scissor-tailed Flycatchers prefer open, tallgrass prairies with small, isolated groups of deciduous trees. These birds primarily feed on flying and ground-dwelling insects they hunt from perch sites such as tall prairie plants, utility lines, fences or dead tree limbs, although seeds and berries are eaten as well. Isolated groups of trees within herbland savannas or croplands are preferred for nesting sites (Author Unknown 1980f).

SCISSOR-TAILED FLYCATCHER

COVER TYPE:
Grassland / Old Field
Tree Savanna

LIFE REQUISITES:
Tall, dense herbaceous cover
Perch sites in forage habitat
Nearby tall trees

Baseline Conditions Determination

Field sampling was conducted by the HEP team on October 12-14, 19-20, and November 2, 2016. **Appendix A** to this HEP report provides maps, including an aerial overview (Figure 1), the distribution of cover types identified in the current study area (Figure 2), and the locations of the sampling sites shown on an aerial photograph (Figure 3a-3c). Field measurements were made within 0.1-acre plots at each sampling site. Photographs taken at HEP sampling sites representative of each cover type are presented in **Appendix B** to this HEP report.

Cover Type Descriptions and Habitat Variable Measurements

The following cover type descriptions are based on the results of field measurements and observations made during October-November 2016. Each cover type description is followed by a table which lists the variables sampled for each cover type, field measurements for each habitat variable needed to calculate the appropriate suitability indices and HIS values, and a list of the representative species for each cover type followed by their appropriate habitat variables in parentheses (Tables 3-10).

Emergent / Herbaceous Wetland

EMERGENT / HERBACEOUS WETLAND

Vegetative cover >30% dominated by hydrophytic plants.

EVALUATION SPECIES:
Great Blue Heron
Green Heron
Raccoon

Herbaceous wetlands are defined as wetland areas with a total vegetation cover of greater than 30 percent that is dominated by hydrophytic plants growing on or below the water surface (USFWS 1980c). The "emergent wetlands" of Cowardin et al. (1979) are included in this cover type. There are approximately 102 acres of herbaceous wetland within the proposed conservation pool areas of Lake Ringgold. Most of these wetlands have an ephemeral water regime, meaning they are inundated with standing water for only short periods following rain.

The shrub layer found within these herbaceous wetlands are primarily dominated by cedar elm (*Ulmus crassifolia*) and hawthorn (*Crataegus* sp.), when present. The herbaceous layer is primarily dominated by wetland obligates, such as spikerush (*Eleocharis* spp.) and smartweed (*Polygonum* spp.), but also includes facultative species such as Cherokee sedge (*Carex cherokeensis*) and sumpweed (*Iva annua*). Other plants commonly found in herbaceous wetlands include raven's foot sedge *(Carex crus-corvi*), water-primrose *(Ludwigia* sp.), and water willow (*Justicia americana*). Herbaceous canopy cover averages approximately 71 percent, 57 percent of which resides in a littoral zone. Results of HEP field measurements for this cover type are shown in Table 3.

Wildlife species observed in herbaceous wetlands consisted of birds such as eastern bluebird (*Sialia sialis*), eastern phoebe (*Sayornis phoebe*), mourning dove (*Zenaida macroura*), and red-tailed hawk (*Buteo jamaicensis*). Flying insect such as butterflies (Order: Lepidoptera), bees (Order: Hymenoptera), and dragonflies (Order: Odonata) were also observed.

Table 3. HEP Field Data Summary:
Habitat Variable Measurements at Emergent / Herbaceous Wetland Sites

Cover Type: Emergent / Herbaceous Wetland
Species: American Kestrel (3, 4, 5, 8, 9, 13), Great Blue Heron (1, 2, 17),
Green Heron (6, 7, 10, 11, 12, 15, 17, 18), Raccoon (5, 14, 16)

Habitat Variable	Sample Site Number			
	1	2	3	4
1) Presence of 100m disturbance free zone (sunset/sunrise)	Y	Y	Y	Y
2) Presence of shallow (<20") water body with suitable prey population (≤ 10") and firm substrate	N	Y	N	Y
3) Availability of lone trees (≥12" dbh) or groves (≤1 acre) within 1 mi dia: A) abundant; B) moderate; C) scarce	B	A	A	A
4) Availability of ledges, banks, buildings within 1 mi: A) abundant; B) moderate; C) scarce	B	C	C	C
5) Water regime (Year-round): A) permanent; B) semi-permanent; C) none or ephemeral	C	C	C	C
6) Water regime (Summer): A) permanent; B) semi-permanent; C) none or ephemeral	C	C	C	C
7) Aquatic substrate composition in littoral zone: A) muddy; B) sandy; C) rocky	A	A	A	A
8) % herbaceous canopy cover	50	100	40	95
9) % herbaceous canopy cover ≤ 12"	20	0	5	90
10) % emergent herbaceous canopy cover in littoral zone	50	60	40	80
11) % water area <10" deep (avg. summer conditions)	0	100	0	0
12) % water surface covered by logs, tree limbs or shrub overhangs (alive or dead) (avg. summer conditions)	0	5	0	0
13) Distance to perch site (forest edge, posts, poles, wire) (km)	0.05	0.03	0.01	0.01
14) # of refuge sites/acre (burrows, crevices, brush piles)	0	0	0	0
15) Water current: A) still/slow (<6"/sec); B) moderately slow (6 – 24"/sec); C) moderately fast (24-40"/sec); D) fast (40"/sec)	A	A	A	A
16) Distance to water (mi)	0.06	0.20	0.24	0.23
17) Distance to Riparian Woodland / Bottomland Hardwood (km)	0.12	0.14	0.04	0.20
18) Distance to Shrub Wetland (if closer than BHFW) (km)	2.22	1.81	0.01	1.58

Grassland / Old Field

GRASSLAND / OLD FIELD

Dominated by grasses & non-woody vegetation. Canopy cover of at least 25 percent.

EVALUATION SPECIES:
American Kestrel
Eastern Cottontail
Eastern Meadowlark
Racer
Scissor-tailed Flycatcher

The grassland/old field cover type consists of upland areas with at least a 25 percent canopy cover of predominantly non-woody vegetation in which grasses, whether native or introduced, are dominant. This cover type includes mostly prairies and rangeland (USFWS 1980c). The grassland/old fields in the project area are a combination of short-, mid-, and tallgrass prairies, along with upland improved pastures typically the result of forest clearing. These areas may be currently or recently grazed or thickly grown over by grasses and forbs. Grasslands in the proposed project area of Lake Ringgold cover an area of approximately 5,162 acres.

Dominant grass species include bermudagrass (*Cynodon dactylon*), buffalograss (*Bouteloua dactyloides*), King Ranch bluestem (*Bothriochloa ischaemum*), silver bluestem (*Bothriochloa saccharoides*), tall dropseed (*Sporobolus compositus*), vine mesquite (*Panicum obtusum*), and white tridens (*Tridens albescens*). Common forbs included annual broomweed (*Amphiachyris dracunculoides*), Cherokee sedge, silverleaf nightshade (*Solanum elaeagnifolium*), sumpweed, and western ragweed (*Ambrosia psilostachya*). The herbaceous canopy averages approximately 84 percent of total ground cover, while the percentage of the herbaceous canopy which is grass is approximately 67 percent. The average height of herbaceous vegetation is 7 inches. Results of HEP field measurements for this cover type are shown in Table 4.

Bird species observed in grassland/old field areas include American crow (*Corvus brachyrhynchos*), American kestrel, downy woodpecker, eastern bluebird, eastern meadowlark, northern bobwhite, northern harrier (*Circus cyaneus*), northern flicker (*Colaptes auratus*), and red-tailed hawk. Mammals identified by sight include white-tailed deer (*Odocoileus virginianus*) and deer mice (*Peromyscus* sp.). Signs of feral hogs (*Sus scrofa*) were also observed.

Table 4. HEP Field Data Summary:
Habitat Variable Measurements at Grassland / Old Field Sites

Cover Type: Grassland / Old Field

Species: American Kestrel (1, 2, 6, 8, 13), Eastern Cottontail (4, 5, 7), Eastern Meadowlark (5, 6, 10, 12, 13), Racer (6, 12, 15, 17), Scissor-tailed Flycatcher (6, 12, 14, 16)

Habitat Variable	Sample Site Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1) Availability of lone trees (> 12” dbh) or groves (< 1 acre) within 1 mi dia.: A) abundant; B) moderate; C) scarce	B	A	A	A	A	A	A	C	A	B	A	A	A
2) Availability of ledges, banks, buildings within 1 mi.: A) abundant; B) moderate; C) few to none	C	C	C	C	B	C	C	B	B	C	C	C	C
3) Soil moisture regime: A) saturated-moist; B) moist-dry; C) dry	C	C	C	C	C	C	C	C	B	C	C	C	C
4) % tree canopy closure (>16.5 ft)	0	0	0	0	0	0	0	0	0	0	0	0	0
5) % shrub canopy closure (<16.5 ft)	0	0	5	0	0	0	0	0	0	0	5	0	5
6) % herbaceous canopy cover	100	100	45	60	95	100	80	90	100	60	85	80	95
7) % persistent herbaceous canopy cover	20	5	35	60	90	90	25	25	100	10	35	40	50
8) % herbaceous canopy $\leq$ 12” tall	95	100	15	0	15	0	50	10	15	30	25	40	20
9) % preferred Northern Bobwhite herbaceous food plants (legumes, croton, ragweed, etc.)	20	10	35	60	5	0	5	25	0	10	5	40	25
10) % herbaceous canopy cover that is grass	80	90	15	5	95	95	90	35	100	65	70	55	75
11) % bare ground/light litter	0	0	55	45	5	0	15	5	10	40	20	20	5
12) Avg. height of herbaceous vegetation in spring (in)	12	12	4	6	8	6	4	6	6	5	6	6	8
13) Distance to perch site (forest edge, posts, poles, wire) (km)	0.1	0.05	0.05	0.1	0.05	0.05	0.05	0.05	0.1	0.08	0.02	0.01	0.01
14) Distance to deciduous trees (clumps, forest edge, wind breaks, isolated trees, etc.) (m)	120	50	85	100	50	90	100	220	100	85	75	55	50
15) Distance to shrubby edge or thickets (ft)	1200	150	300	300	750	800	300	330	100	325	200	300	150
16) # deciduous trees/acre	0	0	0	0	0	0	0	0	0	0	0	0	0
17) # refuge sites/acre (burrows, crevices, brush piles)	0	0	10	0	0	0	0	0	10	0	0	0	30

Riparian Woodland / Bottomland Hardwood Forest

RIPARIAN WOODLAND / BOTTOMLAND HARDWOOD FOREST

Wetland areas dominated by trees. Vegetation cover greater than 30%.

EVALUATION SPECIES:
Barred Owl
Carolina Chickadee
Downy Woodpecker
Fox Squirrel
Racoon

The riparian woodland/bottomland hardwood cover type includes wetland areas dominated by woody vegetation at least six meters tall, with a total vegetation cover of more than 30 percent; this designation is synonymous with the Forested Wetland cover type described in ESM 103 (USFWS 1980c). The riparian woodland/bottomland hardwood cover type in the project area includes the predominantly deciduous forests of riparian zones and wetlands, and is associated with the floodplain of the Little Wichita River and its tributaries. Water regimes of these areas are largely ephemeral in nature, meaning standing water is only present periodically after rain. Riparian woodlands/bottomland hardwood forests in the project area are, on average, completely dominated by deciduous trees, with an average canopy closure of approximately 62 percent. The average overstory tree height and diameter-at-breast-height (dbh) are 39 feet and 12 inches, respectively. There are approximately 4,298 acres of riparian woodland/bottomland hardwood forest in the proposed Lake Ringgold conservation pool area. Results of the HEP field measurements for this cover type are shown in Table 5.

Dominant trees include cedar elm, green ash (*Fraxinus pennsylvanica*), hawthorn, pecan (*Carya illinoinensis*), post oak (*Quercus stellata*), sugarberry (*Celtis laevigata*), and western soapberry (*Sapindus saponaria*). Dominant shrubs are often small trees of the species listed above, as well as coralberry (*Symphoricarpos orbiculatus*), honey locust (*Gleditsia triacanthos*), and gum bumelia (*Sideroxylon lanuginosum*). Vines include greenbrier (*Smilax* sp.), poison ivy (*Toxicodendron radicans*), and Virginia creeper (*Parthenocissus quinquefolia*). Common herbaceous plants include grasses such as Virginia wildrye (*Elymus virginicus*) and woodoats (*Chasmanthium latifolium*), while common sedges include raven's foot sedge and Cherokee sedge. Common herbaceous forbs include dewberry (*Rubus* sp.), wild passion vine (*Passiflora incarnata*), sumpweed, and wood sorrel (*Oxalis* sp.).

Common bird species identified in this cover type include American crow, blue jay, Carolina chickadee, downy woodpecker, eastern phoebe, green heron, northern cardinal (*Cardinalis cardinalis*), northern flicker, red-bellied woodpecker (*Melanerpes carolinus*), red-shouldered hawk (*Buteo lineatus*), and wild turkey (*Meleagris gallopavo*). Signs of common mammals included primarily fox squirrels, while the most commonly observed amphibians were southern leopard frogs (*Lithobates sphenocephalus*).

Table 5. HEP Field Data Summary:
Habitat Variable Measurements at Riparian Woodland / Bottomland Hardwood Sites

Cover Type: Riparian Woodland / Bottomland Hardwood

Species: Barred Owl (6, 9, 10), Carolina Chickadee (3, 5, 8, 12), Downy Woodpecker (11, 14),

Fox Squirrel (3, 4, 7, 9, 16), Raccoon (1, 2, 13, 15)

Habitat Variable	Sample Site Number											
	1	2	3	4	5	6	7	8	9	10	11	12
1) Overstory forest size class: A) <6"dbh; B) 6-10"dbh; C) 10-20"dbh; D) >20"dbh	C	C	B	B	C	C	C	B	B	C	C	C
2) Water regime (Year-round): A) permanent; B) semi-permanent; C) none or ephemeral	C	C	C	C	C	C	C	C	C	C	C	C
3) % tree canopy closure (>16.5 ft)	70	50	50	40	65	50	70	75	80	50	75	70
4) % tree canopy closure of hard mast producers (≥10" dbh)	0	0	0	0	5	20	60	10	10	0	25	25
5) % deciduous canopy closure in stand	100	100	100	100	100	100	100	100	100	100	100	100
6) % canopy closure of overstory trees	35	45	40	40	45	50	60	30	35	50	25	40
7) % shrub canopy closure (<16.5 ft)	0	5	0	25	5	10	5	20	15	5	15	10
8) Avg. height of overstory trees (ft)	35	40	35	35	30	48	35	35	30	45	50	50
9) Avg. dbh of overstory trees (in)	12	8	8	8	12	15	12	10	10	13	18	13
10) # of trees ≥ 20" dbh/acre	0	0	0	0	0	0	0	0	0	0	0	0
11) # snags > 6" dbh/acre	30	10	0	30	0	0	0	20	0	0	30	0
12) # snags <10" dbh/acre	30	20	40	50	0	0	40	10	150	20	90	0
13) # refuge sites per/acre (burrows, crevices, brush piles)	10	20	0	20	0	30	40	20	20	0	40	0
14) Basal area (area of exposed stems of woody veg. if cut horizontally at 4.5 ft. height in ft^2/acre)	140	80	110	40	160	140	130	110	120	110	80	140
15) Distance to water (mi)	0.03	0.46	0.04	0.01	0.21	0.13	0.01	0.06	0.15	0.22	0.11	0.10
16) Distance to available grain (yd)	1430	1518	756	1174	591	1882	1646	187	589	1204	1070	931

Shrubland

> **SHRUBLAND**
>
> Dominated by shrubs (including small trees < 5 meters tall)
>
> Shrub canopy cover of at least 25 percent
>
> EVALUATION SPECIES:
> Brown Thrasher
> Eastern Cottontail
> Field Sparrow
> Northern Bobwhite
> Racer

Shrublands are defined as upland areas that are dominated by a shrub layer, which may be composed of shrub species and/or small trees shorter than five meters. This cover type should have a shrub canopy cover of at least 25 percent (USFWS 1980c). There are approximately 2,243 acres of shrubland within the proposed Lake Ringgold conversation pool area.

Shrublands in the project area represent a midpoint in the successional transition from upland old fields to forests, with a shrub layer dominated by American elm (*Ulmus americana*), cedar elm, gum bumelia, honey locust, honey mesquite (*Prosopis glandulosa*), Mexican plum (*Prunus Mexicana*), and sugarberry. Occasionally, these species would reach a size deserving tree status. Shrub canopy cover averages approximately 48 percent, while tree canopy cover averages approximately two percent. Weedy forbs, such as broomweed, marestail (*Erigeron canadensis*), silverleaf nightshade, sumpweed, and western ragweed dominate the herbaceous layer. Grasses such as buffalograss, perennial rye (*Lolium perenne*), tall dropseed, and white tridens where accounted for 19 percent of herbaceous species cover. The average herbaceous canopy accounted for 48 percent of total ground cover, and the average height of herbaceous canopy is five inches. These areas often contain dense stands of greenbrier and Texas prickly pear (*Opuntia engelmannii*) was a relatively common cactus present within shrublands. Results of HEP habitat measurements for this cover type are shown in Table 6.

Common shrubland birds identified in the project area include American crow, American kestrel, blue jay (*Cyanocitta cristata*), eastern bluebird, ladder-backed woodpecker (*Picoides scalaris*), northern bobwhite, northern cardinal, and northern flicker. Mammal species identified in shrublands include deer mice, hispid cotton rat (*Sigmodon hispidus*), and nine-banded armadillo (*Dasypus novemcinctus*).

Table 6. HEP Field Data Summary:
Habitat Variable Measurements at Shrubland Sites

Cover Type: Shrubland

Species: Brown Thrasher (2, 11, 15), Eastern Cottontail (2, 3, 7), Field Sparrow (3, 5, 9, 13), Northern Bobwhite (1, 4, 6, 8, 10, 12, 13), Racer (6, 13, 14, 16)

Habitat Variable	Sample Site Number							
	1	2	3	4	5	6	7	8
1) Soil moisture regime: A) saturated-moist; B) moist-dry; C) dry	C	C	C	C	C	C	C	C
2) % tree canopy closure (>16.5 ft)	0	0	0	0	0	0	0	15
3) % shrub canopy closure (<16.5 ft)	20	30	75	70	20	40	95	35
4) % canopy cover of woody veg <6.5 ft	20	5	30	5	0	15	90	10
5) % of total shrubs < 4.9 ft	75	5	20	5	0	5	90	0
6) % herbaceous canopy cover	60	60	30	25	80	85	0	40
7) % persistent herbaceous canopy cover	20	5	10	15	65	55	0	30
8) % preferred Northern Bobwhite herbaceous food plants (legumes, croton, ragweed, etc.)	20	0	5	0	65	55	10	30
9) % grass canopy cover	40	20	5	10	10	10	0	5
10) % herbaceous canopy cover that is grass	35	35	15	40	5	10	0	10
11) % litter ≥ 1 cm deep	5	10	0	10	35	50	25	10
12) % bare ground/light litter	20	10	10	5	10	20	30	90
13) Avg. height of herbaceous vegetation in spring (in)	6	6	4	6	8	6	0	4
14) Distance to shrubby edges or shrub thickets (ft)	15	10	5	5	10	3	0	20
15) # woody stems >3.3 ft/2.5 acre (in thousands)	3.75	1.65	5	6.25	1.8	7.5	1.5	3.75
16) # of refuge sites/acre (burrows, crevices, brush piles)	50	50	50	50	20	40	50	10

Shrub Savanna

SHRUB SAVANNA

Shrub canopy cover 5-25%. Vegetation canopy cover at least 25%.

EVALUATION SPECIES:
American Kestrel
Eastern Cottontail
Field Sparrow
Northern Bobwhite
Racer

Shrub savannas are defined as areas where shrubs and trees less than five meters tall dominate a sparser area – between five to 25 percent – than in shrublands, though total canopy cover of all vegetation must be at least 25 percent (USFWS 1980c). This cover type accounts for 1,402 acres of the proposed Lake Ringgold conservation pool area.

Tree canopy cover averages three percent in this cover type and consists primarily of cedar elm and post oak. Shrub canopy cover in these areas averaged approximately 26 percent. Shrub species in shrub savannas are often smaller versions of the trees listed above, along with coralberry, honey mesquite, and sugarberry, and include vines such as greenbrier.

Herbaceous cover in shrub savannas consisted of almost equal amounts of grasses and forbs at 53 percent and 47 percent, respectively. Dominant grass species include buffalograss, King Ranch bluestem, little bluestem (*Schizachyrium scoparium*), silver bluestem, and white tridens. Dominant forbs include marestail, western ragweed, silverleaf nightshade and sumpweed. Greenbrier was a common vine found in shrub savannas. Herbaceous canopy averaged approximately 69 percent, and the average herbaceous canopy height is six inches. Results of HEP habitat measurements for this cover type are shown in Table 7.

Bird species identified in shrub savannas included American kestrel, American crow, blue jay, eastern bluebird, field sparrow, red-shouldered hawk, red-tailed hawk, and white crowned sparrow (*Zonotrichia leucophrys*). A shed snake skin (Suborder: Serpentes) was also observed, as well as the occasional monarch butterfly (*Danaus plexippus*).

Table 7. HEP Field Data Summary:
Habitat Variable Measurements at Shrub Savanna Sites

Cover Type: Shrub Savanna

Species: American Kestrel (1, 2, 8, 10, 16), Eastern Cottontail (4, 5, 9),
Field Sparrow (5, 7, 12, 15), Northern Bobwhite (3, 8, 6, 11, 13, 14, 15), Racer (8, 15, 17, 18)

Habitat Variable	Sample Site Number				
	1	2	3	4	5
1) Availability of lone trees (≥ 12” dbh) or groves (≤ 1 acre) within 1 mi dia.: A) abundant; B) moderate; C) scarce	A	B	A	A	A
2) Availability of ledges, banks, buildings within 1 mi.: A) abundant; B) moderate; C) few to none	C	C	C	C	C
3) Soil moisture regime: A) saturated-moist; B) moist-dry; C) dry	C	C	C	C	C
4) % tree canopy closure (>16.5 ft)	10	5	0	0	0
5) % shrub canopy closure (<16.5 ft)	40	30	20	20	20
6) % canopy cover of woody veg < 6.5 ft	5	5	5	5	0
7) % of total shrubs < 4.9 ft	5	5	0	5	0
8) % herbaceous canopy cover	60	80	80	80	45
9) % persistent herbaceous canopy cover	20	10	20	80	45
10) % herbaceous canopy ≤ 12” tall	50	75	30	15	5
11) % preferred Northern Bobwhite herbaceous food plants (legumes, croton, ragweed, etc.)	15	25	20	5	45
12) % grass canopy cover	50	70	20	80	5
13) % herbaceous canopy cover that is grass	85	50	25	100	5
14) % bare ground/light litter	20	5	10	15	55
15) Avg. height of herbaceous vegetation in spring (in)	6	6	4	12	4
16) Distance to perch site (forest edge, post, pole, wire) (km)	0.02	0.01	0.01	0.01	0.01
17) Distance to shrubby edges or shrub thickets (ft)	0	15	150	50	300
18) # of refuge sites/acre (burrows, crevices, brush piles)	20	20	0	10	10

Shrub Wetland

> **SHRUB WETLAND**
>
> Wetland areas dominated by shrubs; includes shrub-dominated riparian zones
>
> EVALUATION SPECIES:
> Great Blue Heron
> Green Heron
> Racoon

Shrub (or shrub-scrub) wetlands are defined as areas dominated by woody vegetation that is less than five meters tall, with greater than 30 percent total vegetation cover. Shrub-dominated riparian zones are included in this cover type (USFWS 1980c). Shrub wetlands in the study area can be considered wetlands in successional transition between herbaceous wetlands and bottomland hardwood forests. Approximately 38 acres of the proposed Lake Ringgold conservation pool area consist of the shrub wetland cover type.

The shrub layer within the shrub wetlands of the project area are dominated by small trees, such as cedar elm and green ash, as well as shrub species like honey locust and buttonbush (*Cephalanthus occidentalis*). Dominant herbaceous plants include obligate wetlands species, such as raven's foot sedge, spike rush, and smartweed; an average of 67 percent of which is located in a littoral zone. Shrub wetlands within the project areas also commonly include facultative and upland herbaceous species, such as buffalograss, Cherokee sedge, sumpweed, and switchgrass (*Panicum virgatum*). Results of HEP habitat measurements for this cover type are shown in Table 8.

Wildlife species directly observed in shrub wetlands include the southern leopard frog, as well as several species of butterflies, bees, and damselflies. Tracks and scat were also identified for mammalian species, such as the coyote (*Canis latrans*), raccoon, and white-tailed deer.

Table 8. HEP Field Data Summary:
Habitat Variable Measurements at Shrub Wetland Sites

Cover Type: Shrub Wetland
Species: Great Blue Heron (1, 2, 12), Green Heron (4, 5, 6, 7, 8, 10), Raccoon (3, 9, 11)

Habitat Variable	Sample Site Number		
	1	2	3
1) Presence of 100m disturbance free zone (sunset/sunrise)	Y	Y	Y
2) Presence of shallow (<20") water body with suitable prey population and firm substrate	N	Y	Y
3) Water regime (Year-round): A) permanent; B) semi-permanent; C) none or ephemeral	C	C	B
4) Water regime (Summer): A) permanent; B) semi-permanent; C) none or ephemeral	C	C	B
5) Aquatic substrate composition in littoral zone: A) muddy; B) sandy; C) rocky	A	A	A
6) % emergent herbaceous canopy cover in littoral zone	40	95	65
7) % water area <10" deep (avg. summer conditions)	100	0	75
8) % water surface covered by logs, tree limbs or shrub overhangs, (alive of dead) (avg. summer conditions)	0	0	20
9) # of refuge sites/acre (burrows, crevices, brush piles)	0	10	30
10) Water current: A) still/slow (<6"/sec); B) moderately slow (6 – 24"/sec); C) moderately fast (24-40"/sec); D) fast (40"/sec)	A	A	A
11) Distance to water (mi)	0.21	0.24	0.24
12) Distance to Riparian Woodland / Bottomland Hardwood (km)	0.11	0.02	0.01

Tree Savanna

TREE SAVANNA

Tree canopy cover 5-25%.
Vegetation canopy cover at least 25%.

EVALUATION SPECIES:
American Kestrel
Fox Squirrel
Northern Bobwhite
Racer
Scissor-tailed Flycatcher

In tree savannas, trees taller than five meters make up a sparser canopy – between five to 25 percent – than in upland forests. Total canopy cover of all vegetation in this cover type is at least 25 percent (USFWS 1980c). Tree savannas in the project site have relatively moderate tree canopy and abundant herbaceous cover. This cover type makes up approximately 791 acres of the proposed Lake Ringgold conservation pool area.

Tree Savannas in the project site primarily consists of large lone trees or groves of cedar elms or post oaks with an average overstory dbh of 10 inches. Tree canopy cover within this cover type averages 24 percent. Shrub canopy cover canopy cover is low in these areas, averaging about nine percent. Shrubs commonly found in these areas include smaller versions of the trees listed above, as well as shrub species including gum bumelia and honey mesquite.

Herbaceous cover in tree savannas averages 67 percent, and the average height of the herbaceous canopy is six inches. Grass species, which make up approximately 33 percent of the herbaceous layer, include buffalograss, dropseed (*Sporobolus* spp.), and white tridens. Sedges and forbs are the more dominant members of the herbaceous canopy, and include Cherokee sedge, chufa (*Cyperus esculentus*), silverleaf nightshade, and sumpweed. Results of HEP field measurements for this cover type are shown in Table 9.

Wildlife species identified in tree savannas were primarily birds, including American crow, blue jay, eastern bluebird, northern harrier, and red-tailed hawk. Deer mice were the most common mammals identified in the tree savannah cover type.

**Table 9. HEP Field Data Summary:
Habitat Variable Measurements at Tree Savanna Sites**

Cover Type: Tree Savanna

Species: American Kestrel (1, 2, 8, 9, 14), Fox Squirrel (4, 5, 6, 18, 22), Northern Bobwhite (3, 7, 8, 10, 11, 12, 13, 17, 20), Racer (8, 13, 16, 21), Scissor-tailed Flycatcher (8, 13, 15, 19)

Habitat Variable	Sample Site Number			
	1	2	3	4
1) Availability of lone trees (≥ 12” dbh) or groves (≤ 1 acre) within 1 mi dia: A) abundant; B) moderate; C) scarce	A	A	A	A
2) Availability of ledges, banks, buildings within 1 mi.: A) abundant; B) moderate; C) few to none	C	C	C	C
3) Soil Moisture Regime: A) saturated-moist; B) moist-dry; C) dry	C	C	C	C
4) % tree canopy closure (>16.5 ft)	40	15	30	10
5) % tree canopy closure of hard mast producers (≥10" dbh)	15	10	0	0
6) % shrub canopy closure (<16.5 ft)	15	5	10	5
7) % canopy cover of woody veg < 6.5 ft	55	5	0	0
8) % herbaceous canopy cover	30	95	65	75
9) % herbaceous canopy ≤ 12” tall	30	95	65	40
10) % preferred Northern Bobwhite herbaceous food plants (legumes, croton, ragweed, etc.)	20	5	90	35
11) % herbaceous canopy cover that is grass	20	60	10	45
12) % bare ground/light litter	70	5	5	10
13) Avg. height of herbaceous vegetation in spring (in)	6	6	8	4
14) Distance to perch site (forest edge, post, pole, wire) (km)	0	0	0.01	0.01
15) Distance to deciduous trees (clumps, forest edge, wind breaks, isolated trees, etc.) (m)	0	10	4	50
16) Distance to shrubby edges or shrub thickets (ft)	2	75	250	150
17) Avg. dbh of pine/oak trees that are ≥ 10” dbh (cm)	25.4	31.75	0	0
18) Avg. dbh of overstory trees (in)	8	10	12	9
19) # deciduous trees/acre	50	50	10	20
20) # pine/oak trees that are ≥ 10” dbh/2.5 acre	25	25	0	0
21) # of refuge sites/acre (burrows, crevices, brush piles)	20	20	10	0
22) Distance to available grain (yd)	1306	1179	1792	1457

Upland Deciduous Forest

UPLAND DECIDUOUS FORESTS

Non-wetland areas dominated by trees and with a minimal tree canopy closure of 25%.

EVALUATION SPECIES:
Barred Owl
Brown Thrasher
Carolina Chickadee
Downy Woodpecker
Fox Squirrel

Upland forests are defined as non-wetland areas dominated by trees of at least five meters in height with a minimum tree canopy closure of 25 percent. In upland deciduous forests, at least 50 percent of the canopy is composed of deciduous species, or those that completely shed their foliage during part of the year (USFWS 1980c). Upland forests in the project area are, on average, completely dominated by deciduous trees and have an average total canopy closure of 53 percent. The average overstory tree height and dbh is approximately 28 feet and ten inches, respectively. The upland deciduous forest cover type makes up approximately 1,195 acres of the proposed conservation pool of Lake Ringgold. Dominant tree species include post oak and cedar elm.

Dominant shrub and vine species include post oak, cedar elm, sugarberry, honey locust, gum bumelia, and greenbrier. Shrub canopy closure averages approximately 23 percent. Dominant herbaceous species include annual broomweed, Cherokee sedge, sumpweed, tall dropseed, and Virginia wildrye. Results of HEP field measurements for this cover type are shown in Table 10.

Wildlife observed in this cover type include a variety of bird species, such as American crow, blue jay, Carolina chickadee, northern cardinal, northern flicker, red-bellied woodpecker, and red-tailed hawk. The only mammal species identified within this cover type was the coyote.

Table 10. HEP Field Data Summary:
Habitat Variable Measurements at Upland Deciduous Forest Sites

Cover Type: Upland Deciduous Forest

Species: Barred Owl (4, 8, 9), Brown Thrasher (1, 6, 12), Carolina Chickadee (1, 3, 7, 11), Downy Woodpecker (10, 13), Fox Squirrel (1, 2, 5, 8, 14)

Habitat Variable	Sample Site Number			
	1	2	3	4
1) % tree canopy closure (>16.5 ft)	55	60	55	40
2) % tree canopy closure of hard mast producers (≥10" dbh)	50	0	15	30
3) % deciduous canopy closure in stand	100	100	100	100
4) % canopy closure of overstory trees	55	50	50	20
5) % shrub canopy closure (<16.5 ft)	25	25	25	15
6) % litter ≥ 1 cm deep	85	20	20	60
7) Avg. height of overstory trees (ft)	10	7	8	9
8) Avg. dbh of overstory trees (in)	14	6	8	11
9) # of trees ≥ 20" dbh/acre	0	0	0	0
10) # snags > 6" dbh/acre	20	0	0	0
11) # snags <10" dbh/acre	60	0	20	0
12) # woody stems >3.3 ft/2.5 acre (in thousands)	1.23	1.25	2.50	0.65
13) Basal area (area of exposed stems of woody veg. if cut horizontally at 4.5 ft. height in ft^2/acre)	80	30	80	70
14) Distance to available grain (yd)	1656	1310	1234	2239

Baseline Habitat Suitability Indices

Calculation of HSI values were performed according to standard models developed for each evaluation species, excepting the Great Blue Heron. This model's HSI formula was modified from the recommended formula due to the absence of suitability index values in the cover types in which it was used. Since emergent/herbaceous wetlands and shrub wetlands lack nest supporting tree-land, it was not possible to attain a reproductive life requisite value for the Great Blue Heron model from these cover types. Therefore, the foraging life requisite was used as the HSI score for this model. To compute the HSI value for individual cover types, site measurements for each variable were averaged for each cover type and then were used in the HSI model for each species. The HSI value for each cover type was calculated as the arithmetic mean of all the individual species' HSIs (Table 11).

Table 11. Habitat Suitability Indices by Cover Type within the Proposed Lake Ringgold Project Site

	Cover Types							
Species	**Emergent / Herbaceous Wetland**	**Grassland / Old Field**	**Riparian Woodland / Bottomland Hardwood**	**Shrubland**	**Shrub Savanna**	**Shrub Wetland**	**Tree Savanna**	**Upland Deciduous Forest**
American Kestrel	0.76	0.69	--	--	0.69	--	0.81	--
Barred Owl	--	--	0.18	--	--	--	--	0.10
Brown Thrasher	--	--	--	0.01	--	--	--	0.07
Carolina Chickadee	--	--	0.54	--	--	--	--	0.32
Downy Woodpecker	--	--	0.35	--	--	--	--	0.25
Eastern Cottontail	--	0.32	--	0.84	0.96	--	--	--
Eastern Meadowlark	--	0.51	--	--	--	--	--	--
Field Sparrow	--	--	--	0.25	0.39	--	--	--
Fox Squirrel	--	--	0.26	--	--	--	0.14	0.42
Great Blue Heron	0.50	--	--	--	--	0.67	--	--
Green Heron	0.09	--	--	--	--	0.28	--	--
Northern Bobwhite	--	--	--	0.12	0.10	--	0.10	--
Racoon	0.00	--	0.30	--	--	0.34	--	--
Racer	--	0.20	--	0.77	0.69	--	0.63	--
Scissor-tailed Flycatcher	--	0.88	--	--	--	--	0.86	--
Average HSI Values	**0.34**	**0.52**	**0.33**	**0.40**	**0.57**	**0.43**	**0.51**	**0.23**

Baseline Habitat Units

Baseline Habitat Units (HUs) were calculated for each cover type within the Lake Ringgold project area by multiplying the average Habitat Suitability Index (HSI) values (Table 11) for each cover type by their respective cover type acreage (Table 12).

Table 12. Baseline Habitat Units by Cover Type within the Proposed Lake Ringgold Project Site.

Cover Type	Average HSI Values	Area (acres)	Habitat Units (HUs)
Emergent / Herbaceous Wetland	0.34	102	35
Grassland / Old Field	0.52	5,162	2,684
Riparian Woodland / Bottomland Hardwood	0.33	4,298[1]	1,418
Shrubland	0.40	2,243	897
Shrub Savanna	0.57	1,402	799
Shrub Wetland	0.43	38	16
Tree Savanna	0.51	791	403
Upland Deciduous Forest	0.23	1,195	275
TOTAL HABITAT UNITS			**6,527**

1. Of this acreage, 278 acres are considered forested wetlands. The remaining acreage is not wetland.

Conclusion

The habitat suitability indices within the project area varied from 0.23 for upland deciduous forest to 0.57 for shrub savanna, indicating poor to moderate habitat suitability for wildlife. The suitability indices for wetlands were 0.34 for emergent wetlands, 0.43 for shrub wetlands, and 0.33 for forested wetlands. In total, there are 418 acres of wetlands within the project area. These wetlands have a total habitat value of 143 HUs. The uplands have a total habitat value of 6,384 HUs. Considering both wetlands and uplands, the habitat value within the project area is 6,527 HUs.

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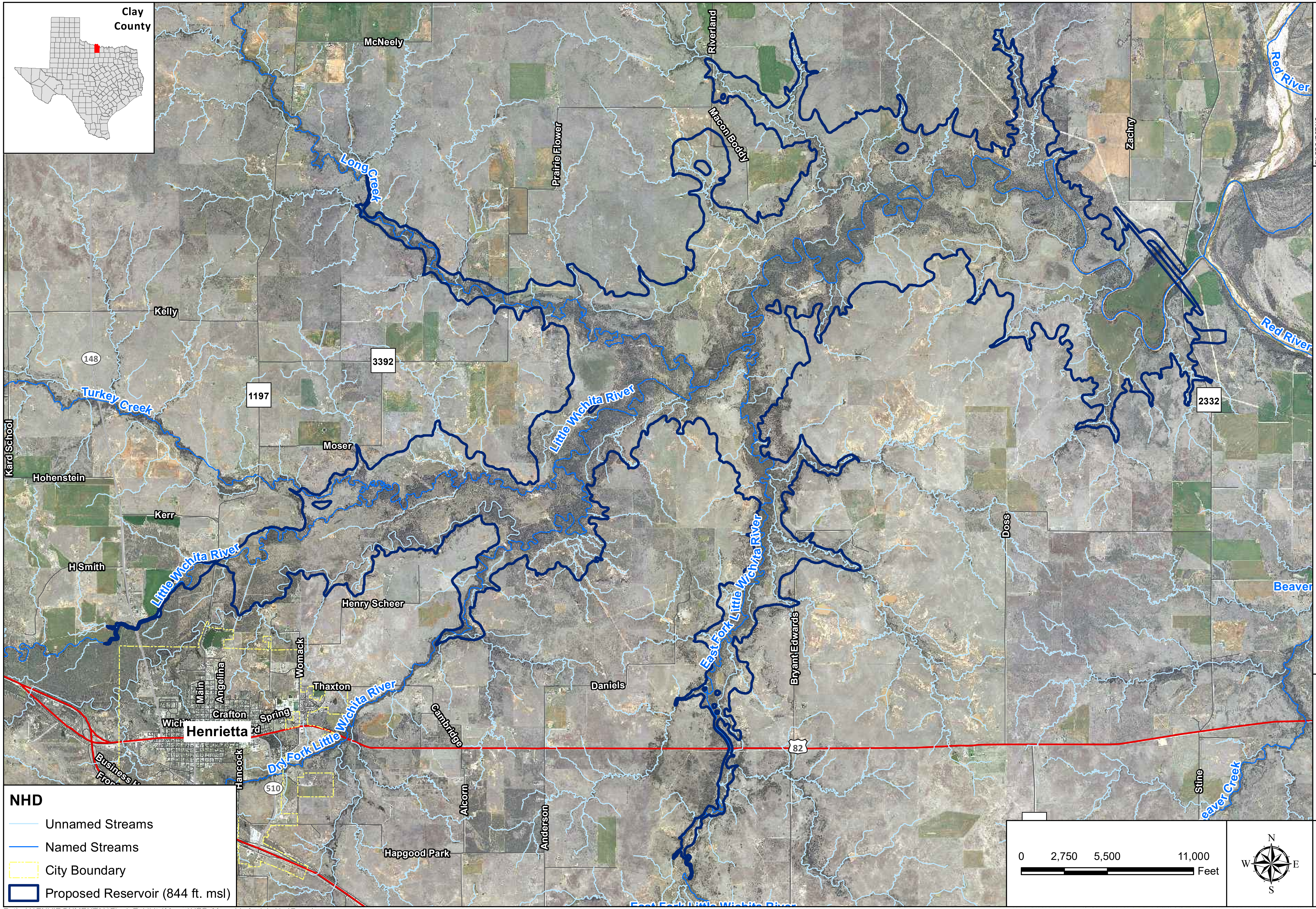
Appendix A

Figures



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FILE NAME	1_Aerial_11x17
PREPARED BY	HHM

CITY OF WICHITA FALLS

Proposed Lake Ringgold

PROJECT OVERVIEW
AERIAL MAP

FREESE NICHOLS
FREESE AND NICHOLS
4055 International Plaza Suite 200
Fort Worth, Texas 76109-4895
(817) 735-7300

1

FIGURE

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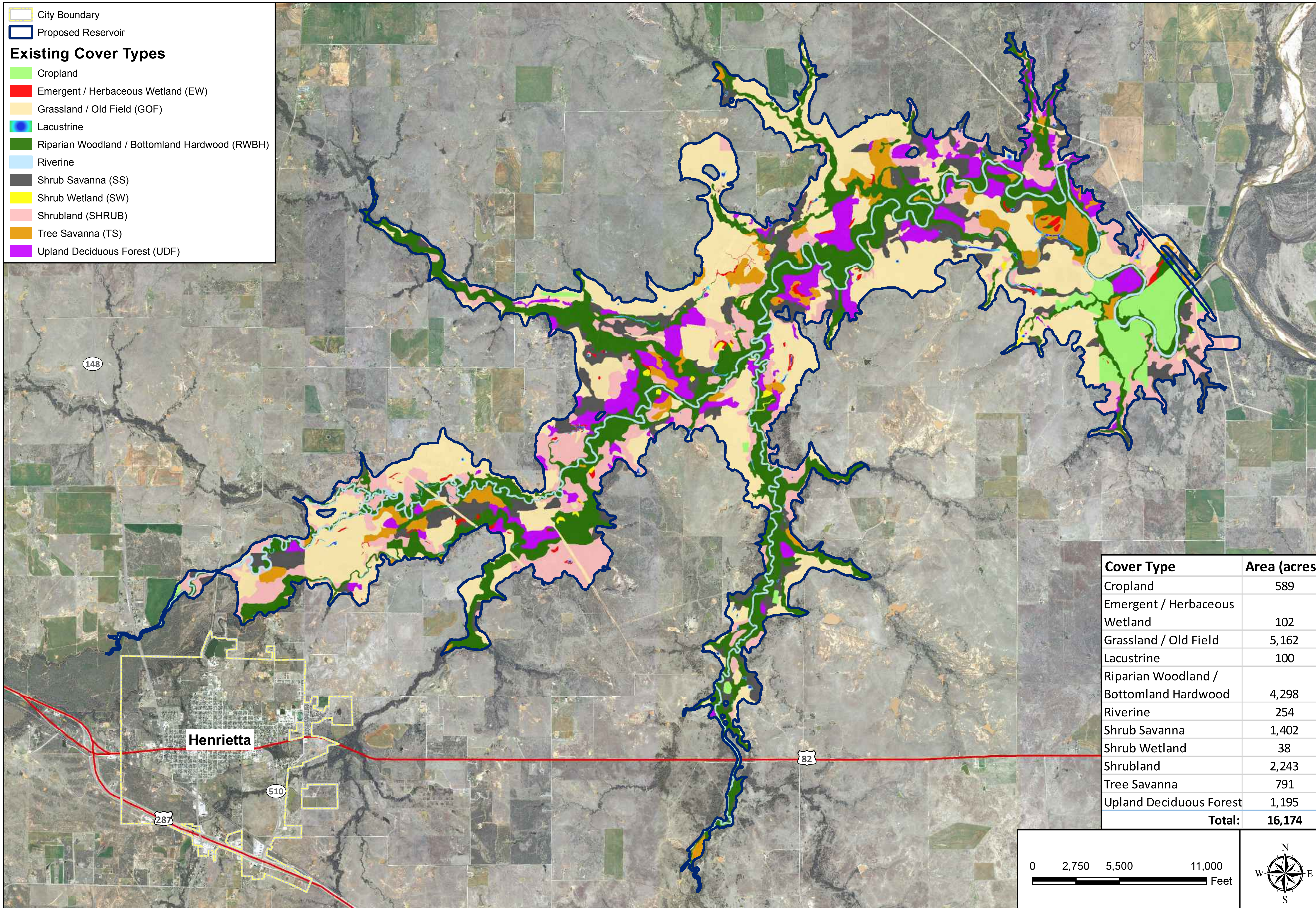

Cover Type	Area (acres)
Cropland	589
Emergent / Herbaceous Wetland	102
Grassland / Old Field	5,162
Lacustrine	100
Riparian Woodland / Bottomland Hardwood	4,298
Riverine	254
Shrub Savanna	1,402
Shrub Wetland	38
Shrubland	2,243
Tree Savanna	791
Upland Deciduous Forest	1,195
Total:	16,174

FN PROJECT NO. WCH15215
DATE CREATED 3/22/2017
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central
FILE NAME 2_CoverType_11x17
PREPARED BY HHM

CITY OF WICHITA FALLS
Proposed Lake Ringgold
EXISTING COVER TYPE MAP

FREESE NICHOLS
FREESE AND NICHOLS
4055 International Plaza Suite 200
Fort Worth, Texas 76109-4895
(817) 735-7300

FIGURE 2

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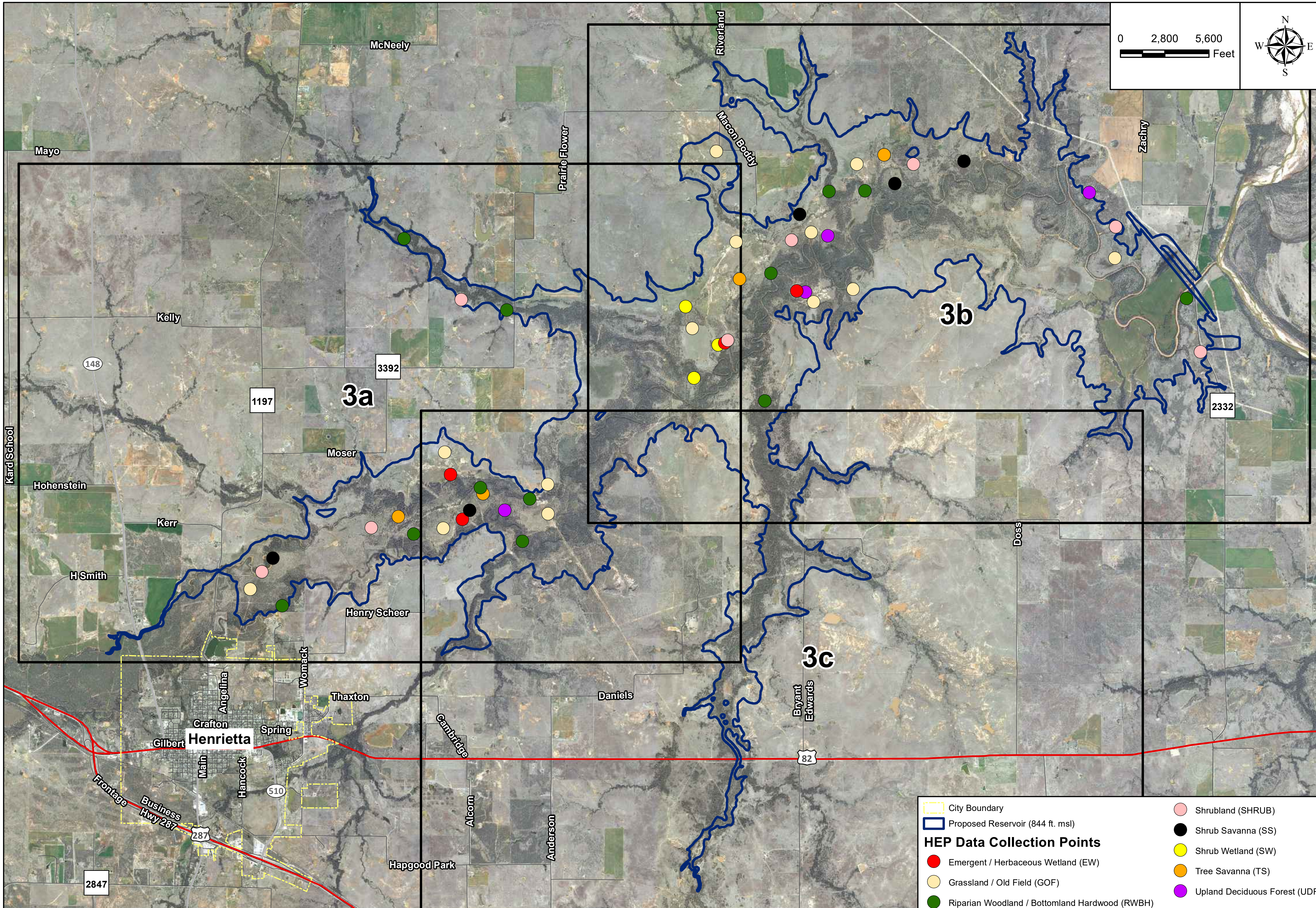

FN PROJECT NO. WCH15215

DATE CREATED 12/9/2016

DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central

FILE NAME 3_HEP_Pts_11x17

PREPARED BY HHM

CITY OF WICHITA FALLS

Proposed Lake Ringgold

HEP DATA COLLECTION POINTS

FREESE NICHOLS

FREESE AND NICHOLS
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FIGURE

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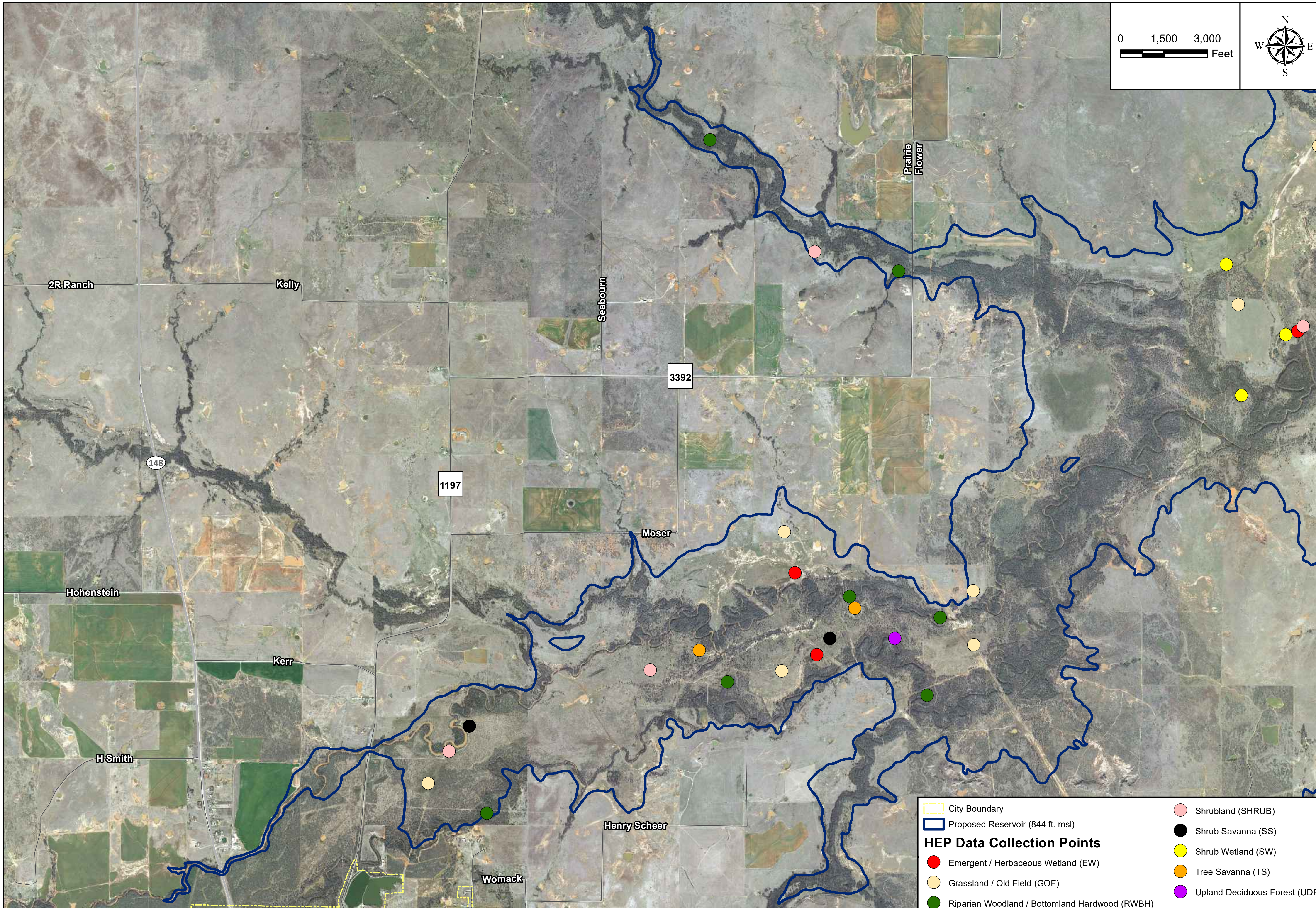

CITY OF WICHITA FALLS

Proposed Lake Ringgold

HEP DATA COLLECTION POINTS

FN PROJECT NO. WCH15215

DATE CREATED 12/9/2016

DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central

FILE NAME 3_HEP_Pts_11x17

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FIGURE

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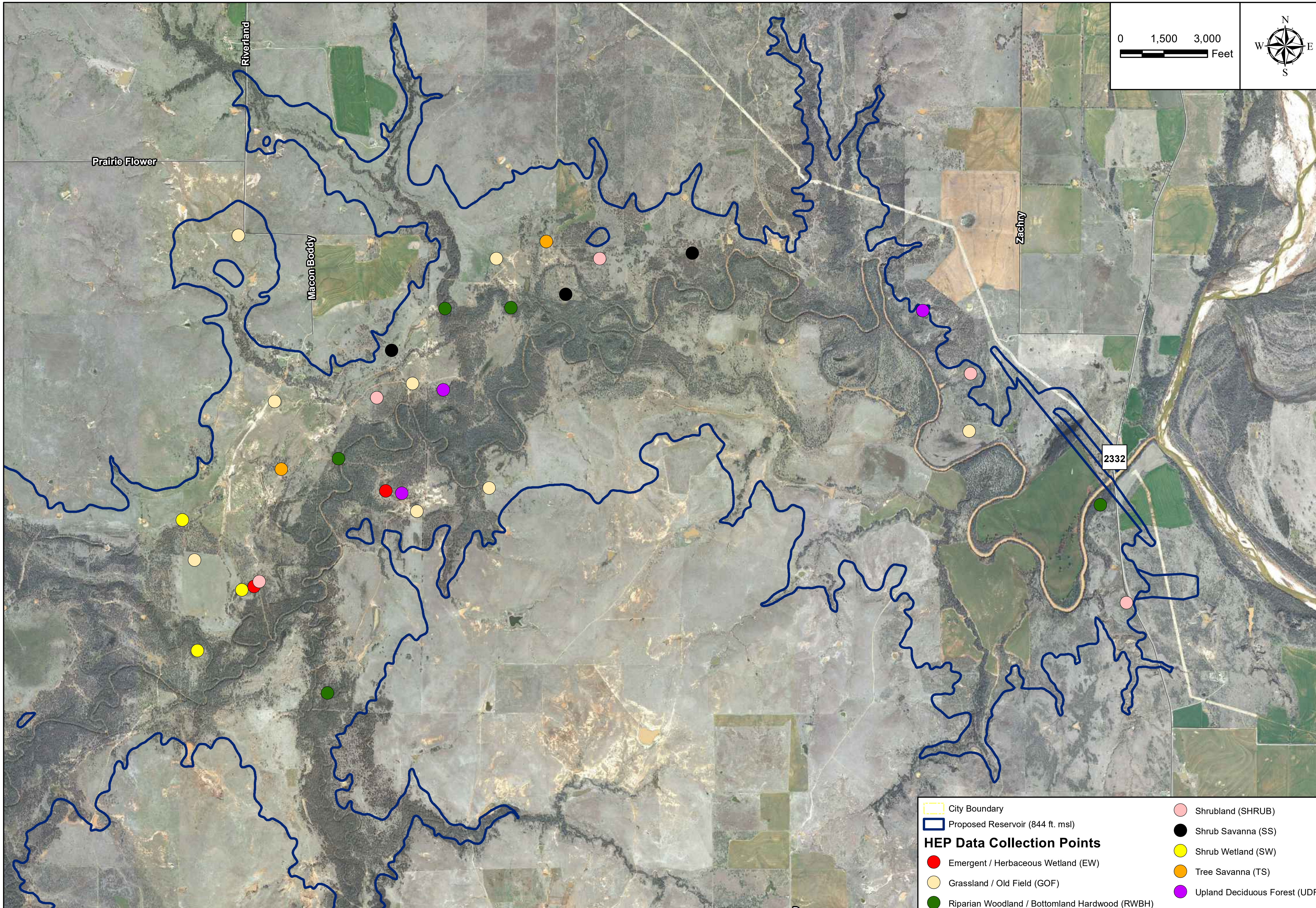

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FIGURE

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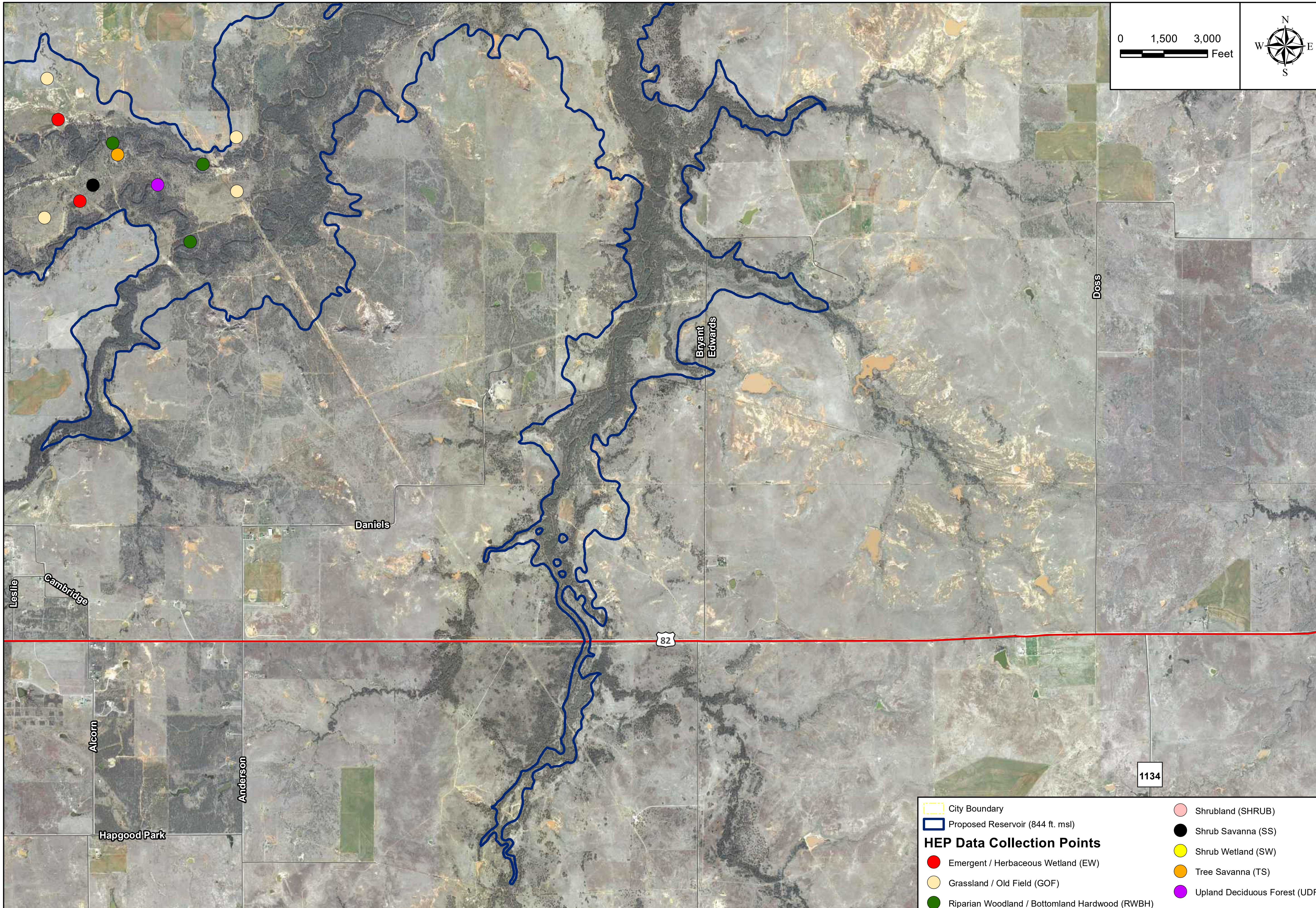

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Proposed Lake Ringgold

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FIGURE

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Appendix B

Photographs

Emergent / Herbaceous Wetland HEP Evaluation Sites

DOMINANT VEGETATION

SHRUBS
Cedar Elm, Hawthorn

HERBACEOUS
Cherokee Sedge, Spikerush, Smartweed, Sumpweed

Photo 1. Evaluation site EHW 1. Photo taken facing south in October 2016.

Photo 2. Evaluation site EHW 2. Photo taken facing south in October 2016.

Grassland / Old Field HEP Evaluation Sites

DOMINANT VEGETATION

HERBACEOUS
Bermudagrass, Buffalograss, King Ranch Bluestem, Tall Dropseed, Vine Mesquite, White Tridens, Broomweed, Cherokee Sedge, Silverleaf Nightshade, Sumpweed, Western Ragweed

Photo 3. Evaluation site GOF 8. Photo taken facing west in October 2016.

Photo 4. Evaluation site GOF 13. Photo taken facing east in November 2016.

Riparian Woodland / Bottomland Hardwood HEP Evaluation Sites

DOMINANT VEGETATION

TREES
Cedar Elm, Green Ash, Hawthorn, Pecan, Post Oak, Sugarberry, Western Soapberry

SHRUBS & VINES
Coralberry, Honey Locust, Greenbrier, Gum Bumelia, Poison Ivy

HERBACEOUS
Cherokee Sedge, Dewberry, Raven's foot Sedge, Sumpweed, Virginia Wildrye, Wild Passion Vine, Woodoats, Wood Sorrel

Photo 5. Evaluation site RWBH 5. Photo taken facing west in October 2016.

Photo 6. Evaluation site RWBH 8. Photo taken facing north in October 2016.

Shrubland HEP Evaluation Sites

DOMINANT VEGETATION

TREES
American Elm, Cedar Elm, Sugarberry

SHRUBS & VINES
Greenbrier, Gum Bumelia, Honey Locust, Honey Mesquite, Mexican Plum

HERBACEOUS
Buffalograss, Broomweed, Marestail, Perennial Rye, Silverleaf Nightshade, Sumpweed, Tall Dropseed, Western Ragweed, White Tridens

Photo 7. Evaluation site SHRUB 3. Photo taken facing north in October 2016.

Photo 8. Evaluation site SHRUB 6. Photo taken facing west in October 2016.

Shrub Savanna HEP Evaluation Sites

DOMINANT VEGETATION

TREES
Cedar Elm, Post Oak

SHRUBS
Coralberry, Honey Mesquite, Sugarberry

HERBACEOUS
Buffalograss, Marestail, King Ranch Bluestem, Little Bluestem, Silver Bluestem, Silverleaf Nightshade, Sumpweed, Western Ragweed, White Tridens

Photo 9. Evaluation site SS 2. Photo taken facing north in October 2016.

Photo 10. Evaluation site SS 4. Photo taken facing west in October 2016.

Shrub Wetland HEP Evaluation Sites

DOMINANT VEGETATION

TREES
Cedar Elm, Green Ash

SHRUBS
Honey Locust, Buttonbush

HERBACEOUS
Raven's foot Sedge, Spikerush, Sumpweed, Smartweed

Photo 11. Evaluation site SW 2. Photo taken facing east in October 2016.

Photo 12. Evaluation site SW 3. Photo taken facing north in October 2016.

Tree Savanna HEP Evaluation Sites

DOMINANT VEGETATION

TREES
Cedar Elm, Post Oak

SHRUBS
Gum Bumelia, Honey Mesquite

HERBACEOUS
Buffalograss, Cherokee Sedge, Chufa, Dropseed, Silverleaf Nightshade, Sumpweed, White Tridens

Photo 13. Evaluation site TS 2. Photo taken facing north in October 2016.

Photo 14. Evaluation site TS 3. Photo taken facing south in October 2016.

Upland Deciduous Forest HEP Evaluation Sites

Photo 15. Evaluation site UDF 1. Photo taken facing north in October 2016.

Photo 16. Evaluation site UDF 4. Photo taken facing north in November 2016.

APPENDIX J

STREAM EVALUATION

MEMORANDUM

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TO: Russel Schreiber, P.E.

CC: Simone Kiel, P.E.

FROM: David Coffman, P.G., C.F.M.; Stephen Norair, G.I.T.

SUBJECT: Lake Ringgold Stream Evaluation

DATE: May 16, 2017

PROJECT: WCH15215

1.0 Introduction

Freese and Nichols, Inc. (FNI) conducted a study for the City of Wichita Falls to evaluate the length of stream that would be impacted by the development of Lake Ringgold, as required for an administratively complete Texas water right application. The two study objectives are as follows:

1. Define the total linear feet of stream that would be impacted by the proposed reservoir, and
2. Evaluate the stream type of streams in the proposed project area (perennial, intermittent, or ephemeral).

FNI conducted a stream verification study that included desktop analysis and field investigation, in coordination with Texas Commission for Environmental Quality (TCEQ). This was approved by TCEQ on July 15, 2016.

2.0 Stream Presence-Absence Evaluation

A Texas water right application requires a reporting of streams that would be impacted by the proposed project, in this case, the proposed Lake Ringgold water supply reservoir in Clay County, Texas. The proposed reservoir project area would be located northeast of the City of Henrietta and would impact approximately 16,147 acres at normal pool, including the dam and spillways.

One method of evaluating stream impacts in a large project area such as a reservoir is to use the National Hydrography Dataset (NHD). The NHD is a digital vector dataset produced by the U.S. Geological Survey (USGS) that contains hydrologic features such as lakes, ponds, streams, rivers, and canals. The USGS 1:24,000-scale printed topographic maps are the original data source for the NHD. Comparison of the features lines in the NHD dataset to the USGS topographic maps in the project area showed that all blue lines on the topographic maps were contained within the NHD dataset, and no other streams were included the NHD dataset in addition to those blue lines.

Raw NHD data in the proposed project was then compared to recent (2015) high-resolution (0.5 and 1 meter) aerial imagery. This review in early 2016 revealed that there might have been inaccuracies in the NHD data, such as where NHD lines were present, but stream features, like a defined channel, were not visible in the high-resolution aerial imagery. These initial observations indicated the need for further verification of the streams in the proposed project area.

The evaluation of the presence of streams was a three-step process that included an initial desktop assessment, followed by field verification of streams within accessible areas, and then based on the findings in the field, a refined desktop analysis for the streams that were inaccessible for field verification. Approximately 42 percent of the total area that would be impacted by the proposed reservoir (16,147 acres) was accessible for field verification (6,712 acres). Table 1 shows the land area and the length of raw NHD documented streams that would be impacted by Lake Ringgold, based on field accessibility.

Table 1 – Land access and raw NHD stream length that would be impacted by proposed Lake Ringgold

	Area (acres)	NHD Stream Length (feet)
Accessible	6,712	328,043
Non-accessible	9,462	545,257
Total	16,174	873,300

2.1 Initial Desktop Analysis

The initial desktop analysis used a combination of information from the National Hydrography Dataset (NHD), aerial photography, and USGS topographic maps to evaluate the total stream length and streams types that would be impacted by the proposed reservoir. Stream features in the NHD were compared to aerial photographs from 2014 (NAIP 1m NC\CIR) and 2015 (TOP 0.5 NC/CIR). During the initial desktop analysis, NHD streams were separated into three categories, as follows:

1. NHD stream lines that were not visible on the aerial imagery were marked with a qualifier of *NOT STREAM*.
2. NHD stream lines that corresponded with visible stream channels on the aerial imagery were marked with a qualifier of *STREAM*.
3. The remaining NHD stream lines were marked with a qualifier of *MAYBE STREAM*. These were features where aerial imagery was insufficient to observe stream channels, primarily due to the presence of dense treed riparian areas.

2.2 Field Verification

Multiple field visits, from August 2016 to March 2017, were conducted to verify the presence and type of streams documented by the NHD that were legally accessible. The FNI team was accompanied by Mr. Robert Hanson (TCEQ) on the October 13, 2016 site visit.

As shown in Table 1, approximately 42 percent of the proposed reservoir pool was accessible for stream verification field work. These accessible lands were those that are owned by the City of Wichita Falls or private landowners that granted access permission for this initial field study. All NHD stream features on accessible lands were visited and evaluated as either *stream* or *not stream*. NHD features were considered a stream if:

- The feature had a defined bed and banks
- The feature had an ordinary highwater mark
- The feature was hydrologically connected to a jurisdictional waterbody

One inconsistency observed between the NHD data and actual field conditions was the labeling of open water features as streams in the NHD. The area to be inundated by the proposed reservoir contained numerous linear open water features (stock tanks) that had been formed by placing low dams or berms on streams. Per consultation with Mr. Robert Hanson (TCEQ), open water features are formed by man-made impoundment structures (dams or berms), and the extent of the open water feature is dictated by the crest elevation of the dam spillway, in other words, the normal pool elevation of the impoundment. The crest elevation of the dam spillway is projected upstream to a point where it intersects the ground surface. This is to determine where the open water ends and the feature becomes a stream. For these instances, NHD streams were reclassified from stream to open water.

There were also locations where NHD stream lines were shown but were instead occupied by either emergent or forested wetlands. It was observed that streams could be discontinuous, with stream segments connected by open water or wetlands.

Finally, there were locations where NHD data showed the presence of a stream, but no stream features were located/observed in the area.

2.3 Updated Desktop Analysis for Inaccessible Areas

As shown in Table 1, NHD features in approximately 60 percent of the proposed reservoir pool were inaccessible for field verification. NHD features that were not accessible and could not be field verified were evaluated using aerial imagery and knowledge gained from field experience. As previously discussed, all NHD features were classified into three categories: *STREAM*, *NOT STREAM*, or *MAYBE STREAM*. For purposes of the current analysis, however, inaccessible NHD features have been grouped into two categories; *STREAM* or *NOT STREAM*, with all *MAYBE STREAM* features included in the *STREAM* category. For NHD streams that were reclassified as open water or wetland, whether on accessible or inaccessible lands, vegetative cover classifications for these resources were updated to account for these adjustments.

3.0 Stream Type Evaluation

In many cases, the stream type (perennial, intermittent or ephemeral) in the NHD did not match observed conditions. A combination of NHD data, United States Geological Survey (USGS) stream gage data, aerial imagery, and field observations were used to evaluate stream type. TCEQ classifies the Little Wichita River as perennial from its confluence with the Red River to the Lake Arrowhead Dam. The USGS operates a stream gage on the Little Wichita River at the HWY 287 bridge (USGS 07314900 Little Wichita Rv abv Henrietta, TX). The median (50 percentile) daily flow measured at the stream gage during the period of record from 1952 to present is zero (0.0) cubic feet per second (cfs). Therefore, our assumption based on USGS stream gage data is that upstream of HWY 287, the Little Wichita River could be reclassified as intermittent. We also assume that the Little Wichita River could be reclassified as intermittent for some distance downstream of the HWY 287 bridge, but more data would be needed to determine the location where it truly becomes perennial.

The USGS also operates a stream gage on the East Fork Little Wichita River at HWY 82 (USGS 07315200 E Fk Little Wichita Rv nr Henrietta). The median (50th percentile) daily flow measured at the stream gage during the period of record from 1963 to present is 0.05 cfs, and the 25th percentile daily flow is zero (0.00) cfs. Therefore, upstream of HWY 82, the East Fork Little Wichita River should be classified as intermittent. Observations made during site visits to the downstream end of the East Fork at its confluence with the Little Wichita River confirm that the classification of the East Fork Little Wichita River is intermittent.

Stream gage records and observations of all other streams on accessible lands informed the following stream type classification breakdown for the streams in the proposed reservoir pool:

- Perennial (continuous flow all year) – Little Wichita River
- Intermittent (flows most of the time but ceases flowing for weeks to months each year) – East Fork Little Wichita River, Dry Fork Little Wichita River, Turkey Creek, Long Creek, and Tributary 12 (Exhibit 1)
- Ephemeral (flows only during and immediately after a rainfall event) – all headwater streams, defined as tributaries to the Little Wichita River, East Fork Little Wichita River, Dry Fork Little Wichita River, Turkey Creek, Long Creek, or Tributary 12 (Exhibit 1)

4.0 Results

Stream Length

The results of this analysis show that 651,741 linear feet of stream would be impacted by the development of Lake Ringgold. This includes 5,517 linear feet of streams that were identified as *STREAM* during the field investigations that were not previously captured in the NHD data. Approximately 26 percent of the raw NHD streams (227,076 linear feet) were determined to be *NOT STREAM*. Exhibit 1 shows the streams that would be impacted by Lake Ringgold, including the NHD features that were evaluated as *NOT STREAM*. Discrepancies in the NHD data were exhibited in a variety of ways. Recurring patterns where NHD features were evaluated as *NOT STREAM* include:

- Absence of flow features (Exhibit 2)
- Emergent wetlands being present in place of a stream (Exhibit 3)
- Forested Wetland being present in place of a stream (Exhibit 4)
- Open Water being present in place of a stream (Exhibit 5)

Often there was no evidence of a stream on the aerial images or in the field (Exhibit 2). In other cases, other types of aquatic features were mistaken as streams including standing water after rainfall, open water, emergent wetlands, and, and forested wetlands. Table 2 shows the breakdown of features identified in place of NHD lines designated *NOT STREAM*.

One unique geomorphologic feature that was repeatedly associated with *NOT STREAM* were paleochannels. A paleochannel is a remnant of an old drainage pattern that is no longer an active stream. Paleochannels form when a stream channel migrates, meanders, or is artificially re-routed. In the proposed Lake Ringgold study area, most paleochannels of the Little Wichita River are presently occupied by non-stream aquatic features including open water, emergent wetlands, or forested wetlands, but were shown as streams in the NHD data. In these cases, the NHD line was designated NOT STREAM, and vegetation cover types were modified to reflect these changes.

Table 2 – Length of features in place of NHD lines designated NOT STREAM

Feature in Place of NHD Stream	Length of NOT STREAM NHD Features (feet)
Absence of Feature	117,491
Emergent Wetland	13,792
Forested Wetland	43,261
Open Water	52,532
Total	227,076

Stream Type

Using the protocols outlined in Section 3.0 for stream type, most of the streams impacted by the project are ephemeral streams (47 percent of the total stream length). The remaining stream length is classified as either perennial or intermittent. The length of streams and stream types on accessible and non-accessible land are shown in Table 3.

Table 3 – Length and type of stream that would be impacted by Lake Ringgold

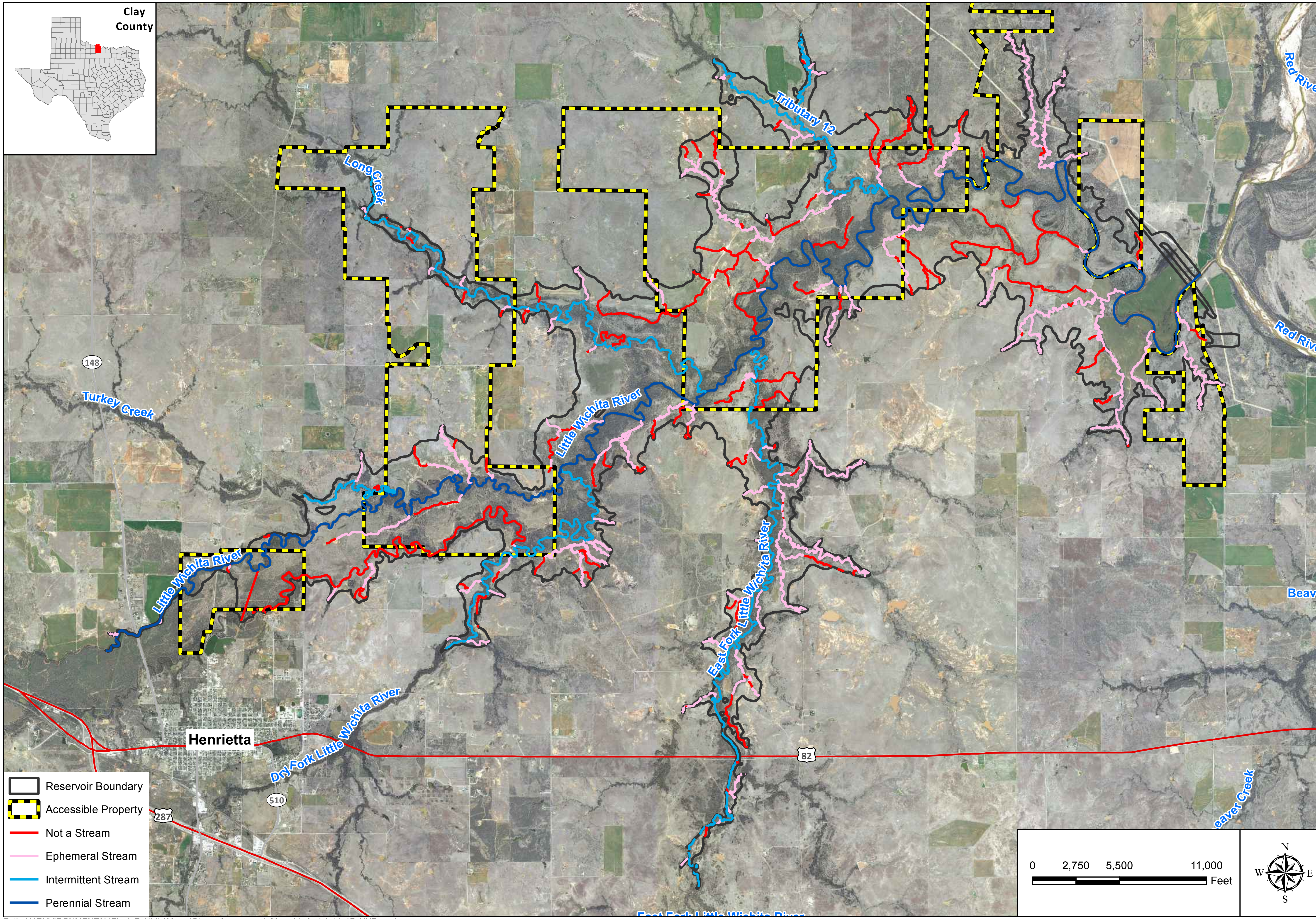
	Perennial Stream Length (feet)	Intermittent Stream Length (feet)	Ephemeral Stream Length (feet)	Total Stream Length (feet)
Accessible	94,956	51,730	82,770	229,456
Non-Accessible	71,821	128,926	221,538	422,285
Total	166,777	180,656	304,308	651,741

5.0 Conclusion

This study was conducted to evaluate the streams that would be impacted by the proposed development of Lake Ringgold, as needed for a Texas Water Rights permit application. A combination of aerial photographs, USGS topographic maps, NHD data, USGS stream gage data, and field verification were used to evaluate the presence or absence of streams and the types of streams that would be impacted by proposed Lake Ringgold. All streams that were legally accessible were field verified. Streams that were not accessible were evaluated using aerial photos and knowledge acquired from field visits. However, when definitive evaluation of non-accessible streams was not possible, NHD data were used.

This study found that the total length of streams that would be impacted by Lake Ringgold is 651,741 linear feet (Table 2). Of this total, 166,777 linear feet are considered to be perennial, 180,656 linear feet are intermittent, and 304,308 linear feet are ephemeral.

EXHIBITS



FN PROJECT NO.	WCH15215
DATE CREATED	5/15/2017
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas North Central
FILE NAME	1_Aerial_11x17_NHD
PREPARED BY	HHM

CITY OF WICHITA FALLS

Stream Evaluation Results: Lake Ringgold

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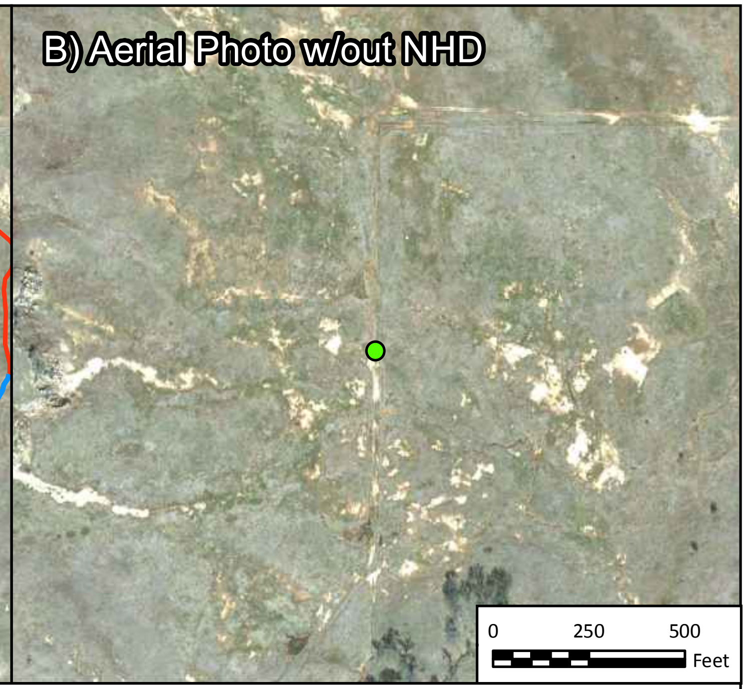
1

Exhibit



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N W E S

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Absence of Flow Features

Example of "Not a Stream" NHD Evaluation

FN JOB NO	WCH15215
FILE NAME	NoStream_Examples.mxd
DATE	5/15/2017
SCALE	1:6,000
DESIGNED	MK
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2
Exhibit

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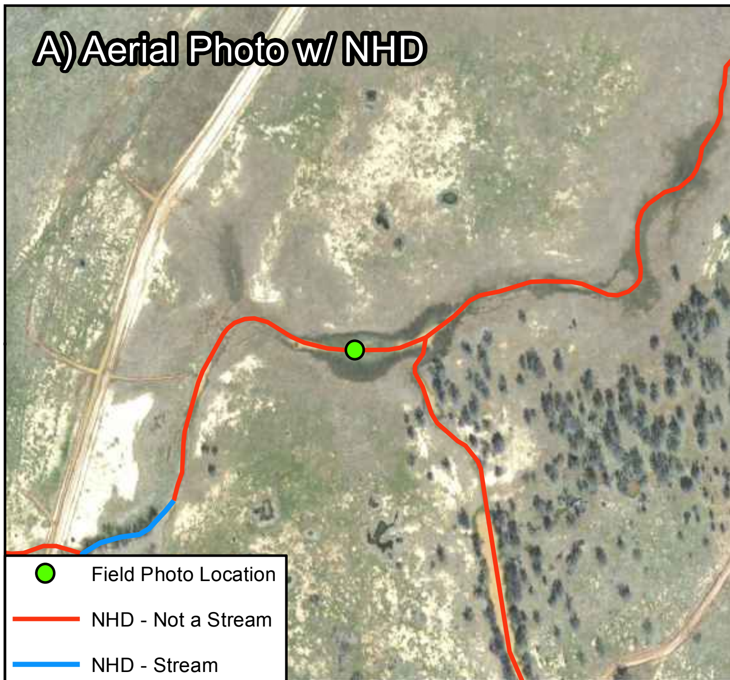
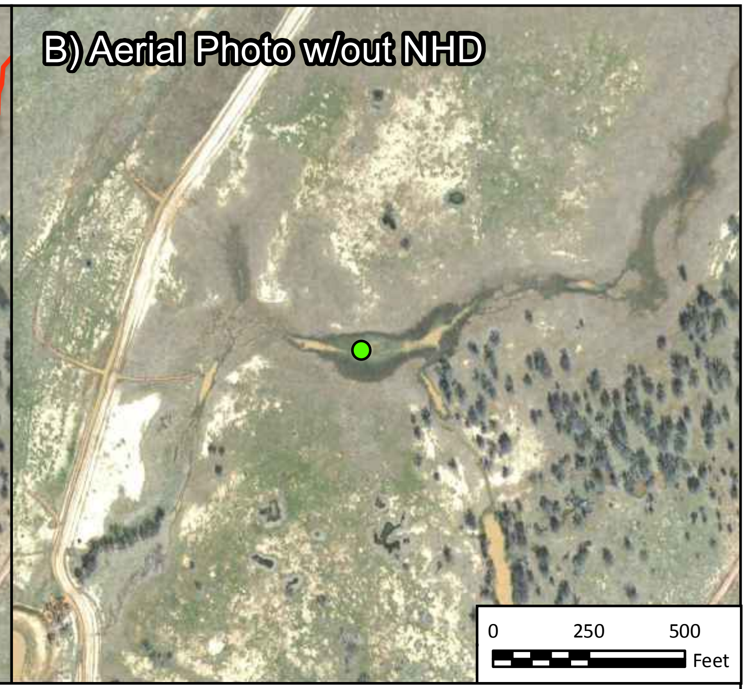
NAD 1983 StatePlane Texas North Central FIPS 4202 Feet





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Emergent Wetlands in Place of Stream

Example of "Not a Stream" NHD Evaluation

FN JOB NO	WCH15215
FILE NAME	NoStream_Examples.mxd
DATE	5/15/2017
SCALE	1:6,000
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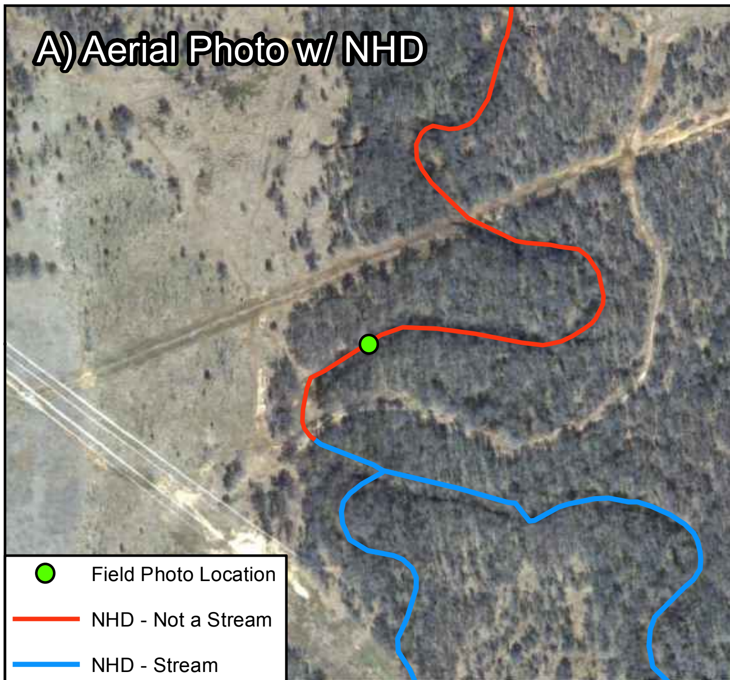
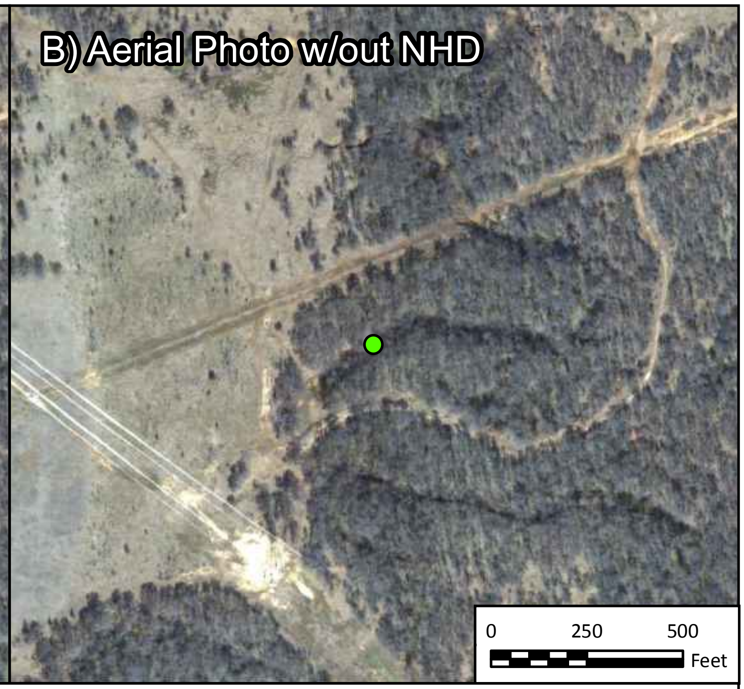
Exhibit





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Forested Wetlands in Place of Stream

Example of "Not a Stream" NHD Evaluation

FN JOB NO	WCH15215
FILE NAME	NoStream_Examples.mxd
DATE	5/15/2017
SCALE	1:6,000
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4
Exhibit

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Open Water in Place of Stream

Example of "Not a Stream" NHD Evaluation

FN JOB NO	WCH15215
FILE NAME	NoStream_Examples.mxd
DATE	5/15/2017
SCALE	1:6,000
DESIGNED	MK
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5

Exhibit

APPENDIX K

MITIGATION PLAN

Conceptual Mitigation Plan for Proposed Lake Ringgold

April 2017

Introduction

This conceptual mitigation plan was developed for the City of Wichita Falls (City) in support of a state water right permit application associated with the proposed Lake Ringgold project. Lake Ringgold is a proposed 15,500-acre reservoir site located in Clay County, northeast of the town of Henrietta, Texas (Figure 1). The proposed dam would be located on the Little Wichita River, approximately 0.5 miles upstream of its confluence with the Red River, and would impound 275,000 acre-feet of water at the normal pool elevation of 844 feet-msl. The proposed project would include construction of the Lake Ringgold dam, intake pump station, and a transmission system to move the water to the City. The water would be treated at an existing water treatment plant.

In accordance with 30 TAC, Chapter 297.53, the TCEQ shall assess the effects, if any, of the proposed project on fish and wildlife habitat, including streams and wetlands. Unavoidable adverse impacts shall be mitigated to an acceptable level approved by the TCEQ. The Commission also considers mitigation required by federal agencies, such as the USACE under Section 404 of the Clean Water Act (CWA), and any net environmental benefit to habitat by the proposed project. Following is a description of the potential impacts to aquatic and terrestrial resources associated with the proposed project as well as a conceptual mitigation plan that would offset those impacts.

Summary of Potential Impacts

The potential impacts of the project to wetlands and terrestrial habitats have been assessed using the USFWS's Habitat Evaluation Procedures (HEP). The HEP methodology is recommended by the USFWS as their basic tool for evaluating project impacts to wildlife habitat and developing mitigation recommendations. In addition, 30 TAC, Chapter 297.53, identifies HEP as an appropriate methodology for evaluating habitats, including wetlands. Detailed information regarding the HEP study conducted within the proposed Lake Ringgold project area is contained in Appendix I.

Potential impacts to streams were determined utilizing a stream assessment to identify stream lengths by type (i.e., perennial, intermittent, and ephemeral) within the footprint of the proposed project. Detailed information regarding the stream assessment conducted within the proposed Lake Ringgold project area are contained in Appendix J. It should be noted that a jurisdictional determination (JD) has not been conducted within the proposed project area, but would be required by the U.S. Army Corps of Engineers

(USACE) as part of the Section 404 permitting process. Potential impacts to streams and open waters identified within the proposed project area are summarized in Table 1. Potential impacts to wetland and terrestrial cover types identified within the proposed project area are summarized in Tables 2 and 3.

Table 1. Streams and Open Waters Identified within the Proposed Lake Ringgold Project Area.

STREAM TYPE	LENGTH (FT.)
Perennial	166,777
Intermittent	180,656
Ephemeral	304,308
TOTAL	**651,741**
OPEN WATER	**ACRES**
Ponds/ Stock Tanks	100

Table 2. Habitat Cover Types Identified within the Proposed Lake Ringgold Project Area.

COVER TYPE	ACRES	HABITAT SUITABILITY INDEX (HSI)	HABITAT UNITS (HUs)
Forested Wetland	278	0.33	75
Emergent / Herbaceous Wetland	102	0.34	35
Shrub Wetland	38	0.43	16
Cropland*	589	--	--
Grassland/Old Field	5,162	0.52	2,684
Riparian Woodland/Bottomland Hardwood	4,020	0.33	1,337
Upland Deciduous Forest	1,195	0.23	275
Shrubland	2,243	0.40	907
Tree Savanna	791	0.51	403
Shrub Savanna	1,402	0.57	799
TOTAL	**15,825**	**--**	**6,531**

**The HEP Procedures were not utilized to calculate HSI values for cropland as no mitigation is proposed for this cover type.*

Table 3. Wetland Cover Types Identified within the Proposed Lake Ringgold Project Area.

Cover Type	Area (acres)	Average HSI Values	Habitat Units (HUs)
Emergent / Herbaceous Wetland	102	0.34	35
Forested Wetland (RW/BH)*	278	0.33	92
Shrub Wetland	38	0.43	16
TOTAL	**418**	**--**	**143**

**Forested Wetlands are a subgroup of the Riparian Woodland/Bottomland Hardwood cover type.*

Goals and Objectives

The purpose of this conceptual mitigation plan is to identify and describe the potential mitigation measures that could be utilized by the City of Wichita Falls to compensate for the unavoidable adverse impacts to aquatic and terrestrial resources related to the proposed Lake Ringgold project. Specific plan objectives are to mitigate, to the extent practicable, for unavoidable adverse impacts to forested wetlands, emergent wetlands, shrub wetlands, grassland / old fields, upland deciduous forests, riparian woodland / bottomland hardwoods, shrub and tree savannas, open water, and streams that would occur as a result of constructing the proposed Lake Ringgold project. Due to the size of the project, this conceptual mitigation proposal is multi-faceted and includes both on-site and near-site mitigation strategies. Currently, no approved stream or wetland compensatory mitigation banks are available with a service area that covers the proposed project site. As such, all proposed compensatory mitigation requirements would be accomplished through permittee-responsible mitigation provided by the City of Wichita Falls.

This conceptual mitigation plan utilizes a watershed approach and includes mitigation for uplands, wetlands, open waters, and streams within the Little Wichita River watershed (Figure 2), where the potential impacts would occur. Utilizing the watershed approach has long been encouraged by the state and federal resource agencies as the preferred method for providing compensatory mitigation.

Mitigation Site Selection

Recognizing the mandate to compensate for impacts as close to the impact site as practicable, the City's mitigation site selection strategy would prioritize site location as follows: (1) on-site, within and adjacent to the reservoir footprint, and (2) near-site, within the same watershed.

On-Site Mitigation

On-site mitigation efforts will be utilized to the extent practicable to offset impacts to both aquatic and terrestrial resources resulting from the construction of the proposed reservoir. Specific sites within the proposed reservoir footprint that could be utilized for emergent/herbaceous and shrub wetland mitigation efforts will be in areas that are less than or equal to three feet in depth (i.e., sites within the footprint of the reservoir with elevations that fall between 841 feet-msl. and 844 feet-msl.) where tributaries enter the reservoir into broad, flat areas. Typically, these areas are lumped into a single class of wetlands identified as littoral wetlands that develop in shallow portions of lakes, ponds, and reservoirs. These emergent and shrub wetlands are expected to develop within the littoral zone of the proposed reservoir and provide a functional wetland community which would offset the impacts to the existing emergent wetlands (35 HUs) and shrub wetlands (16 HUs) identified within the proposed reservoir site.

In addition to the development of littoral wetlands, the proposed reservoir would provide on-site compensatory mitigation for impacts to open waters (ponds, stock tanks, small lakes, etc.) within the proposed reservoir site. The reservoir will provide over 15,000 acres of open water, which would more than offset impacts to the existing 100 acres of ponds, stock tanks, etc.

Other potential on-site mitigation could be provided by lands currently owned, or lands purchased by the City in the future, that are adjacent to the proposed reservoir. Currently, the City owns approximately 525 acres that are located adjacent to the proposed reservoir site (Figure 3). These properties could provide compensatory mitigation for aquatic and terrestrial resources that could be impacted following impoundment of the reservoir. In addition, the NHD dataset indicates that approximately 10,800 linear feet of streams (Figure 3) are located on these properties that could be protected, enhanced, or restored to offset potential impacts to streams within the proposed reservoir site.

Near-Site Mitigation

To provide additional mitigation beyond on-site compensatory mitigation efforts, the City of Wichita Falls intends to utilize lands they currently own within the Little Wichita River watershed. The City currently owns approximately 4,621 acres near Lake Kickapoo (Figure 4) that are currently being utilized for agricultural purposes. Although studies have not been conducted on these properties to determine their existing habitat conditions, their current use for agricultural production has likely resulted in reduced habitat quality (i.e., lower HSI values). This provides the City with the opportunity to restore and/or enhance degraded wildlife habitat resulting in greater ecological uplift. Per the NHD dataset, approximately 87,400 linear feet of streams (Figure 4) are located on these properties that could be protected, enhanced, or restored to offset potential impacts to streams within the proposed reservoir site. An additional benefit of owning these properties is that it provides the opportunity for implementation of compensatory mitigation in advance of or concurrent with potential impacts at the proposed reservoir site.

Currently, no other near-site mitigation property has been purchased by the City. However, if additional mitigation land is needed, the City could purchase additional property within the Little Wichita River watershed that could be used for compensatory mitigation. During the process of identifying an appropriate near-site mitigation property, multiple landscape factors will be evaluated to determine the sites suitability to provide appropriate compensatory mitigation, including:

- Proximity of the mitigation site to the impact site. The goal will be to locate the mitigation site as near as possible to the impact site;
- Location of the mitigation site within the Little Wichita River watershed. The goal will be to identify a mitigation site encompassing all, or the upper-most portion, of a sub-watershed of the Little Wichita River to reduce the risk of potential upstream uses that would not be compatible with mitigation efforts;
- Overall size of the mitigation site. The goal will be to identify one large contiguous tract of property to avoid fragmentation of mitigation. This could include purchase of additional property adjacent to existing City-owned property at Lakes Kickapoo or Ringgold; and
- Existing land use and cover types of the mitigation site. The goal will be to identify a site with degraded habitat conditions that could be restored resulting in higher ecological uplift.

If no suitable sites are identified meeting the above criteria or additional mitigation areas are required beyond those identified within the Little Wichita River watershed, the City may consider mitigation areas within the adjoining Wichita River and Red River basins.

Mitigation Work Plan

The purpose of the mitigation work plan is to describe the type of work that would be conducted as part of the overall mitigation project. This mitigation work plan was developed with the intent of achieving ecological/functional uplift by improving aquatic and terrestrial habitat value for the many species of wildlife that are native to this area of Texas. The attainment of ecological uplift and improvement in habitat value for wildlife for wetland and terrestrial cover types will be evaluated utilizing the HEP procedures. The goal would be to offset impacts to each habitat type quantified in HUs, to the extent practicable. Mitigation for open waters would be based on mitigated acreage and stream mitigation would be based on mitigated stream length. Mitigation for open water, emergent wetlands, and shrub wetlands are expected to occur at the reservoir site following construction. It should be noted that mitigation for potential impacts to waters of the U.S. (i.e., aquatic resources regulated by the USACE under Section 404 of the Clean Water Act) will be determined by the USACE during the Section 404 permitting process. As such, mitigation requirements for these resources could change during that process.

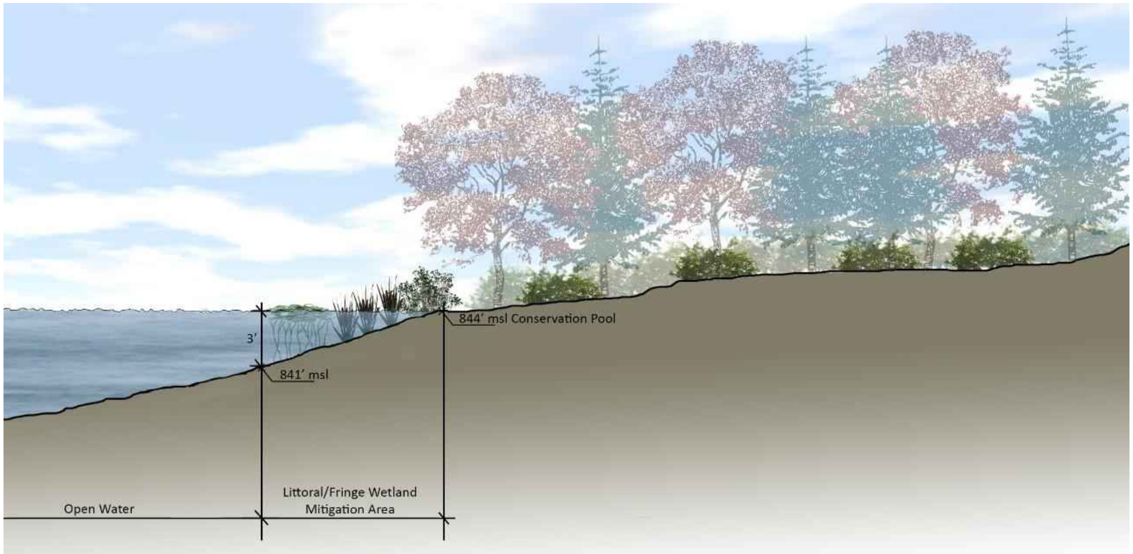
Timing of Mitigation Activities

When possible, the implementation of compensatory mitigation should be in advance of or concurrent with the impacts. Because the City already owns lands within the Little Wichita River watershed that are suitable for providing mitigation, they would be able to accomplish this goal. As part of this mitigation work plan, the City could also implement mitigation measures such as securing site protection instruments and removing cattle from proposed mitigation sites prior to the start of construction at the proposed reservoir site. Implementing such measures would result in immediate ecological uplift within the Little Wichita River watershed.

Littoral Wetlands

Littoral wetland areas at the proposed reservoir site would be in specified areas within the upper three feet of inundation (841 feet-msl-844 feet-msl) for the normal conservation pool. Due to the presence of existing emergent and shrub wetland vegetation and seed banks at the reservoir site, no plant list or planting plan has been developed. If fluctuating water levels or other causes prevent this expected wetland development, then actions would be taken to facilitate wetland plant establishment and development as part of the adaptive management plan. Graphic 1 shows the expected development of littoral wetlands at the reservoir site.

Graphic 1 Expected Littoral Wetland Development at Lake Ringgold



Restored Forested Wetland, Bottomland Hardwood, and Upland Deciduous Forest Cover Types

The goal for restored forested wetlands, bottomland hardwoods, and upland deciduous forest cover types would be to offset potential impacts (HUs), to the extent practicable, that could occur to these resources following construction of the proposed reservoir. This would be accomplished by planting tree species that are native to this area of Texas at a rate to achieve the highest HSI value for each of these cover types. HSI values are based on two components: the habitat characteristics that provide ideal conditions for an evaluation species and the habitat characteristics existing in the study area. These characteristics are described by a set of measurable habitat variables, such as the height and percent cover of various vegetation types, the distance to water or grain, the availability of perching or nesting sites, or the frequency of flooding. The set of habitat variables needed to determine HSI values are obtained from documented habitat suitability models for each evaluation species. These models describe the species' life requisites (i.e., its habitat requirements for food, cover, and reproduction), the relationship between the habitat variables' values and the suitability of the area to meet its life requisites. For example, within the restored upland deciduous forest sites, achieving a percent tree canopy closure of 50% that is comprised of 50% deciduous, hard mast producing trees increases the overall HSI score for this cover type. As such, the restored upland deciduous forest sites would be planted with the goal of attaining these percentages. A similar approach would be taken within the restored forested wetlands and bottomland hardwood restoration sites.

Tree Savanna, Shrub Savanna, and Shrubland Cover Types

Similar to the forested areas, the goal for restored shrub/tree savanna and shrubland cover types would be to offset potential impacts (HUs), to the extent practicable, that could occur to these resources following construction of the proposed reservoir. This would be accomplished by planting tree/shrub species that are native to this area of Texas at a rate to achieve the highest HSI value for each of these cover types. For example, in evaluating the HSI variables measured in the shrubland cover type, it appears that higher HSI values are attainable in shrublands with 20-35% shrub canopy cover with 50% of the shrubs being less than 4.9 ft. in height. As such, the restored shrubland sites would be planted with the goal of attaining these percentages. A similar approach would be taken within the tree and shrub savanna restoration sites.

Grassland / Old Field Cover Type

The goal for the restored grassland cover type would be to offset potential impacts (HUs), to the extent practicable, that could occur to this resource following construction of the proposed reservoir. This would be accomplished by planting grass and forb species that are native to this area of Texas at a rate to achieve the highest HSI value for this cover type. In evaluating the HSI variables measured in the grassland cover type, it appears that higher HSI values are attainable in grasslands with 90-100% herbaceous canopy cover of persistent grasses. As such, the restored grassland sites would be planted with the goal of attaining these percentages.

Stream Mitigation

To the extent practicable, mitigation for streams would be accomplished based on length. It is well recognized by state and federal resource agencies that stream mitigation is difficult. Both Regulatory Guidance Letter 02-2 (USACE, 2002) and the Final Mitigation Rule (See RGL 02-2, Section 5) recognize the difficulties associated with stream mitigation. This is because, unlike wetlands and other terrestrial habitats, streams cannot be created where the landscape does not afford a watershed to provide hydrology sufficient to support fluvial processes. For successful stream mitigation, compensatory mitigation provided through stream preservation, rehabilitation, or enhancement is generally recommended by USACE and USEPA, if practical. To the extent stream mitigation is available, or deemed feasible, a watershed approach would be undertaken for mitigation to offset impacts to streams within the Little Wichita River watershed.

To compensate for unavoidable impacts to streams, the City would utilize a multi-faceted stream mitigation approach. The approach would likely include: protection, restoration, and enhancement of existing streams on lands owned or purchased by the City near the proposed Ringgold Reservoir site (on-site); protection, restoration, and enhancement of streams on lands owned by the City near Lake Kickapoo (near-site); and protection, restoration, and enhancement of streams on additional lands purchased by the City, if necessary, within the Little Wichita River watershed (near-site).

Protection of the streams that would be utilized for mitigation would be provided by deed restrictions, conservation easements, or another acceptable site protection instrument. Stream enhancement activities would likely include invasive species management, establishing riparian buffers, removal of livestock, etc. Stream restoration activities would likely include restoring stream sinuosity to straightened channels, reconnecting streams to their floodplains, and establishing proper stream slope to stop or slow excessive aggradation and/or degradation.

Monitoring

Monitoring will be conducted for all proposed enhanced and restored mitigation areas to determine if they are on a trajectory to meet expected performance standards. The proposed performance standards for the mitigation sites will be developed after the final mitigation sites have been identified and baseline data have been collected. Monitoring reports will be prepared and sent to the TCEQ. If a site is not performing as expected, the problem will be identified (i.e., herbivory, invasive species, etc.) and corrective actions will be implemented and monitoring will continue until the mitigation areas are on target to meet the established performance standards.

Maintenance Plan

Proposed mitigation would be, to the extent practicable, planned and designed to become self-sustaining over time. However, it is anticipated that some active management and maintenance activities would need to occur to maintain the long-term viability and sustainability of the proposed mitigation project.

Following any necessary construction, the mitigation areas would be monitored to determine if corrective actions are needed to improve mitigation success. In addition to corrective actions, maintenance of the property would be conducted in support of the mitigation areas. Typical maintenance activities could include maintaining fence lines, access roads, protections of newly planted areas, and other activities deemed necessary to promote mitigation success.

Many of the maintenance activities would occur on an as needed and/or as identified basis. It is anticipated that more effort would be required at the mitigation sites during the early phases of the mitigation project for routine maintenance activities and that the effort would diminish over time. This effort would improve the likelihood of achieving a successful mitigation project.

Site Protection

As previously discussed, the mitigation areas utilized by the City to offset potential impacts to aquatic and terrestrial resources would be protected by deed restriction, conservation easement, or another appropriate and acceptable site protection instrument. The site protection instrument would protect the mitigation areas in perpetuity and specifically prohibit incompatible uses that might otherwise jeopardize the objectives of the compensatory mitigation project. Once finalized, a copy of the approved site protection instrument would be provided to TCEQ and the USACE.

Long-Term Management

All components of the mitigation project would be managed long-term as compensatory mitigation areas associated with potential impacts to aquatic and terrestrial resources resulting from construction of the Lake Ringgold project. The long-term management of the mitigation site would be provided by the City until it is determined that the mitigation project is on a trajectory to meet mitigation requirements. Once it is determined that the mitigation project is fulfilling the compensatory mitigation requirements, and the mitigation site is self-sustaining, the City may seek to convey the mitigation site and long-term management to a public agency (i.e., state or federal resource agency). The public agency would have a background in the field of natural resources management and possess the expertise and ability to manage aquatic and terrestrial resources.

Adaptive Management Plan

An adaptive management plan for a compensatory mitigation project is generally described as a management strategy to address unforeseen changes in site conditions or other mitigation components of the mitigation project. Adaptive management plans facilitate the decision-making process for revising mitigation plans and instituting measures to address both foreseeable and unforeseeable circumstances that adversely affect mitigation success. For the current project, the indicator of the need to develop an adaptive management plan would come during monitoring of the mitigation sites. If during monitoring events it is noticed that the mitigation sites are not on a trajectory to meet mitigation requirements, consultation with the TCEQ and USACE would be initiated regarding the need for adaptive management.

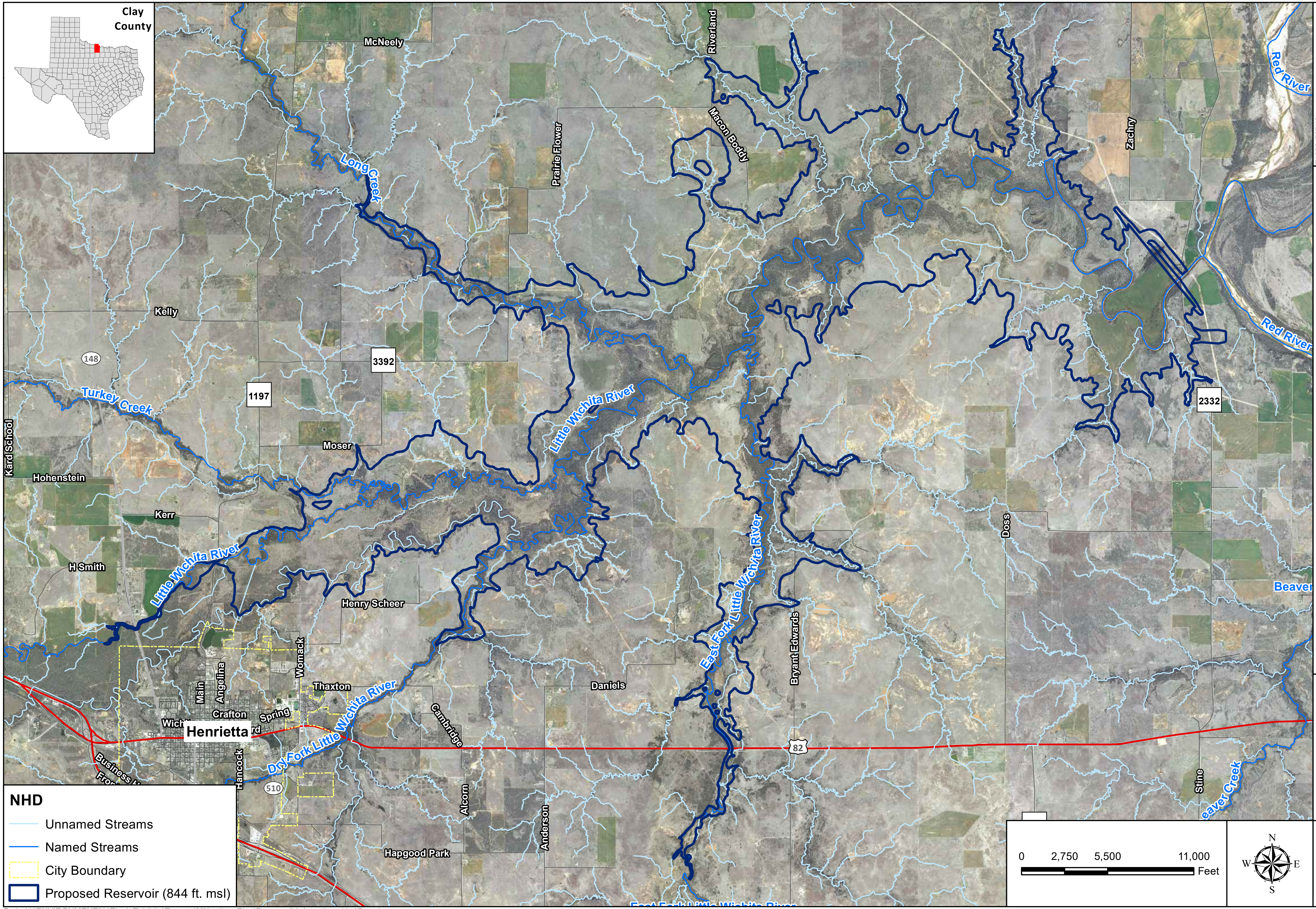
To meet the purpose of the adaptive management plan, the City proposes to implement a method known as the "Plan-Do-Check-Act" cycle. This model was developed for use when implementing change, developing a new product, or starting a new improvement project and it acts as a model for continuous improvement through repetition. Incorporating this model into the adaptive management plan for this mitigation project will increase the likelihood of achieving overall mitigation success.

Financial Assurances

Wichita Falls is a municipality and political subdivision of the State of Texas. The City is committed to providing funding necessary to satisfy compensatory mitigation requirements associated with the Lake Ringgold project.

Conclusion

As proposed, this conceptual mitigation plan would offset potential impacts to aquatic and terrestrial habitats associated with the development of the proposed Lake Ringgold project. The plan is multi-faceted and includes both on-site and near-site mitigation measures located within the Little Wichita River watershed. By utilizing the watershed approach, the ecological uplift expected from the mitigation sites proposed in this Conceptual Mitigation Plan would occur within the same watershed (Little Wichita River) as the potential impacts. In addition, because the City already owns large tracts of land around the proposed Lake Ringgold site and Lake Kickapoo, implementation of the mitigation plan could occur prior to or concurrent with project impacts. As part of this plan, the City is also committing to provide short and long-term management, monitoring, and providing site protection for the mitigation site(s).



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DATE CREATED	2/24/2017
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas North Central
FILE NAME	1_Location_11x17
PREPARED BY	HHM

CITY OF WICHITA FALLS

Proposed Lake Ringgold

PROJECT LOCATION MAP

FREESE NICHOLS

FREESE AND NICHOLS
4055 International Plaza Suite 200
Fort Worth, Texas 76109-4895
(817) 735-7300

1

FIGURE

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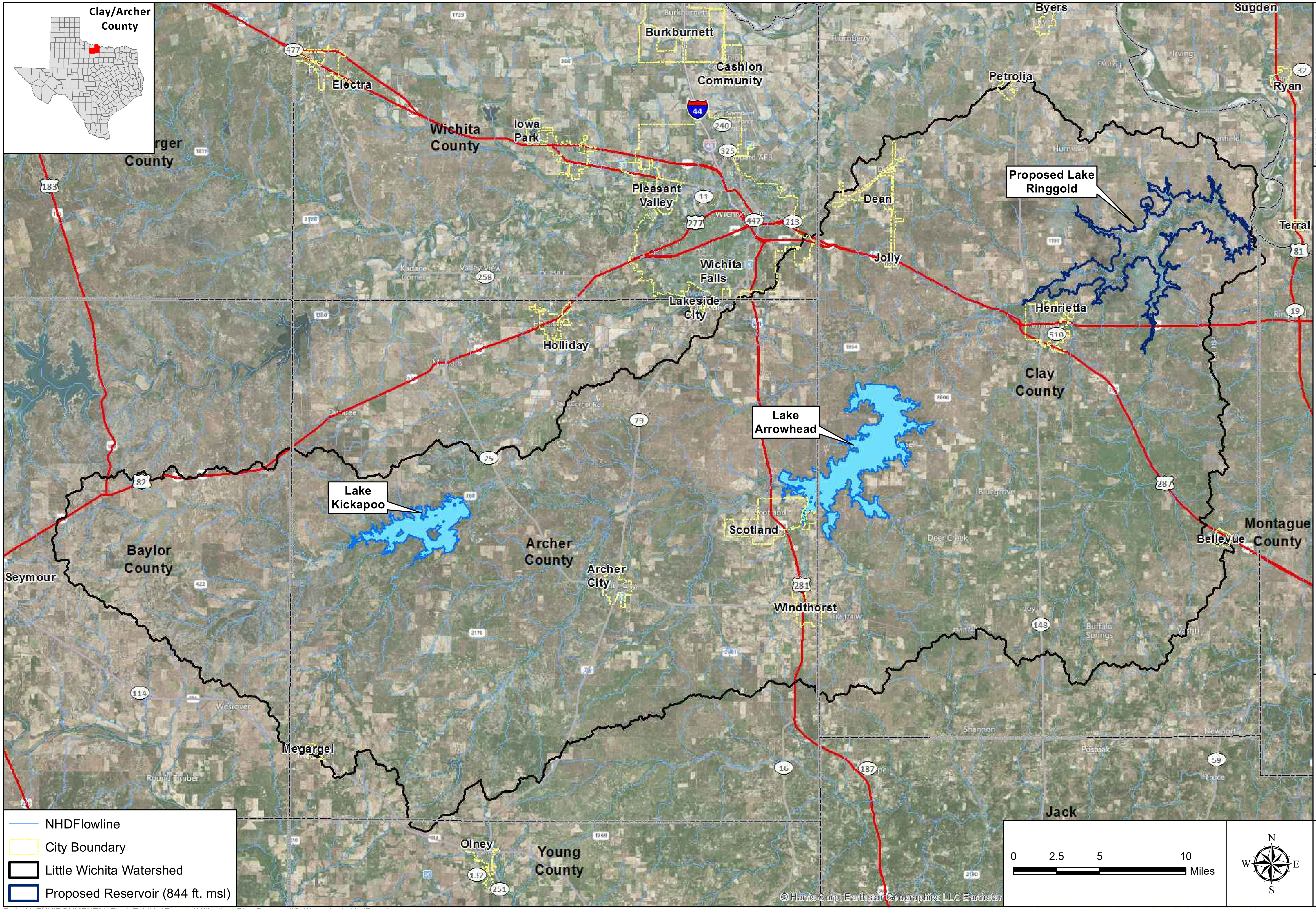

FN PROJECT NO. WCH15215
DATE CREATED 2/27/2017
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central
FILE NAME 2_Watershed_11x17
PREPARED BY HHM

CITY OF WICHITA FALLS

Proposed Lake Ringgold

LITTLE WICHITA RIVER WATERSHED

FREESE NICHOLS

FREESE AND NICHOLS
4055 International Plaza Suite 200
Fort Worth, Texas 76109-4895
(817) 735-7300

FIGURE 2

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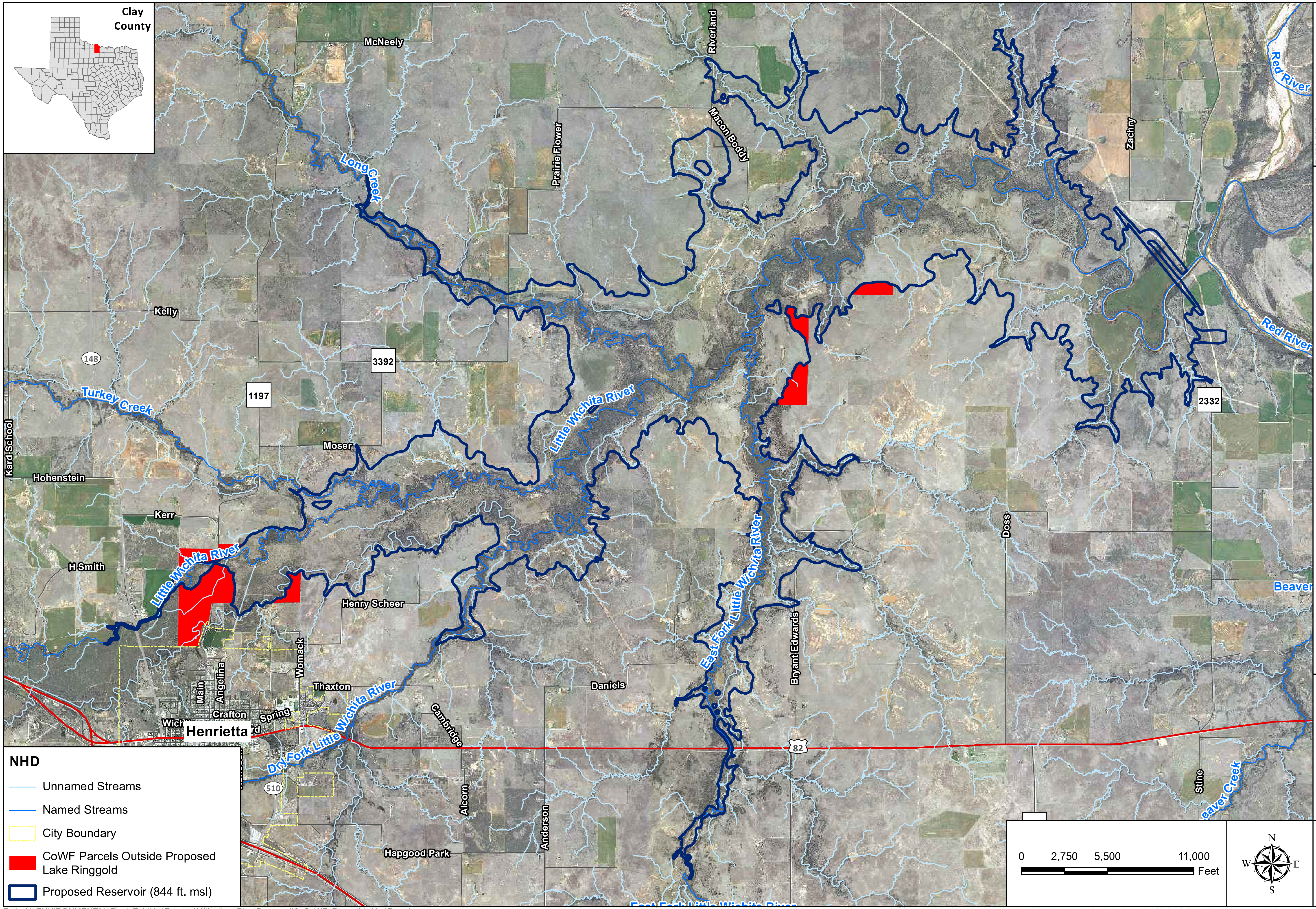


FN PROJECT NO. WCH15215
DATE CREATED 2/27/2017
DATUM & COORDINATE SYSTEM NAD83 State Plane (feet) Texas North Central
FILE NAME 3_CoWF_Ringgold_11x17
PREPARED BY HHM

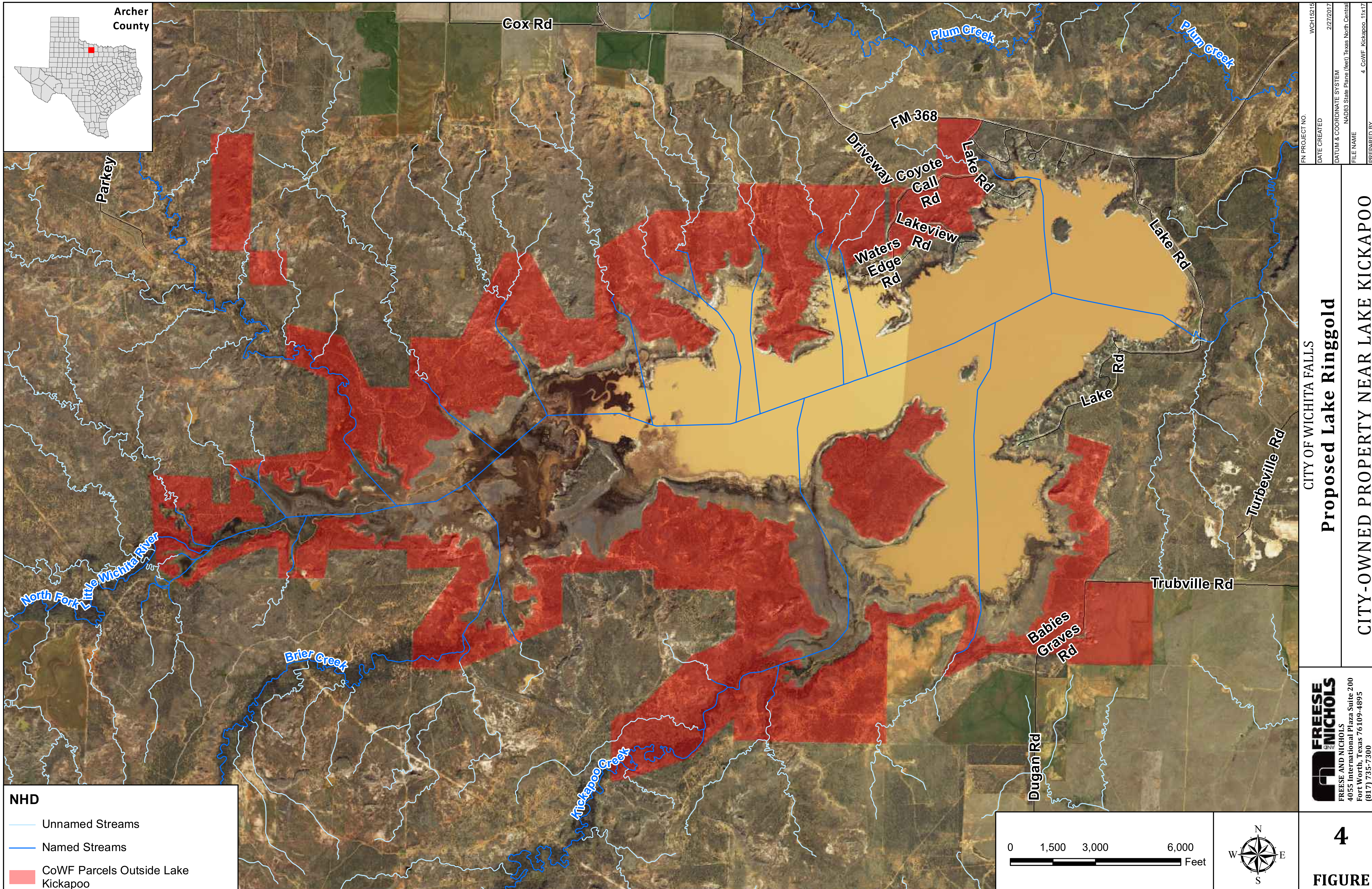
CITY OF WICHITA FALLS
Proposed Lake Ringgold

CITY-OWNED PROPERTY NEAR LAKE RINGGOLD

FREESE NICHOLS
FREESE AND NICHOLS
4055 International Plaza Suite 200
Fort Worth, Texas 76109-4895
(817) 735-7300

3
FIGURE

Path: H:\ENVIRONMENTAL\Final_Exhibits\Reports\Mitigation_Plan\Proposed\3_CoWF_Ringgold_11x17.mxd



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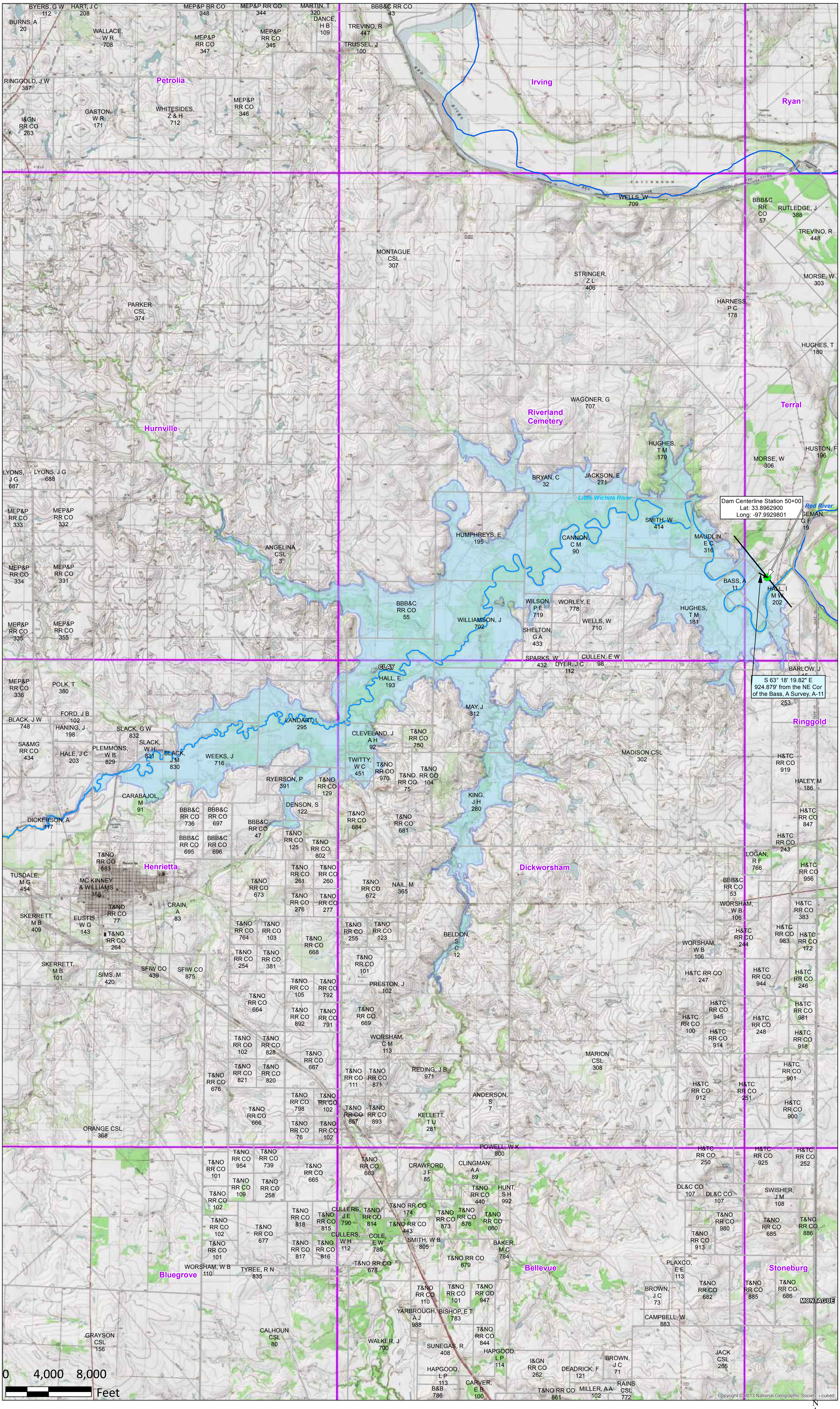
APPENDIX L

USGS TOPOGRAPHIC MAP



Legend

- Original Land Survey
- USGS 24K Grid
- Counties
- Bearing
- Dam_Centerline
- Little Wichita River
- Red River
- Lake Ringgold

Proposed Lake Ringgold
USGS Topographic Map

Proposed Lake Ringgold Water Right Application
City of Wichita Falls
1300 7th St., Wichita Falls, Texas 76307
Clay, County, Texas
USGS Topographic Maps
Riverland Cemetery, Hurnville, Henrietta
Dickworsham and Ringgold

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Legend

- Original Land Survey
- USGS 24K Grid
- Counties
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- Dam_Centerline
- Little Wichita River
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Proposed Lake Ringgold
USGS Topographic Map

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Exhibit B

Authority to File Application

Resolution No. _<u>72-2017</u>_

Resolution authorizing the City Manager to file and prosecute an application with the Texas Commission on Environmental Quality to construct Lake Ringgold Reservoir

WHEREAS, the City of Wichita Falls, Texas, (the "City") provides water to residential, commercial, industrial, and public users, as well as retail and wholesale customers in its service area, including parts of Wichita, Archer, and Clay Counties; and,

WHEREAS, the City has a statutory obligation to plan and secure adequate water supplies for existing and future needs; and,

WHEREAS, pursuant to the approved 2016 Regional B Water Plan (the "Plan"), the City is projected to need additional water supplies by 2020; and,

WHEREAS, the City is implementing water supply strategies to meet both its short-term and long-term water supply needs; and,

WHEREAS, Lake Ringgold Reservoir (the "Reservoir") is identified in the Plan as a water management strategy and is recommended for implementation to meet the City's long-term projected needs; and,

WHEREAS, the Reservoir will provide additional supplies to meet the projected demands of the City; and,

WHEREAS, the City has prepared an application to appropriate state water pursuant to Chapter 11 of the Texas Water Code (the "Application") to authorize the construction of the Reservoir.

NOW THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF WICHITA FALLS THAT:

1. The City Manager is hereby authorized on behalf of the City Council to execute the Application and any other applications as are necessary to be made to the Texas Commission on Environmental Quality (the "Commission") for authorization to capture, store, and divert water from the proposed Lake Ringgold Reservoir for use within the Red River Basin to meet the future water supply needs of the City and the City's residents; and

2. The City Manager is hereby authorized and directed on behalf of the City Council to file the Application and to appear and arrange for the appearances of persons representing the City at the hearings and other proceedings on the Application before the Commission, and otherwise direct prosecution of the Application on behalf of the City Council.

PASSED AND APPROVED this 16th day of May, 2017.

MAYOR

ATTEST:

City Clerk

Exhibit C

Water Conservation and Drought Contingency Plan

Ordinance No. 50-2015

Ordinance amending Division 6 of Article II of Chapter 106 of the Code of Ordinances of the City Of Wichita Falls, to establish modified water conservation drought contingency rules; providing for a penalty not to exceed $2,000 per violation; providing for codification

WHEREAS, the Water Resources Commission and City Staff reviewed the City's current water conservation ordinance to determine areas for modification to increase water conservation; and,

WHEREAS, it was determined that certain sections of the ordinance could be amended to result in increased water conservation; and,

WHEREAS, the City Council finds the attached Revised Water Conservation Ordinance complies with all state laws and regulations relating thereto, including, but not limited to, Texas Water Code §§ 11.1271 & 11.127 and 30 TAC §§ 288.2 & 288.20.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF WICHITA FALLS, TEXAS, THAT:

The City of Wichita Falls hereby adopts the attached Revised Water Conservation Ordinance for the City of Wichita Falls.

PASSED AND APPROVED this the 20th day of October, 2015.

Glenn Barham

MAYOR

ATTEST:

Tracy Brown

City Clerk

DIVISION 6. WATER CONSERVATION / DROUGHT CONTINGENCY

Sec. 106-185. Definitions.

Unless otherwise expressly stated or the context clearly indicates a different intention, the following terms shall, for the purpose of this article, have the meanings indicated in this section:

Automatic Sprinkler System -- a system of irrigation components made up of permanently installed underground PVC lines and spray irrigation devices that are controlled from an automatic irrigation controller.

Auxiliary Water: water from a source other than the City of Wichita Falls water supply.

Bucket: a deep, cylindrical container holding five (5) gallons or less, designed to be used by one person.

Car Wash – a place or business equipped for washing cars, trucks, motorbikes, boats, airplanes, other motor vehicles and trailers.

Drip Irrigation -- a method of irrigation that applies water in a dropwise fashion directly to the soil beneath rather than projecting the water in a stream away from its orifice. To be classified in this category, the maximum allowable flow is 6 gallons per hour per emitter.

Drought: for this division “drought” is not intended to be limited to any meteorological definition of the term. "Drought" is intended to have broad meaning and refers to any condition, whether manmade or natural, where the available water supply or resources are not meeting the water demand, or if the water supply or resources are being depleted at a faster rate than they are being replenished.

Essential Water Use: water that is required by Federal, State or Local regulation and/or is attributed to the health and safety of the citizens of Wichita Falls.

Fleet – A group of commercial motor vehicles owned by a single entity that totals more than 5 vehicles.

Foundation Watering: the application of water using a hand-held hose, soaker hose or drip irrigation system placed within 24 inches of the foundation, which does not produce a spray above ground or result in water run-off.

Graywater: wastewater from showers, bathtubs, hand washing lavatories, sinks that are not used for the preparation/disposal of food or hazardous/toxic ingredients, and clothes-washing machines. It <u>does not</u> include wastewater from washing of material, including diapers, soiled with human excreta or wastewater that has come into contact with toilet waste.

Hose-end sprinkler system -- a device on the end of a garden hose that can be set in place and can periodically be moved from one location to another.

Impervious surface: any structure or any street, driveway, sidewalk, patio or other surface area covered with asphalt, concrete, brick, paving, tile or other material preventing water from penetrating the ground.

Indoor Pool – pool located entirely within a fully enclosed, climate controlled structure.

MGD: Million gallons per day

Non-Essential Water Use: water use that does not directly impact the health or safety of the citizens of Wichita Falls, or are a requirement of a Federal, State or Local regulation.

Non-Potable Water: water that is not intended or suitable for drinking and has not been approved for human consumption.

Owner/Operator of a pool – Fee title holder of the property upon which the pool is located, and/or business manager, complex manager, property owners, association manager, rental agent or other individual who is in charge of the day to day operation or maintenance of the property.

Positive Shut-Off: a valve or nozzle that is held in a closed position by system pressure until overridden by an outside force.

Potable Water: water that is suitable for drinking by the public.

Rain Water Harvesting: the practice of capturing, infiltrating, or utilizing rainfall from roofs, constructed catchment surfaces, driveways, sidewalks, parking lots, and streets.

Residential Pool – A pool that is located on private property under the control of the property owner or the owner's tenant and that is intended for use by not more than two residential families and their guests. It includes a pool serving only a single-family home or duplex.

Single – Pass – A cooling system that removes heat by transferring it to a supply of clean water, once, and releasing it down the drain.

Soaker hose -- an irrigation device made of permeable rubber hose that allows water to be applied slowly and directly to the soil without being sprayed up into the air. Soaker hoses fall into the drip irrigation category. A soaker hose will not spray water regardless of its orientation.

Spa and/or Hot-Tub--a structure that is intended to be filled with water that circulates through an on-site filtration system and is not intended to be drained or refilled after each use.

Spray Irrigate or *Spray Irrigation* -- a category of irrigation method that utilizes devices that spray water away from the device orifice(s). These include, but are not limited to, pop-up sprays, rotors, oscillating sprinklers, and impact sprinklers. A hand held hose is not Spray Irrigation.

Vehicle – A motor vehicle, car, truck, motorcycle, bicycle, boat, trailer, or other conveyance.

Water Well: water that has been, or is, obtained from the ground by digging, boring, or drilling to access an underground aquifer.

Sec. 106-186. Water shortage; authority of department.

(a) *Water conservation measures effective at all times*. It shall be unlawful for any person, firm, corporation or other entity, at any time of the year, to:

(1) Irrigation:
  a) run outside spray-type irrigation on any day of the week between 10:00 a.m. and 7:00 p.m. unless one is using a hand-held hose that is equipped with a positive shut-off nozzle, soaker hose, bucket, watering can, bubbler or drip irrigation system,
  b) fail to repair a controllable leak, including but not limited to a broken sprinkler head, a broken pipe or a leaking valve,
  c) operate an irrigation system with a broken or missing head, or a head that is out of adjustment and the arc of the spray head is over a street, parking area, or other impervious surface,
  d) allow water flow during irrigation that runs, flows, or streams in a way that extends a distance of 50 feet or greater from the area being irrigated,
  e) operate a soaker hose, bubbler or drip irrigation system in a manner that causes the delivery of more water than the hose, bubbler, or system was intended by the manufacturer to deliver, or that allows water to run for a distance of 5 feet or greater from the area being irrigated.

(2) Car Washing
  a) wash a vehicle at any location other than a commercial car wash, car dealership, detail shop or automotive shop unless the hose is equipped with a positive shut-off nozzle that stops the flow of water through the hose when released by the operator,
  b) allow a customer to use a nozzle at a commercial car wash, car dealership, detail shop or automotive shop that discharges more than 3.0 gallons per minute.

(3) Restaurants/Bars/Clubs/School Cafeterias
  a) provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.
  b) use a pre-rinse nozzle that discharges more than 1.6 gallons per minute.

c) use a hand-held pre-rinse, or rinsing nozzle without a positive shut-off.

(4) Ice Machines
a) install new ice machines that are single-pass, water cooled.

(5) Hotels/Motels/Short-Term Lodging
a) Owners or operators of a hotel, motel short term rental or other establishment that offers or provides lodging or rental accommodations for compensation, to fail to offer a towel and linen reuse water conservation option to its lodgers, renters, or customers, and maintain in each applicable guest room, suite, or property, informational signage to communicate information relating to this requirement and to offer the opportunity for guest participation.

(b) Discretionary drought restrictions. The Director of Public Works may declare any stage of drought restrictions described in this ordinance to be effective if:

(1) the system demand exceeds 90% design treatment capacity for three or more consecutive days,

(2) the water supply system is unable to deliver water due to mechanical failure or damage of major water system components which are expected to require more than 72 hours to repair, or

(3) the water system is contaminated either accidentally or intentionally, or the water system fails from acts of nature or man.

The establishment of a discretionary drought restriction will be effective when publicized in the media and the filing of a written declaration with the City Manager and City Clerk. Upon any declaration of such drought stage, it shall be unlawful for a person to fail to comply with the restrictions applicable to that stage. The Director of Public Works may terminate any of the aforementioned discretionary drought restrictions by filing a written notice of termination with the City Manager and City Clerk.

(c) *Stage 1 - Drought Watch*

(1) The Director of Public Works shall declare a Stage 1 Drought Watch when the levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 65 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of water being used by 5%:
a) The City Council and other City Departments will be notified of the impending problem and the proposed immediate and future actions.
b) The City shall initiate an education program through all available media to:
i) Alert the public to the depletion of the reservoirs; current rate of withdrawals and the effect of such withdrawals; current treatment rates;

current meteorological conditions; and the long-range weather forecast from the National Weather Service.

ii) Alert the public to the drought management program, the various stages and measures, and the possibility of implementation.

iii) Keep a constant flow of information to the public to condition them for more stringent measures.

c) The Public Works Department will coordinate with other departments on the structure of a program to implement water restrictions.

d) The Public Works Department will conduct training necessary to implement the water restriction program.

e) The Public Works Department will prepare all administrative processes (forms, affidavits, maps, offices, etc.) for the restriction program.

(3) Irrigation:

a) It shall be unlawful to:

i) run outside irrigation systems (including sprinklers, automatic sprinkler systems and unattended hoses) except for two days a week, based on the following physical address schedule where the sprinkler system is located:

Addresses ending in an Even Number = Mondays and Thursdays
Addresses ending in an Odd Number = Tuesdays and Friday

ii) utilize spray irrigation between the hours of 10:00 a.m. to 7:00 p.m., unless one is using a hand-held hose that is equipped with a positive shut-off nozzle, soaker hose, bucket, watering can, bubbler or drip irrigation system,

iii) fail to repair a controllable leak, including but not limited to a broken sprinkler head, a broken pipe or a leaking valve,

iv) operate an irrigation system with a broken or missing head, or a head that is out of adjustment and the arc of the spray head is over a street, parking area, or other impervious surface,

v) allow water flow during irrigation that runs, flows, or streams in a way that extends for a distance of 50 feet or greater from the area being irrigated,

vi) operate a soaker hose, bubbler or drip irrigation system in a manner that causes the delivery of more water than the hose, bubbler, or system was intended by the manufacturer to deliver, or that allows water to run for a distance of 5 feet or greater from the area being irrigated.

b) Landscape watering is permitted any day at any time with a hand-held hose that is equipped with a positive shut-off nozzle, soaker hose, bucket (five gallons or less), watering can, bubbler or drip irrigation system.

c) On days other than the days of the week established in (c)(3)a)i), testing and troubleshooting of irrigation systems that involve the release of water is permissible any time, including between the hours of 10:00 a.m. to 7:00 p.m., as long as a licensed plumber or irrigator is present on location during testing (and available to the ticket writer). Testing and troubleshooting of irrigation systems by other than a licensed plumber or irrigator that involves the release of water is otherwise permissible only on the days of the week established in (c)(3)a)i) and time of day established in (c)(3)c)ii).

d) *New Landscape Waiver.* A waiver of this subsection may be granted for the irrigation of new landscaping plants whereby watering would be permitted to maintain adequate growth until the plants are established but not to exceed a 30-day time period. Any person wishing such a waiver must make application to the City Public Works Department and pay a nonrefundable fee as set by separate ordinance. The water rate during this stage shall be the same as the normal rate for that customer for all consumption over 10 CCF as registered by residential meters and all consumption as registered by Irrigation meters or commercial meters.

e) *Public and Private Golf Courses.*

i) <u>Greens:</u> Golf Courses may utilize Spray Irrigation on greens at any time for the purpose of cooling golf course greens when warranted by weather conditions and only with run cycles of less than 5 minutes every 60 minutes. Golf course greens are exempt from the Spray Irrigation days established in (c)(3)a)i), and greens may be Spray Irrigated any day of the week, but will be subject to the prohibition of spray irrigation during the daylight hours between 10:00 a.m. and 7:00 p.m.

ii) <u>All other Golf Course Features:</u> It shall be unlawful for golf courses to Spray Irrigate Tee-Boxes, Fairways, Roughs, Trees, Shrubs, etc., except on the day of the week permitted for the area as established in (c)(3)a)i), and will be subject to the prohibition of spray irrigation during the daylight hours between 10:00 a.m. and 7:00 p.m.

f) Nursery Plant Stock is exempt from the irrigation and landscape watering restrictions of this subsection.

(4) Car Washing:

a) It shall be unlawful:

i) to wash a vehicle at your residence or place of business, unless the hose is equipped with a positive shut-off nozzle that stops the flow of water through the hose when released by the operator.

ii) for the owner or operator of a commercial business to allow a customer to use a nozzle at a commercial car wash, car dealership, detail shop or automotive shop that discharges more than 3.0 gallons per minute.

(5) Restaurants/Bars/Clubs/School Cafeterias.

a) It shall be unlawful to:

i) provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.

ii) use a pre-rinse nozzle that discharges more than 1.6 gallons per minute.

iii) use a hand-held pre-rinse, or rinsing nozzle without a positive shut-off.

(6) Ice Machines

a) It shall be unlawful, for any person, firm, corporation or other entity, to install new ice machines that are single-pass, water cooled.

(7) Hotels/Motels/Short-Term Lodging.

a) It shall be unlawful for owners or operators of a hotel, motel, short-term rental or other establishment that offers or provides lodging or rental accommodations for compensation, to fail to offer a towel and linen reuse water conservation option to its lodgers, renters, or customers, and maintain in each applicable guest room, suite, or property, informational signage to communicate information relating to this requirement, and to offer the opportunity for guest participation.

(d) *Stage 2 - Drought Warning.*

(1) The Director of Public Works shall declare a Stage 2 Drought Warning when levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 50 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of water being used by 15%:

a) Form a Drought Emergency Task Force for guidance through the remainder of the drought and to interface with the public.

b) Suspend all non-essential operational use of water by City of Wichita Falls, such as flushing water mains, street sweeping, water jet cleaning of sanitary sewer mains, fire fighter training, etc.), except where such use of water is critical to the health and safety of the citizens.

c) Notify all wholesale (raw and treated) customers of the situation and inform them of their specific mandatory reduction goals in accordance with Texas Water Code § 11.039.

(3) Irrigation:

a) It shall be unlawful to:

i) run outside irrigation systems (including sprinklers, automatic sprinkler systems and unattended hoses) except on the day of the week based on the following physical address schedule where the sprinkler system is located:
Addresses ending in 0 or 1 = Monday
Addresses ending in 2 or 3 = Tuesday
Addresses ending in 4 or 5 = Wednesday
Addresses ending in 6 or 7 = Thursday
Addresses ending in 8 or 9 = Friday
Saturday and Sunday irrigation is prohibited.

ii) utilize spray irrigation between the hours of 10:00 a.m. and 7:00 p.m., unless one is using a hand-held hose that is equipped with a positive shut-off nozzle, soaker hose, bucket, watering can, bubbler or drip irrigation system,

iii) fail to repair a controllable leak, including but not limited to a broken sprinkler head, a broken pipe or a leaking valve,

iv) operate an irrigation system with a broken or missing head, or a head that is out of adjustment and the arc of the spray head is over a street, parking area, or other impervious surface,
v) allow water flow during irrigation that runs, flows, or streams in a way that extends for a distance of 50 feet or greater from the area being irrigated,
vi) operate a soaker hose, bubbler or drip irrigation system in a manner that causes the delivery of more water than the hose, bubbler, or system was intended by the manufacturer to deliver; or that allows water to run for a distance of 5 feet or greater from the area being irrigated.

b) Landscape watering is permitted any day at any time with a hand-held hose that is equipped with a positive shut-off nozzle, soaker hose, bucket (five gallons or less), watering can, bubbler or drip irrigation system.

c) On days other than the day of the week established in (d)(3)a)i), testing and troubleshooting of irrigation systems that involve the release of water is permissible any time, including between the hours of 10:00 a.m. to 7:00 p.m., as long as a licensed plumber or irrigator is present on location during testing (and available on site to the ticket writer). Testing and troubleshooting of irrigation systems by other than a licensed plumber or irrigator that involves the release of water is otherwise permissible only on the day of week established in (d)(3)a.i. and time of day established in (d)(3)a)ii).

d) *New Landscape Waiver.* A waiver of this subsection may be granted for the irrigation of new landscaping plants whereby watering would be permitted to maintain adequate growth until the plants are established but not to exceed a 30-day time period. Any person wishing such a waiver must make application to the City Public Works Department and pay a ~~$50.00~~ nonrefundable fee as set by separate ordinance. The applicant must agree to pay a water rate that is <u>three (3) times</u> the normal rate for that customer for all consumption over 10 CCF as registered by residential meters and all consumption as registered by Irrigation meters or commercial meters.

e) *Public and Private Golf Courses.*
i) <u>Greens:</u> Golf Courses may utilize Spray Irrigation on greens at any time for the purpose of cooling golf course greens when warranted by weather conditions and only with run cycles of less than 5 minutes every 60 minutes. Golf course greens are exempt from the Spray Irrigation days established in (d)(3)a.i., and greens may be Spray Irrigated any day of the week, but will be subject to the prohibition of spray irrigation during the daylight hours between 11a.m. & 6 p.m.
ii) <u>Tee Boxes and Fairways:</u> It shall be unlawful for golf courses to Spray Irrigate Tee-Boxes and Fairways, except on the day of the week permitted for the area as established in (d)(3)a)i) and will be subject to the prohibition of spray irrigation during the daylight hours between 10:00 a.m. and 7:00 p.m.

iii) <u>All other Golf Course Features:</u> It shall be unlawful for golf courses to Spray Irrigate any other landscape features, such as roughs, trees, shrubs, etc.

f) Nursery plant stock is exempt from the irrigation and landscape watering restrictions of this subsection.

(4) Car Washing:

a) It shall be unlawful:

i) to wash a vehicle at a residence or place of business, unless the hose is equipped with a positive shut-off nozzle that stops the flow of water through the hose when released by the operator

ii) for the owner or operator of a commercial business to allow a customer to use a nozzle at a commercial car wash, car dealership, detail shop or automotive shop that discharges more than 3.0 gallons per minute.

(5) Restaurants/Bars/Clubs/School Cafeterias.

a) It shall be unlawful to:

i) provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.

ii) use a pre-rinse nozzle that discharges more than 1.6 gallons per minute.

iii) use a hand-held pre-rinse, or rinsing nozzle without a positive shut-off.

(6) Ice Machines

a) It shall be unlawful, for any person, firm, corporation or other entity, to install new ice machines that are single-pass, water cooled.

(7) Hotels/Motels/Short-Term Lodging.

a) It shall be unlawful for owners or operators of a hotel, motel, short-term rental or other establishment that offers or provides lodging or rental accommodations for compensation, to fail to offer a towel and linen reuse water conservation option to its lodgers, renters, or customers, and maintain in each applicable guest room, suite, or property, informational signage to communicate information relating to this requirement, and to offer the opportunity for guest participation.

(8) Washing sidewalks, driveways, buildings or concrete slabs.

a) It shall be unlawful to wash sidewalks, driveways, buildings or concrete slabs unless an immediate health or safety risk is present.

(9) During a Stage 2 Drought Warning, the following surcharges will be applied to all applicable accounts:

a) <u>For Residential Water Meters;</u>
$0.50 per hundred cubic feet (CCF) between 10 CCF and 20 CCF,
$1.00 per CCF between 20 CCF and 40 CCF, and

$2.00 per CCF over 40 CCF.

b) For Irrigation Water Meters;
$0.50 per CCF between 0 CCF and 10 CCF,
$1.00 per CCF between 10 CCF and 20 CCF,
$2.00 per CCF between 20 CCF and 40 CCF, and
$4.00 for each CCF over 40 CCF.

(e) *Stage 3 – Drought Emergency*:

(1) The Director of Public Works shall declare a Stage 3 Drought Emergency when the levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 40 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of water being used by 35%:

a) monitor all Fire Hydrant Meters that are for contractor use, to determine what conservation can be achieved through this type of water usage,
b) notify all wholesale (raw & treated) water customers of the situation and inform them of their specific mandatory reduction goals in accordance with Texas Water Code § 11.039, and
c) begin establishing a program for a Drought Disaster, which will allow restriction on the essential uses of water and prepare for implementation.

(3) Irrigation. It shall be unlawful to:

i) run outside irrigation systems (including sprinklers, automatic sprinkler systems and unattended hoses) except on the day of the week established in (d)(3)a)i
ii) utilize spray irrigation during the day specified in (d)(~~4~~3)a)i), except for the following hours:
    2:00 a.m. to 7:00 a.m. for Automatic Sprinkler Systems
    7:00 p.m. to 11:00 p.m. for Hose-End Sprinkler Systems
iii) fail to repair a controllable leak, including but not limited to a broken sprinkler head, a broken pipe or a leaking valve
iv) operate an irrigation system with a broken or missing head, or a head that is out of adjustment and the arc of the spray head is over a street, parking area, or other impervious surface,
v) allow water flow during irrigation that runs, flows, or streams in a way that extends for a distance of 50 feet or greater from the area being irrigated,
vi) operate a soaker hose, bubbler or drip irrigation system in a manner that causes the delivery of more water than the hose, bubbler, or system was intended by the manufacturer to deliver, or that allows water to run for a distance of 5 feet or greater from the area being irrigated.

b) New Landscape Waiver: The Public Works Department will not issue any waivers during a Stage 3 Drought Emergency.
c) *Public and Private Golf Courses.*

i) Greens: Golf Courses may utilize Spray Irrigation on greens at any time for the purpose of cooling golf course greens when warranted by weather conditions and only with run cycles of less than 5 minutes every 60 minutes. Golf course greens are exempt from the Spray Irrigation times, and greens may be Spray Irrigated any day of the week, but will continue to be subject to the prohibition of spray irrigation during the daylight hours between 10:00 a.m. and 7:00 p.m..

ii) Tee Boxes: It shall be unlawful for golf courses to Spray Irrigate Tee-Boxes, except on the day of the week established in (d)(3)a)i) and will continue to be subject to the prohibition of spray irrigation during the daylight hours between 10:00 a.m. and 7:00 p.m.

iii) All other Golf Course Features: It shall be unlawful for golf courses to Spray Irrigate any other landscape features, such as fairways, roughs, trees, shrubs, etc.

d) Nursery Plant Stock is exempt from the irrigation and landscape watering restrictions of this subsection.

(4) Car Washing ~~:~~

a) It shall be unlawful:

i) to wash a vehicle at a residence or place of business, unless the hose is equipped with a positive shut-off nozzle that stops the flow of water through the hose when released by the operator.

ii) for the owner or operator of a commercial car wash, detail shop or automotive shop to utilize Potable Water for its operations on the day of the week that coincides with the day of the week established in (d)(3)a)i), that the car wash was allowed to irrigate.

iii) for the owner or operator of a commercial business to allow a customer to use a nozzle at a commercial car wash, car dealership, detail shop or automotive shop that discharges more than 3.0 gallons per minute.

iv) for a car wash to wash any of its bays with water, except on Sunday.

(5) Car Dealers/Fleets.

a) It shall be unlawful:

i) for a car dealer or an entity that maintains a fleet of motor vehicles to wash its inventory of cars on any day other than the day the property is authorized to spray irrigate in accordance with the days established in (d)(3)a)i).

ii) to wash Fleets at any location used for residential purposes.

b) It is an affirmative defense to prosecution that if a car dealer or car rental is preparing a car for pickup, it washed that vehicle (and only that vehicle) on the day of pick up by the customer. Otherwise, all vehicles are subject to (e)(5)a)i) above.

c) The washing of any vehicle in a fleet may take place only at a commercial car wash or at a location owned by the fleet’s owner and that is used solely for commercial uses.

(6) Restaurants/Bars/Clubs/School Cafeterias:

a) It shall be unlawful:
   i) to provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.
   ii) to use a pre-rinse nozzle that discharges more than 1.6 gallons per minute
   iii) to use a hand-held pre-rinse, or rinsing nozzle without a positive shut-off.
   iv) for a food establishment to thaw food with water. Food must be thawed by another legal method, such Refrigeration or Cooking Process.
   v) for a food establishment to clean kitchen or food handling areas with spray hoses.

(7) Ice Machines
   a) It shall be unlawful, for any person, firm, corporation or other entity, to install new ice machines that are single-pass, water cooled.

(8) Pools:
   a) It shall be unlawful:
      i) to operate a water feature on a Residential Pool, including, but not limited to, fountains, waterfalls, descents, arcs, and slides.
      ii) if repairing a pool, to drain the water below a level necessary to effect the repair. Owners of pools who follow this restriction will be allowed to re-fill their pool after the repair.
      iii) for Owners and Operators of pools to drain their pools once they are closed for the season.

(9) Hotels/Motels/Short-Term Lodging.
   a) It shall be unlawful for owners or operators of a hotel, motel, short-term rental or other establishment that offers or provides lodging or rental accommodations for compensation, to fail to offer a towel and linen reuse water conservation option to its lodgers, renters, or customers, and maintain in each applicable guest room, suite, or property, informational signage to communicate information relating to this requirement, and to offer the opportunity for guest participation.

(10) Washing sidewalks, driveways, buildings or concrete slabs.
   a) It shall be unlawful to wash sidewalks, driveways, buildings or concrete slabs unless an immediate health or safety risk is present.

(11) During a Stage 3 Drought Emergency, the following surcharges will be applied to all applicable accounts:

   a) <u>For Residential Water Meters;</u>
      $1.00 per CCF between 10 CCF and 20 CCF,
      $2.00 per CCF between 20 CCF and 40 CCF, and
      $4.00 per CCF over 40 CCF.

   b) <u>For Irrigation Water Meters</u>;

$1.00 per CCF between 0 CCF and 10 CCF,
$2.00 per CCF between 10 CCF and 20 CCF,
$4.00 per CCF between 20 CCF and 40 CCF, and
$8.00 per CCF over 40 CCF.

(f) *Stage 4 - Drought Disaster*

(1) The Director of Public Works shall declare a Stage 4 Drought Disaster when the levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 30 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of water being used by 45%:

a) Impose further mandatory restrictions on non-essential uses of water and essential uses of water.
b) Pull Hydrant Meters and suspend service thereon until conditions return to a Drought Emergency status.
c) Continue the aggressive public relations and education program.

(3) Irrigation.:

a) *Irrigation Prohibited*. It shall be unlawful to utilize any type of irrigation using potable water produced by the City of Wichita Falls that is distributed through the City's distribution system on any day at any time. This restriction includes all forms of irrigation, including, spray, bubbler, drip, hand-watering, etc.
.b) *Public and Private Golf Courses.* It shall be unlawful to irrigate any and all vegetated landscape areas on the golf course including greens, tee boxes, fairways, roughs, trees, shrubs, etc.. Golf Courses will be allowed to utilize the remaining water within their pond system, as they see fit; but, will not be allowed to refill the ponds from the City potable or raw water system, while in a Stage 4 Drought Disaster.
.c) *Nursery Plant Stock.* Nursery Plant Stock is exempt from the irrigation and landscape watering restrictions of this subsection.

(4) Car Washing.

a) It shall be unlawful:
   i) to wash a vehicle at any location other than a commercial car wash, car dealership, detail shop or automotive shop.
   ii) for the owner or operator of a commercial car wash, detail shop or automotive shop to utilize Potable Water for its operations on the day of the week that coincides with the day of the week established in (d)(3)a)i), that the car wash was allowed to irrigate
   iii) for the owner or operator of a commercial business to allow a customer to use a nozzle at a commercial car wash, car dealership, detail shop or automotive shop that discharges more than 3.0 gallons per minute.
   iv) Fundraising car washes are prohibited.

v) The washing of a vehicle for health and safety reasons, sufficient to remove the hazard, is permitted any time.

vi) It shall be unlawful for a car wash to wash any of its bays with water, except on Sundays.

(5) Car Dealers/Fleets.

a) It shall unlawful:

i) for a car dealer or an entity that maintains a fleet of vehicles to wash its inventory of cars on any day other than the day the property was authorized to Spray Irrigate in accordance with the days established in (d)(3)a)i). .

ii) to wash Fleets at any location used for residential purposes.

b) It is an affirmative defense to prosecution that if a car dealer or car rental is preparing a car for pickup, it washed that vehicle (and only that vehicle) on the day of pick up by the customer. Otherwise, all vehicles are subject to (f)(5)a)i) above.

c) The washing of any vehicle in a fleet may take place only at a commercial car wash or at a location owned by the fleet's owner and that is used solely for commercial uses.

(6) Restaurants/Bars/Clubs/School Cafeterias:

a) It shall be unlawful:

i) to provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.

ii) use a pre-rinse nozzle that discharges more than 1.6 gallons per minute.

iii) use a hand-held pre-rinse, or rinsing nozzle without a positive shut-off

iv) thaw food at a food establishment with water. Food must be thawed by another legal method, such Refrigeration or Cooking Process.

v) clean kitchen or food handling areas at a food establishment with spray hoses.

(7) Ice Machines

a) It shall be unlawful, for any person, firm, corporation or other entity, to install new ice machines that are single-pass, water cooled.

(8) Pools:

a) It shall be unlawful:

i) to operate a water feature on a Residential Pool, including, but not limited to, fountains, waterfalls, descents, arcs, and slides.

ii) to fill, refill or add potable water to a private or public swimming or wading pool that is not located entirely within a fully-enclosed, climate-controlled structure.

b) Indoor pools are exempt from the restrictions of (f)(8)a)i).

(9) Hotels/Motels/Short-Term Lodging.

a) It shall be unlawful, as the owner or operator of a hotel, motel, short-term rental or other establishment that offers or provides lodging or rental accommodations for compensation, to fail to offer a towel and linen reuse water conservation option to its lodgers, renters, or customers, and maintain in each applicable guest room, suite, or property, informational signage to communicate information relating to this requirement, and to offer the opportunity for guest participation.

(10) Large Industries

a) Large Industries will be notified by the City to initiate a Water Audit of their facilities.

b) The Water Audit will include where water is being used within the facilities and where reductions in water usage can be made.

c) Large Industries will have 60 days to conduct the Water Audit and submit a written report to the Director of Public Works detailing the findings of the Water Audit and the percent reduction in water consumption that can be achieved.

d) Each Large Industry will be required to have all internal modifications to implement the water reduction completed and functioning by the time a Combined Lake Level of 20% is reached.

(11) Watering Structures

a) The watering of Home Foundations is restricted to once a week, on the day the property was authorized to irrigate established in (d)(3)a)i).

i) Foundations may only be watered between the hours of 7:00 p.m. and 11:00 p.m.

ii) Foundations may only be watered with Soaker Hoses.

b) It shall be unlawful to wash sidewalks, driveways, buildings, concrete slabs, any structure or any part of a structure during Stage 4 restrictions.

(12) During a Stage 4 Drought Disaster the following surcharges will be applied to all applicable accounts:

a) <u>For Residential Water Meters;</u>
$3.00 per CCF between 10 CCF and 20 CCF,
$6.00 per CCF between 20 CCF and 40 CCF, and
$12.00 per CCF over 40 CCF.

b) <u>For Irrigation Water Meters</u>;
$3.00 per CCF between 0 CCF and 10 CCF,
$6.00 per CCF between 10 CCF and 20 CCF,
$12.00 per CCF between 20 CCF and 40 CCF, and
$24.00 per CCF over 40 CCF.

(g) *Stage 5: Drought Catastrophe*

(1) The Director of Public Works shall declare a Stage 5 Drought Catastrophe when the levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 25 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of water being used by 55%:
- a) Impose further mandatory restrictions on non-essential uses of water and essential uses of water.
- b) Continue the aggressive public relations and education program.

(3) Irrigation:
- a) *Irrigation Prohibited*. It shall be unlawful to utilize any type of irrigation using potable water produced by the City of Wichita Falls that is distributed through the City's distribution system on any day at any time. This restriction includes all forms of irrigation, including, spray, bubbler, drip, hand-watering, etc.
- b) *Public and Private Golf Courses.* It shall be unlawful to irrigate any and all vegetated landscape areas on the golf course including greens, tee boxes, fairways, roughs, trees, shrubs, etc. The Golf Courses will be allowed to utilize the remaining water within their pond system, as they see fit; but, will not be allowed to refill the ponds from the City system, while in a Stage 5 Drought Disaster.
- c) *Nursery Plant Stock*. Nursery Plant Stock is exempt from the irrigation and landscape watering restrictions of this subsection.

(4) Car Washing:
- a) It shall be unlawful:
  - i) for any person to wash a vehicle at any location other than a commercial car wash, car dealership, detail shop, automotive shop, or commercial property that is owned by the owner of a Fleet of vehicles.
  - ii) for the owner or operator of a commercial car wash, car dealership, detail shop or automotive shop to utilize potable water for its operations on Sunday or Monday.
  - iii) for the owner or operator of a commercial business to allow a customer to use a nozzle that discharges more than 3.0 gallons per minute.
  - iv) for a car wash to wash any of its bays with water, except on Fridays.
  - v) to conduct a Fundraising car wash.
- b) It shall be an affirmative defense to prosecution under (g)(4) that a person was washing a vehicle for health and safety reasons, only to an extent sufficient to remove the hazard, is permitted any time.
- c) It shall be an affirmative defense to prosecution under (g)(4) that a car dealer or car rental company was preparing a vehicle for pickup and washed that vehicle on the day of pick up by the customer.

(5) Restaurants/Bars/Clubs/School Cafeterias:
- a) It shall be unlawful:

i) to provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.
ii) to use a pre-rinse nozzle that discharges more than 1.6 gallons per minute.
iii) to use a hand-held pre-rinse, or rinsing nozzle without a positive shut-off.
iv) for a food establishment to thaw food with water. Food must be thawed by another legal method, such as Refrigeration or Cooking Process.
v) for a food establishment to clean kitchen or food handling areas with spray hoses.

(6) Ice Machines
a) It shall be unlawful, for any person, firm, corporation or other entity, to install new ice machines that are single-pass, water cooled.

(7) Pools:
a) It shall be unlawful:
i) to operate a water feature on any pool, including, but not limited to, fountains, water falls, descents, arcs, and slides.
ii) to fill, refill or add potable water to a private or public swimming or wading pool that is not located entirely within a fully-enclosed, climate-controlled structure.
iii) Indoor pools are exempt from the restrictions of (g)(7).

(8) Hotels/Motels/Short-Term Lodging.
a) It shall be unlawful for owners or operators of a hotel, motel, short-term rental or other establishment that offers or provides lodging or rental accommodations for compensation, to fail to offer a towel and linen reuse water conservation option to its lodgers, renters, or customers, and maintain in each applicable guest room, suite, or property, informational signage to communicate information relating to this requirement, and to offer the opportunity for guest participation.

(9) Watering Structures:
a) The watering of Home Foundations is restricted to once a week, on the day the property was authorized to irrigate established in (d)(3)a)i.
i) Foundations may only be watered between the hours of 7:00 p.m. and 11:00 p.m.
ii) Foundations may only be watered with Soaker Hoses.
b) It shall be unlawful to wash sidewalks, driveways, buildings, concrete slabs, any structure or any part of a structure.

(10) During a Stage 5 Drought Catastrophe the following surcharges will be applied to all applicable accounts:

a) <u>For Residential Water Meters;</u>
$6.00 per CCF between 10 CCF and 20 CCF,
$12.00 per CCF between 20 CCF and 40 CCF, and

$24.00 per CCF over 40 CCF.

b) <u>For Irrigation Water Meters</u>;
$6.00 per CCF between 0 CCF and 10 CCF,
$12.00 per CCF between 10 CCF and 20 CCF,
$24.00 per CCF between 20 CCF and 40 CCF, and
$48.00 per CCF over 40 CCF.

(h) Surcharges will remain in effect until the City Council announces the end to the restrictions. Water utilized by commercial nurseries for plant stock production shall not be subject to the surcharges established herein.

(i) *Triggering & Terminating Drought Stages.*

(1) The Director of Public Works shall declare that each "trigger level" has been reached and that the water use restrictions for each respective stage are in effect. The water restrictions will remain in effect until the lakes rise to a level that, when combined with the long-term forecast, assures the city an adequate supply of water.

(2) When an adequate supply of water is available, the City Council, by majority vote, and after consultation with the Director of Public Works, shall announce the termination of each respective stage of the restrictions that are triggered by lake levels.

(j) *Drought Restrictions only apply to City-supplied Water*.
Water supplied from sources other than the City's water delivery system, including private water wells, aerobic septic systems, wastewater effluent, and potable water imported from other areas, is intended to be exempt from the restrictions of this section. Accordingly, it shall be an affirmative defense to prosecution for violation of any provision of this section that the water used in the alleged violation was not from the City's water delivery system.

(k) Wells and Auxiliary Water Sources
(1) Registration:
a) In an effort to protect the City's potable Water System from contamination, any person or property receiving water or wastewater services from the City of Wichita Falls must register any and all non-potable, wells and auxiliary water sources, used for any purpose, with the Department of Public Works.
b) Non-Potable, Auxiliary Water Sources include, but are not limited to:
i) Existing, new or planned Water Wells,
ii) Hauled water from Surface or Groundwater sources,
iii) Rainwater Harvesting storing more than 3,000 gallons,
iv) Graywater systems producing more than 400 gallons per day.
c) The City Department of Public Works shall be responsible for developing and maintaining a governing manual, that regulates the permitting, construction and registration of all water wells and Auxiliary Water Sources.

(2) Systems must be in compliance with all Federal, State and City requirements for the following:
    a) Cross-Connection Control / Backflow Prevention Devices
    b) Building, Plumbing and Electrical Codes
    c) Setback requirements from Sewers and Septic Systems.

(3) The City of Wichita Falls public water supply system may not be held liable for any adverse health effects allegedly caused by the consumption of water collected by wells or auxiliary water sources.

(l) Defenses to Prosecution
  a) It shall be a defense to prosecution that:
    i) The use of water is necessary to protect the health, safety, or welfare of the public;
    ii) The use of water was necessary for lawful repair of a water distribution facility, flushing of utility lines or residential or commercial plumbing lines;
    iii) The use of water was necessary to meet express requirements of federal, state, or local laws and requirements;
    iv) The use of water was necessary to wash or sanitize to prevent disease transmission risk associated with liquid, solid, or particulate residue in or on emergency vehicles, or vehicles, containers or equipment lawfully used to maintain, process, or transport food, perishables, garbage, liquid or solid waste, organic materials, or recyclables; or
    v) The use of water was immediately necessary for or related to fire fighting, fire prevention, or fire suppression activities or operations conducted because of actual risk to the public or environmental health, safety, or welfare, life, or property associated with the presence of an uncontrolled fire on or approaching any person or property.

(m) Variance

(1) The Director of Public Works shall develop specific criteria to be used for the granting of variances from the provisions of this Ordinance, which are appropriate to the provisions for which a variance is being sought. Such criteria shall be applied equally to each request for variance under a particular provision.

(2) The Director, or his designee, may grant a variance from a requirement of this Chapter if the Director, or designee, determines that strict compliance with the provisions at issue adversely affects the health, safety, welfare or sanitation of the public, the applicant, or the environment.

(3) Persons requesting a variance from the provisions of this Drought Ordinance shall file a written request for variance with the Director of Public Works. All written requests for variances shall be reviewed by the Director, or his/her designee, and shall include the following:

(a) Name and address of the petitioner(s).
(b) Purpose of water use.
(c) Specific provision(s) of the Drought Ordinance from which the petitioner is requesting relief.
(d) Detailed statement as to how the specific provision of the Drought Ordinance adversely affects the health, safety, welfare, or sanitation of the public, or what damage or harm will occur to the petitioner or others if petitioner complies with this Ordinance.
(e) Description of the relief requested.
(f) Period of time for which the variance is sought.
(g) Alternative water use restrictions or other measures the petitioner is taking or proposes to take to meet the intent of this Ordinance and the compliance date.
(h) Any other pertinent or requested information.

(4) A variance following its approval by the director may be immediately suspended or revoked if the director or director's designee determines any of the following:
(a) a violation of the terms of the variance occurs at the location during the effective period of the variance;
(b) the application submitted to the director upon which the variance approval was based included false, misleading, incomplete, or inaccurate information or attachments or
(c) the director declares an emergency recall of variances to control use or preserve supply based on protracted drought, unusual operational event, or other public necessity.

(5) All variances are only in effect during the Drought Plan Stage for which the variance was issued.

(6) No variance shall be retroactive or otherwise justify any violation of this Drought Plan, occurring prior to the issuance of the variance.

(7) A variance from a requirement of this chapter expires immediately upon the termination, completion, or resolution of the event, occurrence, condition, or activity for which the variance is granted or at a time specified by the director or director's designee.

(n) Access to Premises.
All persons or agents employed by the Department of Public Works shall, at all responsible hours, have access to premises to ascertain if water is being wasted within the corporate city limits of the city or the extraterritorial jurisdiction or the extent of the jurisdictional authority and whether provisions of the Drought Ordinance have been, and are being, complied with in all respects.

(o) *Violation; penalty*.
Any person, firm, corporation or other entity found in violation of any provision of this section shall be punished by a fine of $25.00 for the first offense; not more than

$500.00 for the second offense; and not more than $2,000.00 for each offense thereafter. Each day of violation of this section shall constitute a separate offense. Proof of a culpable mental state shall not be required for the first or second offense. In the event that this section is violated by repeated offenses, the Director of Public Works is authorized to order the locking or removal of the customer's meter until all fees and fines are paid.

Water Conservation
and
Drought Contingency Plans

Developed to meet Requirements Outlined in
30 TAC § 288.2 and 30 TAC § 288.20

April 2014

Wichita Falls
TEXAS
Blue Skies. Golden Opportunities.

WATER RESOURCES COMMISSION

Adopted: May 6, 2014

Effective May 20, 2014

WATER CONSERVATION & DROUGHT CONTINGENCY PLAN
CITY OF WICHITA FALLS

April 2014

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CITY OF WICHITA FALLS

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Public Utilities Operations Manager

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City of Wichita Falls, Texas
April 2014

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WATER CONSERVATION & DROUGHT CONTIGENCY PLAN
City of Wichita Falls, Texas
April 2014

I. INTRODUCTION & OBJECTIVES

Wichita Falls is a city of approximately 107,000 people located in a semi-arid, somewhat sparse area. The city is the largest in a radius of about 100 miles, and the closer communities and towns are economically and culturally tied to Wichita Falls. The major industries of the area are agriculture, cattle, oil, and government and military facilities. Several small to medium manufacturing industries are located in the city and its environs.

Water resources are an important element in the quality of life and economic well being of the city and its citizens. Local bodies of water serve municipal, industrial, agricultural and recreational purposes. Within the urban areas, water is used extensively for landscape irrigation. "Green" has not the prevailing state of the region and healthy, green landscapes are viewed by the majority of citizens as important to the overall quality of life.

Water as a natural resource is not limited for the current population. Most citizens recognize intuitively that water is a finite resource, but this recognition has not previously translated into conservation as a natural form of behavior.

In order to conserve the available water supply and protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other emergency water supply conditions, the City of Wichita Falls (the “City”) establishes the following Water Conservation and Drought Contingency Plan (subsequently referred to as the “Plan”). The purpose of this Plan is as follows:

- To protect and preserve public health, welfare, and safety
- To maintain supplies for domestic water use, sanitation, and fire protection
- To minimize the adverse impacts of water supply shortages
- To conserve the available water supply in times of drought and emergency
- To minimize the adverse impacts of emergency water supply conditions.

II. TEXAS COMMISSION ON ENVIRONMENTAL QUALITY RULES

For the purpose of these rules, a drought contingency plan is defined as *"a strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water."*

The TCEQ rules governing development of Water Conservation Plan for Municipal Water Uses by Public Water Suppliers are contained in Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.2 of the Texas Administrative Code, which is included in Appendix 1.

Minimum Requirements

TCEQ's minimum requirements for water conservation plans for municipal water uses are addressed in the following subsections of this report:

288.2(a)(1)(A) – Utility Profile – Section III

288.2(a)(1)(C) – 5 & 10 Year Conservation Goals – Section III – E

288.2(a)(1)(D) – Water Accounting – Section IV – D

288.2(a)(1)(E) – Universal Metering – Section IV – D

288.2(a)(1)(F) – Water Loss Control – Section IV – E

288.2(a)(1)(G) – Public Education Program – Section IV – B

288.2(a)(1)(H) – Rate Structure – Section IV – C

288.2(A)(1)(I) – Reservoir Operations Plan – Section IV – O

288.2(a)(1)(J) – Implementation & Enforcement – Section IV – L

288.2(a)(1)(K) – Regional Coordination – Section IV – M

288.2(a)(2)(A) – Leak Detection/Repair Program – Section IV – E

288.2(a)(2)(B) – Records Management System – Sections IV – Q

288.2(a)(2)(C) – Wholesale Water Supply Contract Requirements – Section IV – N

288.2(a)(3) – Additional Conservation Strategies – Sections IV – F, G, H, I, J, K

288.2(b) – TWDB Requirements – Section IV

288.2(c) – Review and Update of Plan – Section IV – P

Title 30 of the Texas Administrative Code, Part 1, Chapter 288, Subchapter A, Rules 288.1 and 288.5, and Subchapter B, Rule 288.22, downloaded from http://www.tceq.state.tx.us/assets/public/legal/rules/rules/pdflib/288a.pdf, March 2007.

Furthermore, the TCEQ rules governing development of Water Conservation Plans for Industrial/Mining Water Suppliers are contained in Title 30, Part 1, Chapter 288, Subchapter A, Rule 288.3 of the Texas Administrative Code, which is included in Appendix 2.

Minimum Requirements

TCEQ's minimum requirements for water conservation plans for industrial/mining water suppliers are addressed in the following subsections of this report:

288.3(a)(1) – Description of Use – Section V – A

288.3(a)(3) – 5 & 10 Year Conservation Goals – Section V – B

288.3(a)(4) – Water Accounting – Section V – C

288.20(a)(5) – Leak Detection/Repair – Section V – D

288.20(a)(6) – State of the Art Equipment/Processes – Section V – C, E

288.20(a)(7) – Other Practices, Methods or Techniques – Section V – E

288.20(b) – Review and Update of Plan – Section IV – P

Title 30 of the Texas Administrative Code, Part 1, Chapter 288, Subchapter A, Rules 288.1 and 288.7, and Subchapter B, Rule 288.22, downloaded from http://www.tceq.state.tx.us/assets/public/legal/rules/rules/pdflib/288a.pdf, December 2008.

III. UTILITY SYSTEM PROFILE

A. Water Supply System

Wichita Falls is located in the drainage basin of the Red River, and uses the watersheds of the Big Wichita and Little Wichita Rivers as the principal sources of water. Other than a few relatively small natural ponds, reservoirs in the area are man made. The City of Wichita Falls is sole owner or co-owner of five lakes (see Appendix 4).

Lake Wichita

Lake Wichita is closest to the City and is an impoundment of the Holliday Creek. The lake was built in 1901, and was used for a number of years as the principal source of drinking water. The quality of the water is generally poor for drinking purposes. The lake has silted badly and does not offer a reliable, significant yield to meet the city's requirements. Its major uses today are recreation and flood control. The dam and spillway has undergone a major renovation in 1992-93 as part of the larger Holliday Creek Flood Control Project, a joint federal/local project.

Lakes Kemp & Diversion

Lakes Kemp and Diversion are jointly owned by the City of Wichita Falls and Wichita County Water Improvement District #2. Both lakes are located on the Big Wichita River watershed and are very high in chlorides, sulfates and total suspended solids. The water does not meet generally accepted standards of quality for drinking purposes, although the City of Wichita Falls used Lake Kemp as a supplementary source of water until the mid-1940's to mix with and extend the primary source, Lake Wichita. A federally funded project, The Red River Chloride Control Project, to reduce the flow of chlorides into Lake Kemp is partially complete. The results achieved on the South Fork of the Big Wichita River promise a fairly substantial reduction in the future chloride levels in Lake Kemp, improving the potential for greater use of the water for drinking. Some quality problems, e.g. sulfates, will remain.

Lake Kemp has a conservation pool storage capacity of 245,434 acre feet (according to the Texas Water Development Board) and an estimated safe yield of 70,000 acre feet per year or 62.5 million gallons per day. Construction of the lake was completed in 1923, and the dam and spillway were reconstructed for flood control purposes in 1973. The U.S. Army Corps of Engineers controls the release of waters above the conservation pool level. The major purposes of the lake are recreation, flood control and source of supply for the downstream, smaller Lake Diversion. The City of Wichita Falls has an annual municipal water right of 31,000 acre-feet for Lake Kemp.

Lake Diversion was completed in 1924 and has a conservation pool storage capacity of 45,000 acre feet. Its principal purpose is to raise the elevation of the water to allow the water to flow into a series of irrigation canals between the Diversion dam site and east of Wichita Falls, a distance of about 35 miles. The earthen dam was substantially modified in 1992 and 1993 to meet current state and federal regulations.

<u>Lakes Arrowhead & Kickapoo</u>

Lakes Arrowhead and Kickapoo are the primary sources of drinking water supply for Wichita Falls and several local towns and communities. The two lakes are on the Little Wichita River watershed and offer a reliable, high quality source of water. In addition to their primary purpose of providing a municipal water supply, Lakes Arrowhead and

Kickapoo are important regional recreational facilities. Lake Arrowhead has a conservation pool storage capacity of 235,997 acre feet and Lake Kickapoo has a conservation pool storage capacity of 85,825 acre feet. The City of Wichita Falls has water rights of 45,000 acre-feet from Lake Arrowhead and 40,000 acre-feet from Lake Kickapoo. The safe yield from Lake Arrowhead is 26.3 million gallons per day and the safe yield from Lake Kickapoo is 14.3 million gallons per day.

Raw water is transmitted from Lake Kickapoo to the Secondary Reservoir in Wichita Falls via a 39-inch concrete pipe. The main pump station at the dam has two pumps, each rated at a capacity of 15 million gallons per day. There are three booster stations along the length of the transmission line that must be operated to achieve the maximum withdrawal of about 28 million gallons per day from the lake. Each booster station also has two pumps, each pump rated at 15 million gallons per day. Lake Kickapoo is at a higher elevation than the City, so water can be withdrawn by gravity during months that require lower flows.

The transmission line from Lake Arrowhead to the secondary reservoir is 54 inches in diameter. The Lake Arrowhead pump station has two pumps, each rated at 35 million gallons per day, and can pump a combined total of about 55 million gallons per day. Water from the two lakes is mixed in the 110 million gallon capacity Secondary Reservoir and then moved to the treatment plants. Water moves to the Jasper Street Water Treatment Plant by gravity and is pumped to the Cypress Street Water Treatment Plant.

All diversions from the lakes are metered at the point of discharge by devices with an accuracy of + or – 5 percent. The metering devices are calibrated by an independent contractor, annually.

B. Water Treatment System

Wichita Falls currently has a treatment capacity in excess of 76.0 million gallons per day, being provided by two water treatment plants. The Jasper Street Water Treatment Facility, has a capacity of 24.0 million gallons per day. It utilizes 2 upflow clarifiers and a series of 12 dual media (anthracite/sand) filters to process drinking water. The Cypress Water Treatment Facility has a treatment capacity of 52 million gallons per day. Cypress has 3 conventional plants that can treat a total of 42 MGD using upflow clarifiers (87 & 10 Plants) and an in-line basin system (61 Plant). The remaining 10 MGD treatment capacity at Cypress is comprised of a Microfiltration / Reverse Osmosis Plant. Both Jasper and Cypress treatment facilities possess a total of 30.5 million gallons worth of storage tanks that store the drinking water on site before it is pumped to the public for consumption.

C. Water Distribution System

The distribution system consists of 720 miles of water lines that range in size from 1-inch to 30-inch in diameter. In addition to the hundreds of miles of pipeline, the distribution system also consists of 2,264 fire hydrants and 11,600 valves. On average, the City repairs 1,200 main leaks, replaces 3,300 meters and handles 7,800 customer inquiries, annually.

There are four pressure planes, each with independent pumping and storage facilities. The North pressure plane is served by a pumping station and ground storage tanks at North Beverly, as well as a pumping station and 1.0 million gallon elevated storage tank at 287 West. The East Pressure Plane is served by a single pump station and ground storage tank at 287 East and the West Pressure Plane is served directly from the Cypress Water Treatment Facility. The majority of the Distribution System, however, lies within the Central Pressure Plane, which is served by both Cypress and Jasper Water Treatment Facilities.

The City has a total storage capacity of 37 million gallons comprised of 30.5 million gallons ground storage and 6.5 million gallons of elevated storage. All treatment, pumping, transmission and storage facilities have redundancy to insure reliability of water service to the various pressure planes.

As of 2014, there were 34, 165 connections in the system, including 36 industrial, 29,933 residential, 491 public and 3,671 commercial connections. The City has entered into contracts with 11 other municipalities to supply them with treated drinking water. All of the connections to the City's water supply are metered. The City's utilities staff is responsible for the periodic inspection, testing and replacement of the large (1.5 inch and larger) metering equipment. The City currently does not regularly test its 5/8 inch and 1 inch meters, but rather adheres to a 10 year change-out of these meters. All meters utilized by the City operate within a +/- 5 % accuracy, or they are repaired/replaced.

D. Historical Water Use Patterns and Trends.

An understanding of the historical use patterns and trends is necessary to determine how best to use water efficiently. The City of Wichita Falls provides water service to 100% of its population. According to the U.S. Census Bureau, the City's population in 2000 was 104,197. The City's total water use in 2000 was 6,752.7 million gallons. Table 1 shows the monthly volume of water treated by the City's plants for the last 10 years.

Table 1 Monthly Volume of Surface Water Treated (Million Gallons)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
January	568.269	494.474	549.937	514.789	538.689	533.764	530.289	521.482	492.310	491.576
February	485.617	430.033	523.982	470.183	496.226	477.630	444.401	580.034	580.034	398.410
March	555.207	518.110	548.912	549.828	524.894	599.312	492.211	636.554	514.739	443.551
April	574.676	679.867	633.835	558.689	586.996	605.583	539.326	764.091	764.091	450.394
May	680.102	715.126	719.647	582.540	731.438	594.299	613.675	826.611	804.558	557.828
June	649.734	772.635	952.542	588.982	915.975	731.074	808.998	1114.476	1114.476	548.084
July	760.648	934.406	1163.506	707.773	1012.046	908.653	744.978	1284.073	1284.073	561.654
August	710.984	806.451	1139.607	876.462	904.683	916.368	988.601	1221.630	848.278	581.205
September	736.330	755.975	679.182	763.480	654.249	711.132	648.980	907.574	640.874	527.338
October	591.566	606.373	674.855	722.822	620.770	554.129	660.078	695.862	578.471	462.445
November	488.611	580.062	549.038	607.459	545.465	523.512	569.745	546.228	546.228	358.718
December	532.041	579.947	535.306	521.080	521.080	512.041	522.116	531.803	531.803	413.256
Total	7333.785	7873.459	8670.349	7464.087	8052.511	7667.497	7563.398	9630.418	8699.935	5794.459

Source: City of Wichita Falls

Table 2 shows the total annual water discharged from the plants into the City's Distribution System, as well as the unaccounted for water for the years 2000-2007. A

15% water loss has been the long term goal, in an effort to keep the unaccounted for water volumes within an acceptable range for a municipal water system. Although the table indicates a few years with water losses above this goal, the overall average for the period was 12.3%.

Table 2 Historical Yearly Water Use (Million Gallons)

	Water Discharged from Plants	Water Metered Sold	Percent Unaccounted
2006	8578.426	7254.563	15.4 %
2007	7353.168	6852.594	6.8 %
2008	7843.722	7849.371	0.0 %
2009	7550.090	6440.808	14.7 %
2010	7401.966	7132.744	3.6 %
2011	9451.733	8194.750	13.3 %
2012	8898.277	7050.134	20.8 %
2013	5510.071	4536.049	17.7 %

Wichita Falls sells water to two principal categories of customer: retail and wholesale. Retail customers buy only treated water while wholesale customers purchase both treated and raw water. Figures 1 and 2 below indicate the average amount of water used by each customer in both raw and treated water categories.

Figure 1

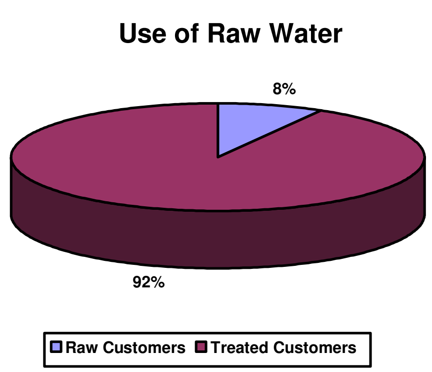
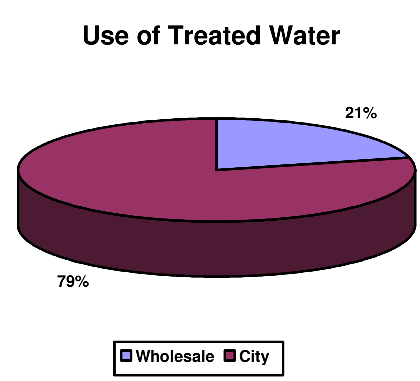


Figure 2



The typical retail customer lives within the city limits of Wichita Falls and takes treated water from City-owned facilities. The retail customer may be of a residential classification or commercial/industrial classification. The City has a larger number of residential customers than commercial/industrial as shown in Figure 3. However, as shown in Figure 4 the commercial/industrial consume as much water as residential.

Figure 3

Retail Meters

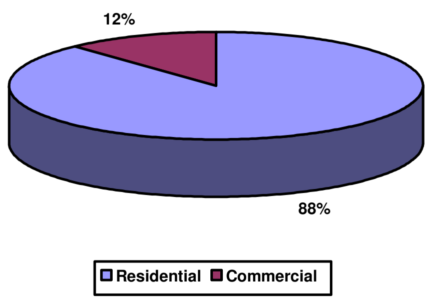


Figure 4

Water Consumption

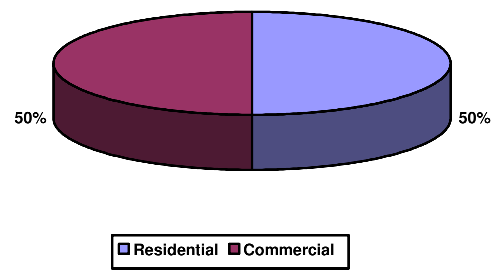


Table 3 shows the City's five largest treated water customers for the period of October 2012 through September 2013. Water consumption for each customer will generally vary from year to year, and rankings of large water customers change over time.

Table 3 Top Five High Volume Water Customers
October 2012 through September 2013

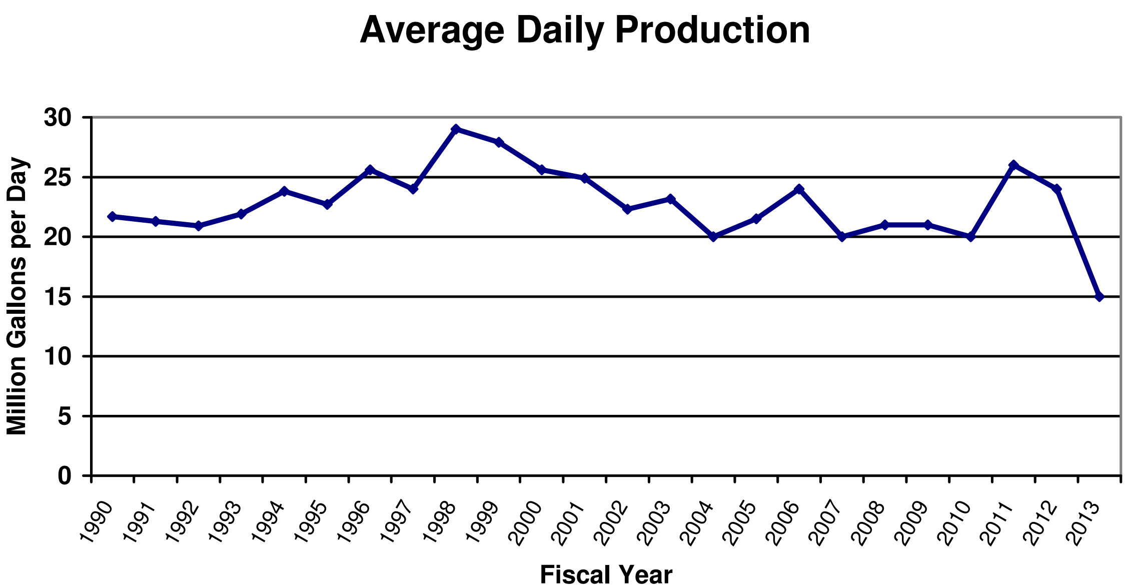
Customer	Million Gallons
Allred Prison	213.307
PPG	106.516
Alcoa / Howmet	27.695
Admiral Linen	26.678
Midwestern State University	22.371

The typical wholesale customer purchases water under special contract arrangement with the City of Wichita Falls. For rate-setting purposes, the wholesale customers are classified as "raw water only", those who purchase raw water and transmit it to their treatment facilities by their own pumping and raw water transmission systems; "raw water transmitted" designates those wholesale customers who depend on the City pumping and transmission system to convey raw water to a designated delivery point; "treated water only" includes the customers who have exclusive use of an express pipeline from a treatment plant to their own storage and distribution facilities; and "treated water transmitted", the customer who purchases treated water from the City distribution system. Appendix 5 is a list of the current wholesale customers by rate category.

Water management includes both the supply of water and the demand for water. As supply and demand are balanced, the needs of the community are being met. A severe imbalance on either side indicates insufficient planning and/or investment.

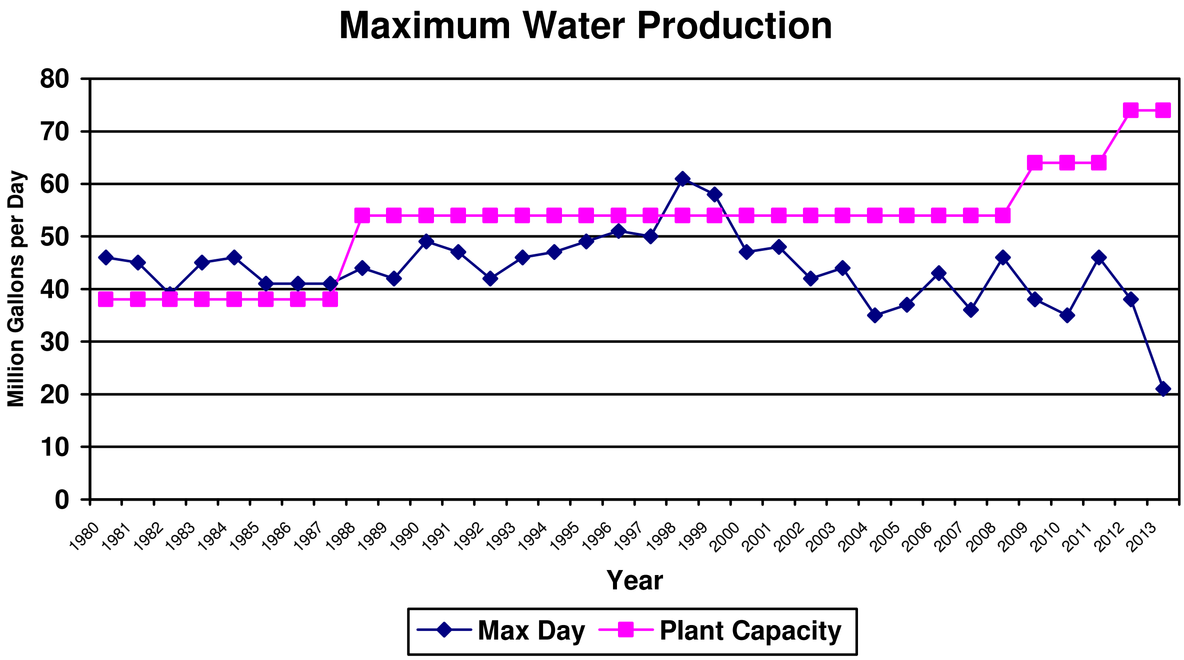
Before the drought of the late 90's, the City was treating an average of 24 million gallons per day for both retail and wholesale customers with a peak daily production rate of about 50 million gallons per day. After that drought, the average daily production dropped to about 21 MGD, with a peak daily production rate of about 45 MGD. However, as the City navigates through the current drought since 2011, the average daily production has dropped to 15 MGD with Stage 3 drought restrictions implemented.

Figure 5



The pattern formed by the peak production rate also demonstrates an overall decrease in water usage since the last drought and through the restrictions of the current drought, as seen in Figure 6.

Figure 6

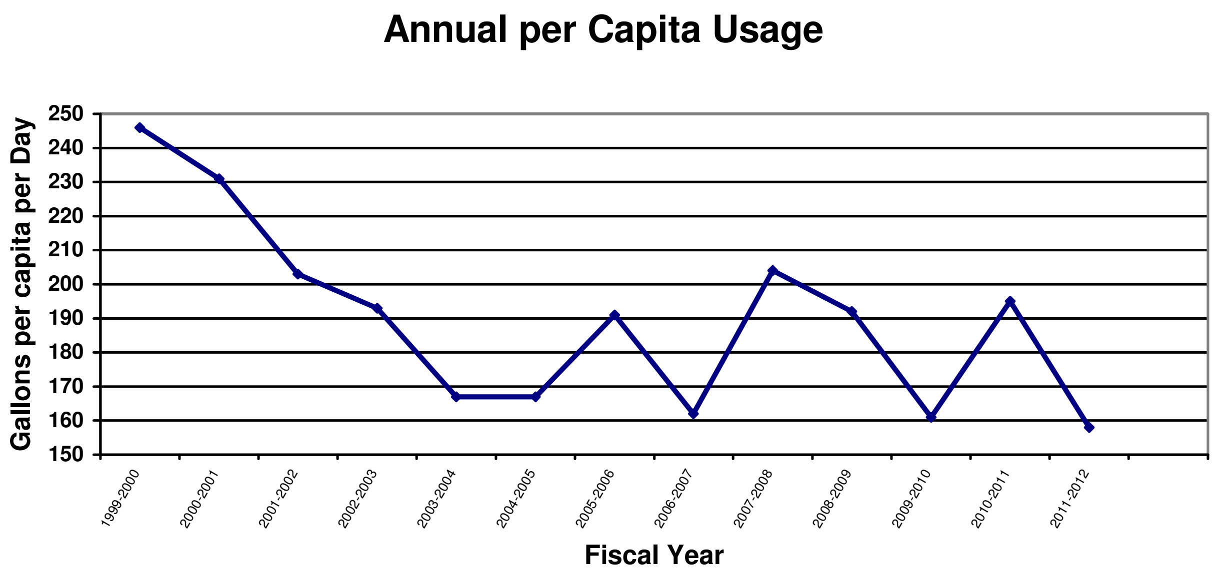


E. Population Trends and Projections.

Growth of the demand for water is a function of the per capita consumption and population. The projected population within the City over the next decade to the year 2020 is approximately 114,576 persons, according to the Region B Water Planning Group. An additional growth of 1,550 persons is anticipated in the next decade in the Wichita County area outside the City of Wichita Falls. Since the City provides water to the majority of the county residents plus additional counties, we can anticipate serving a population increase of approximately 10,000 persons over the next few years to the year 2020. On the assumption the per capita use has reached its maximum growth, the population increase represents an increase in the annual average daily use of water of about 2.4 million gallons.

The City of Wichita Falls has seen a small but steady growth. Figure 7 shows the historical per capita use.

Figure 7



The overall trend has been downward, with a few spikes, mainly due to climatic conditions. The low of 158 gpc/day was during the initial drought restrictions in 2012. Comparing this to the longer historical record in Table 4 indicates that a reversal of habits may be occurring within the Wichita Falls system.

Table 4 Seventy Year Historical Per Capita Water Use

	1940	1951	1991	2000	2010
Population	46,000 *	66,500 *	88,000 *	97,028*	104,553
Gallons per Capita per Day	82	119	194	246	161
Treatment Capacity (MGD)	9.5	21.7	56.0	56.0	64.0

* without SAFB

Some of the growth in the treatment capacity shown in the data above is a result of increasing wholesale sales of water. None of the population of wholesale towns and communities is included, however, in the per capita consumption shown; therefore the per capita use of water by residents had more than doubled in just less than 50 years. The growth in the per capita consumption is a direct result of increasing demand to fulfill lifestyle expectations. But, as can be seen, a reversal of the overall trend may be taking effect due in part to 2 droughts within 10 years of one another.

There have been many discussions at the State and throughout the State's Regional Planning Groups about goals for per capita consumption. However, to date, neither a State nor Region B per capita consumption goal has been forth-coming. In the interim, the City of Wichita Falls has adopted a goal for per capita consumption of 155 gal/cap/day by the year 2030 for both wholesale and retail accounts. The City has also adopted a short-term 5 year goal for per capita consumption of 165 gal/cap/day by 2015 and a 10 year goal of 160 gal/cap/day by 2020. Based on the recent trends, the City of Wichita Falls will have no problem meeting these goals. The TWDB defines municipal water use as residential and commercial water use. Residential use includes single and multi-family residential household water use. Commercial use includes water used by business establishments, public offices, and institutions, but does not include industrial water use. As a result, per capita consumption will be calculated based upon the census population and the water use of the residential and commercial accounts.

The per capita consumption of water is a key indicator of the effect of increasing demands. It is apparent that retarding the growth of the per capita consumption of water will result in a delayed requirement for additional storage, treatment and distribution facilities, perhaps avoiding the requirement for these facilities at all. A primary incentive, therefore, for conservation is the direct and indirect monetary savings that accrue to the customer.

F. Projected Water Requirements.

An engineering study on the adequacy of the supply of water from Lakes Kickapoo and Arrowhead was conducted in 1981 by the engineering firm of Freese and Nichols, Incorporated. The study was conducted to determine the feasibility and necessity for a new reservoir site, commonly called Lake Ringgold, near the confluence of the Little Wichita and Red Rivers at Ringgold, Texas. Based on certain parameters of population growth, use rates and safe yields of the lakes, the study concluded that Wichita Falls had an adequate supply of water until at least the year 2010. The two lakes have a combined safe maximum yield of 42.6 million gallons per day.

The TWDB Region B Planning Group conducted the latest authoritative engineering study on the adequacy of the supply of water from Lakes Kickapoo and Arrowhead in 2000. The study was conducted to determine the feasibility and necessity for new water supply sources for the Region B, of which Wichita Falls is included. Based on certain parameters of population growth, use rates and safe yields of the lakes, the study concluded that Wichita Falls will have a supply shortage (safe supply) of 2,057 acre feet by the year 2060. As a result, three alternatives for new water sources were proposed. These alternatives are; reuse of wastewater effluent, constructing a Reverse Osmosis treatment plant to treat Lake Kemp water and construction of Lake Ringgold. In addition, water conservation was recommended to delay the need for the construction of Lake Ringgold.

The City of Wichita Falls has constructed the Reverse Osmosis plant and is currently evaluating further the reuse of the wastewater effluent. The estimated construction cost of Lake Ringgold and its associated pipeline at this time has made it a low priority with regards to a future water source. However, it remains within the Region B Water Planning Group as an alternative water strategy.

With the 2010 completion of the 20-mgd addition to the Cypress Water Treatment Facility, by the construction of the 10-mgd Reverse Osmosis plant and the 10-mgd conventional plant, the City will have the capacity to meet the projected demand for treated water, plus some capacity for growth in the future. During the drought of 1995-2002, the City did on occasion exceed the maximum treatment capacity of the existing plants. Thus far, the growth of the demand has been slower than predicted by a previous study, although the demand trend has risen. But, even with the estimated population growth to the year 2020, the City should have adequate treatment capacity. Water Conservation, including the use of reclaimed water, can retard the growth of demand for potable water, and delay the requirement for additional new facilities.

With the addition of a new 1.5 million gallon elevated storage tank and new ground storage tanks at the treatment facilities, the distribution and storage system is adequate to meet current needs, but some additional storage and selected transmission lines will be required as the population and demand shifts to undeveloped areas of the City.

G. Wastewater System

The flow to wastewater collection and treatment facilities has a direct correlation with the use of water. Conservation therefore not only will delay the requirement for additional water supply and treatment facilities, but also more wastewater collection and treatment facilities.

The wastewater collection system consists of some 650 miles of collection pipe and 55 lift stations of various sizes and capacities. Deficiencies still exist in the system now, and conservation is not a factor in their correction.

Wichita Falls has two wastewater treatment plants. The newer and smaller of the two is located north of the City and was built principally to attract and serve major industries. The plant treats about 40% of the Sheppard Air Force Base sewage. The plant uses oxidation ditches for treatment, and has a capacity of 1.5 million gallons per day.

The latest state-of-the art technology was incorporated into a major renovation and expansion of the River Road Wastewater Treatment Plant in 1992. This renovation brought the plant capacity to 19.91 million gallons per day. This has been projected to provide sufficient wastewater treatment capacity for population growth perhaps to the year 2015 and possibly beyond.

Figures 8 and 9, below, indicate the average daily use (shaded area titled "Daily") of the existing Northside Wastewater Treatment Plant and the capacity of the River Road

Plant. The area of the pie chart titled "Capacity" indicates the unused, available capacity of the plant. Sheppard Air Force Base (SAFB), a military establishment within the city limits of the City of Wichita Falls, has phased out their wastewater treatment plant, and the City is now accepting their flows. Therefore, data for the Northside Plant include the addition of those flows from SAFB. Approximately 40% of the SAFB flow began at the Northside Plant in September 1990. The remaining 60% flows to the River Road Plant.

Figure 8

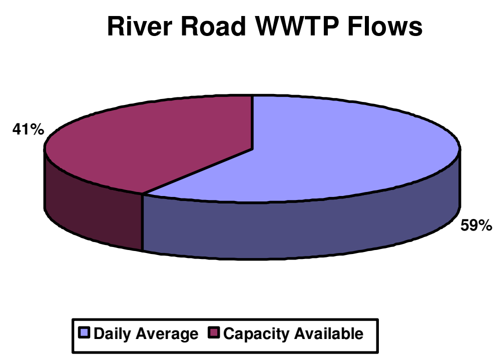
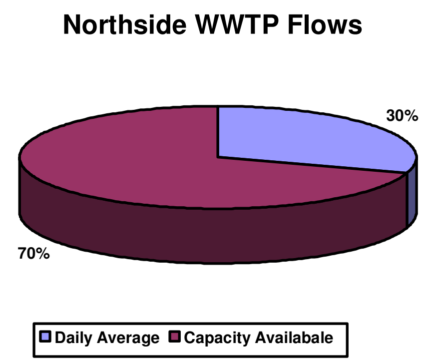


Figure 9



The City of Wichita Falls has prepared a Master Wastewater Plan that calls for the eventual construction of a new wastewater treatment plant at the time the maximum capacity of the River Road Wastewater Treatment Plant is neared. Conservation of water can play a major role in delaying the need for further expansion of collection and treatment facilities.

H. Use of Reclaimed Water

The River Road and Northside Wastewater Treatment Plants currently utilize their treated effluent for on-site irrigation, thereby diminishing their need for potable water to irrigate. Both plants use an approximate total of 539,000 gallons of treated effluent per month. Also, Sheppard Air Force Base (SAFB) is currently using effluent water from the Northside Wastewater Treatment Plant to water an eighteen-hole golf course. SAFB uses approximately 40 million gallons per year to irrigate their golf course. These two irrigation practices alone use approximately 46 million gallons of treated effluent per year, which would have otherwise had to come from the potable water supply.

Additionally, the City of Wichita Falls has recently requested authorization form the TCEQ, in accordance with Title 30, Chapter 210 of the Texas Administrative Code, for the use of reclaimed Type I and Type II effluent water by the City (see Appendix 16). The request is for a Chapter 210 reuse that is as “global” as possible. The categories of usages will be; irrigation of sports complexes, athletic fields, golf courses, ball parks, schools, parks, hospitals, industrial centers, apartment complexes, commercial properties, industrial and manufacturing properties, home lawn watering, food crops, pasture lands, road medians, cooling tower makeup water, process water for owners and operators of oil and gas wells, fire fighting, industrial and manufacturing processing, maintenance of impoundments, toilet and urinal flush water, road construction, construction activities, dust control, use at airports, oil and gas exploration activities, and water for government and military facilities.

The City of Wichita Falls is evaluating the use of reclaimed water from its River Road Wastewater Treatment Plant. This project continues to be evaluated.

A large industry on the north side of Wichita Falls, PPG, is developing a system to utilize 200,000 gpd of effluent from the Northside WWTP for cooling water. This project should be on-line by the end of 2015 and will conserve the 200,000 gallons per day of water from the potable water system.

IV. WATER CONSERVATION PLAN FOR MUNICIPAL WATER USES

A. General Discussion of Conservation Goals

The City Council of the City of Wichita Falls recognizes it has a responsibility to assure an adequate and safe supply of water for the commercial and residential use of the current population of the city as well as future generations. The Council addressed the supply side of the water balance equation in past years, and has provided an adequate and safe water supply by increasing the water treatment capacity and water distribution system capacity, and by initiating action to assure a long-term source of water by developing Lake Kemp as an additional raw water source and evaluating the reuse of wastewater effluent.

The Council is now striving to complement the water supply management achievements by managing the demand for water. The long-term objectives of demand management is to control the per capita consumption of the vital natural resource and to prolong the use of existing water reservoirs, treatment facilities and distribution networks, and sewage collection and treatment facilities. The Council formed a Water Resources Commission and charged the Commission with the responsibility to analyze strategies and recommend programs for the efficient use of water and the management of water demand. This Water Conservation Plan coordinates existing policies and procedures for conservation efforts. The objectives being sought are to:

- Reduce waste of water to slow or halt the growth of per capita consumption

- Make better use of available water resources.
- Educate the public on water saving techniques and the desirability of water conservation as a principle of human behavior.

B. Public Awareness and Education Program

The foundation of a water conservation effort is public awareness of and appreciation for the need to conserve a finite resource. Community education must be a continuing process and directed at all aspects of community life. The ultimate result of the education effort must be to change behavior. There are two distinct community groups to address:

- School-age children in the Wichita Falls Independent School District and other local school districts require a long-term program, at all possible grade levels, in the essential subject elements of "Water and Man", "Water Resources Education", and possibly others.
- The general adult population education is more short-term, targeted at making specific changes in current attitudes and practices.

The goals of the water conservation program need to be made clear to the public as well as the need for the goals. All educational efforts should relate to the local area -- using local statistics, costs, availability, ease of care or use, etc. Since people often infer the term "conservation" to mean a limitation of their desired lifestyle, education efforts should whenever possible use terms that do not convey such implications, for example "efficient use" of water and "efficiency".

The community should be made aware of the effect of the general conservation measures that can be taken, most at relatively small expense. Education programs should be directed toward advertising these general conservation measures. The best approach is cost, emphasizing how the efficient use of water can save dollars indirectly for the customer by lowering municipal bond costs and operations and maintenance expenses, thereby reducing the rate to the customer, and through direct savings on monthly water bills, energy to heat water, and sewer costs. The education program should emphasize the cost of leaks in faucets, toilets, and other household fixtures. Clear, straightforward data should be presented that allow the customer to understand the direct application of water savings, for example the amount of water used for bathing, the amount of water used for showering with various types of shower heads, toilet flushing, etc.

The customer should be told to check for leaks in the toilet using food coloring or special purpose detection tablets. This can be accompanied by simple, straightforward explanations with diagrams of the toilet flapper and other valve replacement in the tanks of the toilet. Customers should be shown that dams can be used in toilet tanks to lower water use, yet maintain adequate flow for the flushing action. Kits or packets can be developed and made available for community distribution. These kits or packets may include dams, bags, literature, flow restricters, etc., all directed toward a "do-it-yourself" water conserving effort. The kits or packets may be distributed free to the full population or at a nominal charge to voluntary customers. Claim coupons can be used to control free distribution to those customers who express interest by redeeming the coupon.

The community should be educated on the types of water saving devices that are available on the market so they can become more informed buyers. They need to understand through community education measures how to examine their existing facilities to determine whether they already have water-saving toilets, shower heads, etc.

While community efforts are going on, the City of Wichita Falls should be advertising the measures taken by the City for the efficient use of water, e.g. rate strategies, meter replacement and repair programs, leak detection and maintenance programs, plumbing ordinances, landscaping practices, water audits, etc.

The seasonal use of water for landscaping and irrigation is the single greatest cause of the large peaks and require the construction, maintenance and operation of large capacity supply systems. The City of Wichita Falls has, for example, water treatment facilities to treat 56 million gallons per day even though the annual average requirement is just over 23 million gallons per day. The reason is the summer peak use of water that must be met. State law requires the public water system to provide treatment and distribution facilities adequate to meet the largest single day of demand in the year. This area then is a major topic for public education and falls in three general areas: correct watering and efficient water devices; yard preparation and mulches; and appropriate plantings. Specific education measures that should be accomplished are:

- Education should avoid creating an impression of crisis, and should instead emphasize that efficient use of water means less cost to the customer.
- Develop and distribute information on correct watering, watering devices, and yard preparation and mulches.
- Encourage off-peak watering of landscapes.
- Prepare a local directory of appropriate plants based on the A & M Extension Services publication, "Xeriscape Bulletin B-1584-7-98" and a publication from the Texas Water Development Board, "A Directory of Water Saving Plants and Trees for Texas".
- Create water wise demonstration areas in city parks, as well as areas of buffalo grass. Emphasize that water wise is not cactus gardens as may be commonly perceived.
- Get local nurseries to stock plants fitting the above requirements, and have lists and displays available in their stores.
- Conduct contest(s) featuring water wise landscaping with nominal prizes.
- Make sure all libraries have updated materials available.

Another major area of water efficiency is the reuse of water from wastewater treatment plants ("reclaimed water"). The main public education effort for this should be directed toward greater public acceptance of the use of reclaimed water in future years. Public attention should be drawn to the successful local reuse of water, for example the use of reclaimed water for irrigating the golf course at Sheppard Air Force Base. A great opportunity for successful education in water reuse is with school children, making them comfortable with the use of reclaimed water as part of the water cycle.

Community education on water conservation should be a joint effort of several public and private partners. The Wichita Falls Independent School District and other local school districts are vitally important in the partnership approach to community education and their active support of the program should be encouraged and sought. Jointly developed materials should allow teachers to easily incorporate local information on the value of water; how to save water in the home; how best to water outside; the constant reuse of water and how it can be reused locally; what plants and trees grow best in Wichita Falls and local environs. The school system is also an avenue through which information can be distributed to homes. "Energy patrols" in school systems have educational and practical value. Sundry materials can be made available to the school systems in limited quantities from the Texas Water Development Board, A & M Extension Service, Water Education Committee of the Texas Society of Engineers, and others.

The education program should seek support and participation from local foundations, garden clubs, nurseries and organizations such as Sierra Club, League of Women Voters, River Bend Nature Works Center, service clubs, etc. Very important will be youth organizations such as Girl Scouts and Boy Scouts.

Some additional techniques for public education include:

- Informational sentences on each water bill sent by the City.
- Preparation of video tapes, slides, short programs for community presentations at clubs, on TV and radio, news articles, etc. Use of materials

from the American Water Works Association, and the Texas Water Development Board should be promoted for this.

The Director of Public Works of the City of Wichita Falls should plan and adopt a community education program and should budget annually for the program.

C. Conservation Type Rate Structure

The City formerly used a declining block rate structure which reduces the cost of water at the higher levels of use. In recognition that this type rate structure is a disincentive to water conservation, the City adopted in September 2004, for residential customers an increasing block structure as a conservation method. For commercial customers, the City adopted a flat rate structure in 2008.

The City will continue to periodically review these rate structures as to their possible impact on water conservation, in the meantime balancing the economic impact on the customers and the City.

D. Universal Metering and Meter Repair and Replacement Program

One of the most positive incentives for conservation of any product is cost. For this and other reasons, an aggressive metering and meter repair and replacement program is vital to the City. Such a program is one aspect of the efficient business operation of water and sewer service as a government function and it preserves the financial integrity of the utility. The individual customer has a right to expect that he is not paying more or less than another customer similarly situated and that all are sharing an equal load. From the conservation perspective, universal metering ensures that the customer is paying for services received and is sensitive to the waste of a product for which he has paid.

The City meters all service connections and operates a comprehensive meter repair and replacement program. Through a central data base system, the City maintains a record of the installation and or calibration date of all meters, regardless of size or class of customer served. The Director of Public Works insures that a new meter is installed or the old meter is calibrated on prescribed anniversary dates, according to the size meter indicated below:

Meter Size	Test Interval	Change Out Interval
5/8" and 1"		10 Years
1 1/2" and 2"	4 Years	
3" and 4"	4 Years	
6" and larger	1 Year	

Any meter of any size is changed when it is determined the meter is inaccurate and cannot be economically repaired, regardless of age or anniversary date. Master production meters at the raw water sources and at the treatment plants are calibrated annually and repaired/replaced as necessary.

Damaged or defective meters are reported by meter readers as they take daily readings. Through predetermined codes, their reports of meter repairs needed are converted to specific work orders by computer. The work orders are then managed, accounted and accomplished by a meter repair section in the Public Works Department. Defective meters can also be reported by citizens/customers, by utility work crews and other sundry persons. These reports are also recorded as work orders and processed as indicated. Finally, defective meters are often found by review of customer use patterns and the analysis of computer summary data on individual accounts.

The City also aggressively pursues the illegal use of water through "straight-line" connections. Such instances are filed with the Municipal Court for prosecution and recovery of revenue.

This metering and meter replacement and repair program is programmed and budgeted annually. Public Works management monitors the accomplishment of the program through submission of tailored monthly reports.

E. Leak Detection and Maintenance Program

To achieve the objective of reducing the waste of water, the Director of Public Works maintains adequate reporting and compiling of data to determine that the total sales of finished water compares favorably with the quantity of water produced and pumped from the plants to the distribution system. The water industry refers to the difference between the two quantities as "unaccounted" water, and we should seek to achieve the standard of the American Water Work Association for an efficiently operated utility of not more than 15% unaccounted water.

One of the principal ways of controlling the amount of unaccounted water is an aggressive leak detection and repair program. So long as the quantity of unaccounted water does not exceed 15% of the total water produced, the City uses a visual leak detection concept. When the total unaccounted water exceeds the stated percentage, the City will begin weighing the cost benefit of more sophisticated means of leak detection, particularly the use of electronic detection equipments and techniques, and of consultants for comprehensive audits.

F. Plumbing Codes for Water Conservation Devices

Representatives of the engineering and plumbing professions serve on the City Plumbing Board, and the Board advises the City Council on matters relating to the Plumbing Code. The Board and Council mutually recognize the desirability of conserving water. This recognition resulted in 1987 in the amendment of the Plumbing Code to add restrictions on the maximum volume of water for certain plumbing facilities and devices.

The City Plumbing Code, integral to the Code of Ordinances, specifies that water conserving plumbing facilities and devices shall be used for construction and remodeling. Urinals must be adequately flushed with no more than one gallon of water per flush and automatic flushing devices of the siphonic design shall not be used to operate urinals. Water closets (toilets), either flush tank or flushometer operated, shall be designed, manufactured and installed to be operable and adequately flushed with no more than 1.6 gallons of water per flushing cycle. Faucets for public lavatories shall be equipped with outlet devices which limit the flow of water to a maximum of one-half gallon per minute or be equipped with self-closing valves that limit the delivery of water to a maximum of one-quarter gallon per minute of hot water for recirculating systems and to a maximum of one-half gallon per minute per non-recirculating systems. Shower heads for private use shall be designed, manufactured and installed to deliver water at a flow rate not to exceed three gallons per minute; sink faucets, not to exceed 2.5 gallons per minute.

G. Retrofit Program to Improve Water Use Efficiency

A mandated retrofit program is not considered necessary nor desirable because there is not a general shortage of water for citizens. Nonetheless, it is recognized that retrofitting wasteful plumbing devices is a valid means of conserving a finite natural resource. The City of Wichita Falls should stress to its citizens the importance and cumulative effect of various water conservation techniques, including the use of restricted flow plumbing devices. Education programs should provide information to the public on flow rates and cost savings; the individual citizen can then consider the cost benefits of retrofitting with water saving plumbing devices.

H. Water Recycling and Reuse

Water reuse affects both the supply and demand side of the water balance equation. Demand for potable water is reduced by water reuse even though the total consumption of water may not be reduced. The reduced demand from reuse affects the supply system in the same way as other conservation measures: a reduced requirement for storage, treatment and distribution facilities. Water reuse may vary from very limited application, such as residential reuse of "gray water," to large scale applications of irrigation with wastewater treatment plant effluent ("reclaimed water").

Industry is on the vanguard of water reuse through recycling. Several local industries have found it advantageous to install treatment facilities that allow recycling of water used in the manufacturing processes, taking only the additional water required for makeup. The reuse of water by industry not only reduces the demand for water, but also reduces the total flow to wastewater treatment plants, often precluding the concentration of chemicals from the manufacturing process.

At this time, the use of gray water in residential areas does not appear to be an area of significant impact. It is, however, an area where the individual customer can be made more sensitive to the potential for water conservation. Therefore, the reuse of water by residential customers should be stressed by the City through various educational initiatives.

Two major non-industrial generators of gray water are commercial laundries and commercial car washes. Commercial laundries are not realistic candidates for reuse because of the expense to process gray water adequately to the required quality. Commercial car washes offer greater potential. Some local car washes now recycle, and technology is being rapidly developed that appears to provide more lucrative returns for the operators to consider water reuse.

The major effort of the City in gray water reuse should be to educate the public on the safe use of gray water and to encourage non-industrial generators of gray water to consider the cost benefits of developing technology for recycling. The City should continue to applaud the leadership of industry and should support industry in the recycling of process water.

An area of considerable potential for conservation of water is the use of effluent ("reclaimed water") from wastewater treatment plants. Sheppard Air Force Base is currently using treatment plant effluent to water an eighteen-hole golf course. This is a prime example of water reuse and of conservation effort. While the effluent must be used within the guidelines of federal and state regulatory agencies, there are several applications that may be cost beneficial in the future. See Section III – H for a complete discussion of the use of reclaimed water in substitution for potable water.

I. Water Conserving Landscaping

As has been indicated, the seasonal use of water for landscape irrigation and other outside uses is the primary reason for the peaks that is the basis for construction, maintenance and operation of large treatment and distribution systems. It follows then, that efficient use of water in this area can have a pronounced effect on water bills for the consumer and the peak demand on water supply facilities; the health of plants and grasses in the landscape is also improved by the efficient use. Through education of the public to certain proven techniques, water can be used more efficiently without any lessening of the concurrent City goals of landscape beautification and industrial recruitment.

There are several efficiencies that will conserve water. Foremost is the method used for irrigation of landscape. It is a tendency to water too often, sometimes too spasmodically, and for too long a period of time to be efficient. Plants and grasses that are watered too often and/or too superficially develop a shallow root system that demands more frequent watering for the adequate health of the plants and grasses. Thorough deep watering draws roots down deep to get the moisture, and the deeper root system is healthier, requires less frequent waterings, and can better withstand long dry spells.

The soil in Wichita Falls and its environs is of rather tight texture and does not absorb water readily. Water running down the curbs is a possible signal of too much water being put on too quickly for the ground to absorb. Water sprinklers that put out water more slowly, or shorter watering periods can relieve this. Lawn aerators that plug small holes in the lawn aid greatly in the absorption rate.

An important aspect of efficient watering of landscapes is the type sprinkling device used. There are hundreds of watering devices on the market. Some are prone to huge evaporation losses because the water is broken up into too fine a mist or because the water is thrown too high into the air. Sprinklers should be chosen and placed carefully to cover the areas needing water, but avoid placing water on driveways, walks, streets, etc. Local merchants should be encouraged to carry, advertise and otherwise promote the more efficient watering devices.

The public should be constantly reminded that the most efficient use of water on plants is by drip irrigation. Water is put at the base of the plant slowly and only where it is needed. This method needs to be greatly expanded through education and by encouraging local merchants to stock and promote drip irrigation systems.

The installation of a complete lawn sprinkler system is a convenient way to maintain a healthy lawn, and the use of automatic electronic timers should be encouraged. The timers prevent leaving water on for too long a period through forgetfulness, and facilitate using the water at the best time of day when there is the greatest effect for the plants and the least evaporation. Technology such as rain sensors should be used in conjunction with electronic timers to prevent the irrigation system from being turned on when adequate moisture is available in the soil. The technology of these devices is adequately proven, the City should consider requiring the devices on all new irrigation system installation and possibly the retrofitting of the existing system over a period of time.

The automatic timers offer flexibility. For example a sloped area that cannot absorb water before runoff can be watered several times each day at selected intervals. This prevents wasted water running down the curb.

The public should also be made aware that water timers are available to hook to a faucet to set watering time; some of these timers are programmable. These devices are fairly new to the market, but they are available at some local suppliers and offer the customer without an irrigation system the opportunity to make more efficient use of hose sprinkling systems.

The use of water wise landscaping techniques should be stressed. This is the use of native grasses and plants that do not have a high water demand. Local nurseries are already stocking and selling a great many of these and many more are coming onto the market. Local nurseries and other landscape dealers and installers should be encouraged to continue and increase their stock of these more efficient plants and to participate in informing the public to the availability and use of the native plants. Sensible water use through drip irrigation and water-efficient plants can achieve a near perfect balance between wise water use and attractive landscaping. The City Parks and Recreation Department should undertake Xeriscape projects to make more efficient use of water and to show the public the attractiveness of this form of landscaping. Wide public attention should be drawn to such Xeriscape projects.

Large customers who are located near raw water transmission systems should be encouraged to use raw water rather than treated. Such programs can save money for the customer and will reduce the load on City treatment facilities and treated water distribution systems. The savings and cost of chemical treating and filtering and additional pumping and distribution is substantial, and more importantly, in the sense of conservation the use of these facilities is prolonged.

Beyond the use of natural landscaping and water conserving irrigation, the use of "water harvesting" could be practiced by capturing rainfall runoff from the property. There are numerous sources for this information available via the internet. This can reduce the need for potable water for landscaping.

J. Other Initiatives for Efficient Water Resource Use

The emphasis of this water conservation plan is on conserving the use of water. However, one of the acknowledged goals of water conservation is to reduce the flow of water to wastewater treatment plants, thereby reducing or delaying the requirement for new collection and treatment facilities or expansion of existing facilities. Another means of achieving this same objective of conserving wastewater facilities is to reduce the invasion of ground and surface waters into the sewage collection system. The City of Wichita Falls has an aggressive program to find and repair the source of invasion of these waters into the system.

The City makes extensive use of smoke generation in sewer collection lines to detect leaks. In 1983-1985, a commercial contractor smoked all of the major collection basins in the City. An extensive and focused program was conducted to repair the leaks detected by the smoke program. In addition, City crews use smoke to find leaks in the collection system. All collection line leaks are repaired as soon as detected.

Manholes are a known source of infiltration and inflow of external water. Manhole leaks are detected by smoke and are repaired immediately. Some manholes are in low areas and are subject to being covered by runoff waters. Special plastic rainguard devices are used in these manholes to prevent the entry of water from the surface.

The City annually conducts a Budget Utility Improvements Project that includes the rehabilitation of aged and deteriorated sewer lines. These old, structurally unsound sewer lines are often major sources of water invasion. The lines are rehabilitated by slip lining with a polyethelene pipe or by replacement of the line.

Another technique to detect the source of water invasion is television of sewer lines. The City of Wichita Falls makes frequent use of this technique to determine the need for rehabilitation of a line and to find sources of water invasion. The City also uses sophisticated electronic flow measuring equipment to isolate areas of potential inflow so leak detection measures can be used in the area.

Another initiative by the City to preclude entry of rainwater into the sewage collection system is an ordinance prohibiting any plumbing installation that admits storm or groundwater to enter the sanitary sewer. When such installations are detected by inspection or by smoke injection, the property owner is required to make repairs under supervision of the City plumbing inspector.

The initiatives to control the unnecessary flow of waters through the collection system to the wastewater treatment plants are conducted on a continuous basis by utilities managers and crews.

K. Permanent Conservation Measures

The City of Wichita Falls has implemented permanent conservation measures. These measures were adopted by ordinance by the City Council. There are four components to this ordinance.

The first is that spray irrigation use is prohibited from 11:00 A.M. to 6:00 P.M.. Non-spray type irrigation systems such as drip or soaker hoses are allowed, as is hand watering.

The second measure is that if washing a car at any location other than a commercial car wash, car dealership, detail shop or automotive shop is prohibited, unless the hose has a positive shutoff nozzle attached.

The third measure is that all new irrigation systems shall be designed by a licensed professional, recognized by the State of Texas. In addition, the design must include water saving devices such as automatic timers and moisture detection devices.

The final measure is that no water shall be served at a restaurant, bar or club unless the customer requests water.

L. Implementation of Plan and Enforcement

Implementation of the Water Conservation Plan is a matter of cooperative effort between the various departments of the City and a permanent Water Resources Commission. The Director of Public Works should coordinate the implementation and enforcement of the plan through existing ordinances and adopted budgets.

The Water Resources Commission advises the staff, participates in the periodic update of the plan and assures the Council that water resources are being managed judiciously in accordance with the Conservation Plan. The Commission consists of five members appointed by the Council to alternating two-year terms. Each citizen member shall have a professional interest in the efficient use of water. The Commission is to meet at least quarterly and a report with observations and recommendations should be submitted to the City Council.

The universal metering and meter repair and replacement program is in effect now and requires no modification or additional implementation. The same is true of the leak detection and maintenance program.

Water conservation landscaping on a routine basis is principally a matter of educating the public and of coordinating and working with local landscape architects and nursery owners. A xeriscape pilot project by the City Parks Department should be installed as a demonstration to the public. This project should be located in an easily accessible area and should be marked with appropriate signs to highlight the water conservation aspects of the landscaping.

The plumbing code for water conservation is adequate at this time and no further implementation is required. However, the Council is receptive to new initiatives from the Plumbing Board.

Reuse and recycling offer potential for significant water savings in the future when costs and regulatory controls make the use more attractive to the typical customer.

M. Regional Coordination

The service area of the City of Wichita Falls is located within the Region B Water Planning Group. To coordinate developing the Plan with the Regional Water Planning Group, the City staff has continuous correspondence with Biggs & Mathews and the Red River Authority representatives of the Region B Water Planning Group, as well as participating on the Region B Planning Board. In addition, a letter was sent to the Region B Water Planning Group providing them a copy of the plan, as submitted to the City Council for approval. Documents verifying this coordination are included in Appendix 6.

N. Retail/Wholesale Water Supply Contract Requirements

The City of Wichita Falls has reviewed all of its retail/wholesale water customer contracts and has ensured that all contracts have additional conservation requirements, as required pursuant to 30 TAC, Chapter 288. If the City's retail/wholesale customer intends to sell the water to another water retailer, then the contract for resale must also include water conservation requirements.

Additionally, all retail/wholesale contracts with the City include a provision that in the case of a shortage of water resulting from a drought, the water to be distributed shall be divided in accordance with Texas Water Code § 11.039 (Appendix 7).

O. Reservoir Systems Operation Plan

The City of Wichita Falls owns Lake Arrowhead, Lake Kickapoo and Lake Wichita and therefore does not coordinate the operation of these reservoirs with other entities which would require an operating plan. However, the City does operate and maintain these three reservoirs in accordance with State and Federal guidelines and coordinates regularly with the appropriate agencies. The City has the following water rights:

14.663 billion gallons (45,000 acre feet) per year from Lake Arrowhead

13.034 billion gallons (40,000 acre feet) per year from Lake Kickapoo

2.375 billion gallons (7,289 acre feet) per year from Lake Wichita

The City jointly owns the Lake Kemp & Diversion water system with Wichita County Water Improvement District #2 (WCWID2). The City coordinates the operation of this lake system with the WCWID2, and has the following water rights:

10.101 billion gallons (31,000 acre feet) per year from Lake Kemp

Under agreement with Wichita County Water Improvement District #2, once Lake Kemp reaches 50% of its storage capacity, all irrigation activities are suspended and water is held in reserve for use by the City for drinking water purposes.

P. Review and Update of Water Conservation and Drought Contingency Plans

The Water Conservation and Drought Contingency Plans will be reviewed annually by City staff and the Water Resource Commission, to ensure that City Ordinances and programs remain current and progressive for water conservation. As required by TCEQ rules, the Water Conservation and Drought Contingency Plans will be reviewed every five years. The plans will be updated as appropriate, based on new or updated information.

Q. Record Management System

The City upgraded its water accounting software system in the late 1990's. This system allows for the identification of residential, commercial, industrial, and public users. The City's Utility Collections Division now identifies and tracks the different categories of water consumption.

All information obtained from the review and evaluation of this data will assist in future planning of conservation strategies.

V. WATER CONSERVATION PLAN FOR INDUSTRIAL / MINING WATER USES

A. Description of Water Use

The City has requested authority to divert and use water associated with both industrial and mining purposes and to do so within the existing diversion rates authorized for Lakes Arrowhead and Kickapoo (see Appendix 8). The majority of use is expected to be towards the development of natural gas, including hydraulic fracturing activities, and is not expected to exceed more than 1,200 acre-feet per year. Water will be diverted from the perimeter of the reservoir and metered prior to delivery by pipeline or trucked to the point of use.

B. Conservation Goals

The water conservation goal for the industrial/mining operations is to reach a specific percentage of water reused by the operation. Reuse of recovered/flowback water from hydraulic fracturing operations will be used to the extent it can feasibly be treated to remove significant chloride concentrations. The City has established a five-year target goal of 2.5% (by 2013) and a ten-year target goal of 5.0% (by 2018). In an attempt to meet these goals, the City has developed the following actions to achieve the goals set in the Water Projections found in Section III (Utility System Profile). The conservation goals of this plan include the following:

- Install, by contract, a flow metering device that can measure the amount of water utilized with a minimum accuracy of +/- 5%. Specific quantitative goals can be determined once the actual amount of water usage is quantified.
- Maintain a program for leak detection and repair of the water supply system.

C. Practices and Devices to Measure Diversions

Devices, such as mechanical or Doppler meters, and methods will be installed and instituted to ensure that all diversions of water are measured and accounted for within an accuracy of +/- 5%. All diversions must be performed, monitored, and recorded in a manner that is consistent with the City's withdrawal and accounting plan authorized pursuant to the Certificate of Adjudication, or any subsequent amendments thereto.

D. Leak Detection, Repair and Water Loss Accounting

The City has a standard policy for leak detection and water loss accounting. This policy is part of the Water Conservation Plan found in Section IV. However, the efforts to detect and repair leaks will largely be the responsibility of the user of the industrial/mining water, whose approaches shall be documented to the City, as part of its loss accounting policy.

E. Means to Improve Water Use Efficiency

Any additional water conservation practices, methods and techniques that are feasible and appropriate to achieve the stated goals of the water conservation plan will be instituted. This includes, but is not limited to, the application of state-of-the-art equipment and-or process modifications to improve water use efficiency.

VI. DROUGHT CONTINGENCY PLAN

A. General

Wichita Falls has adequate water to sustain it through the longest recorded drought in history (safe maximum yield). One has to question, however, whether a drought being experienced is a record-setting drought. Prudence dictates that the safe yields are treated as statistical values and that reasonable contingency plans to be in place to deal with a shortage of water. This drought contingency plan is predicated on maintaining a minimum reservoir storage capacity and a finite treatment capacity by using pre-planned, progressive measures to alter demand and to augment supply. The total objective is to keep the level of Lakes Kickapoo and Arrowhead at more than 25% of the conservation storage capacity, and treatment levels within capacity limits.

The City constructed the Reverse Osmosis (RO) plant to develop the Lake Kemp system into a drinking water supply. However, the RO plant was designed to provide 10 million gallons of drinking water each day (13% of total treatment capacity), which is the amount required to sustain basic sanitary needs during a summer drought condition. Therefore, based on the facts that the RO treatment capacity is such a small contributor to the overall City treatment capacity, and that Lake Kemp is the only "fall back" source of drinking water when all other lakes are below 25%, the City has elected not to utilize the Lake Kemp storage capacity in its calculation for the triggering of the various drought stages. It is felt that this is a more conservative approach to maintaining an adequate supply of source water for the citizens of Wichita Falls.

The Director of Public Works is the responsible official for the coordination, expansion and implementation of this drought contingency plan. All other City departments provide support as requested by the Director of Public Works.

B. Texas Commission on Environmental Quality Rules

The TCEQ rules governing development of drought contingency plans for public water suppliers are contained in Title 30, Part 1, Chapter 288, Subchapter B, Rule 288.20 of the Texas Administrative Code, which is included in Appendix 9. For the purpose of these rules, a drought contingency plan is defined as *"a strategy or combination of strategies for temporary supply and demand management responses to temporary and potentially recurring water supply shortages and other water supply emergencies".*

Minimum Requirements

TCEQ's minimum requirements for drought contingency plans are addressed in the following subsections of this report:

288.20(a)(1)(A) – Provisions to Inform the Public and Provide Opportunity for Public Input – Section VI – C

288.20(a)(1)(B) – Provisions for Continuing Public Education and Information – Section VI – C

288.20(a)(1)(C) – Coordination with the Regional Water Planning Group – Section IV – M

288.20(a)(1)(D) – Criteria for Initiation and Termination of Drought Stages – Section VI – E

288.20(a)(1)(E) – Drought and Emergency Response Stages – Section VI – D

288.20(a)(1)(F) – Quantified Water Use Reduction Targets During Periods of Water Shortage and Drought – Section VI – F

288.20(a)(1)(G) – Water Supply and Demand Management Measures for Each Stage – Section VI – D

288.20(a)(1)(H) – Procedures for Initiation and Termination of Drought Stages – Section VI – E

288.20(a)(1)(I) – Procedures for Granting Variances – Section VI – G

288.20(a)(1)(J) – Procedures for Enforcement of Mandatory Restrictions – Section VI – H

288.20(a)(3) – Consultation with Wholesale Supplier – Sections IV – N

288.20(b) – Notification of Implementation of Mandatory Measures – Section VI – D

288.20(c) – Review and Update of Plan – Section IV – P

Title 30 of the Texas Administrative Code, Part 1, Chapter 288, Subchapter A, Rules 288.1 and 288.5, and Subchapter B, Rule 288.22, downloaded from http://www.tceq.state.tx.us/assets/public/legal/rules/rules/pdflib/288a.pdf, March 2007.

C. Public Involvement, Education and Regional Coordination

The City will provide the opportunity for public input in the development of this drought contingency plan by the following means:

- Providing written notice of the proposed plan and the opportunity to comment on the plan by posted notice and notice on the City of Wichita Falls Web site (www.wichitafallstx.gov)
- Making the draft plan available on the City of Wichita Falls Web site (www.wichitafallstx.gov)
- Providing the draft plan to anyone requesting a copy.

The Region B Water Planning Group was invited to comment and have received a copy of the Plan for coordination with the Region B Regional Water Plan. Public education of drought contingency issues may include public reference materials at the Utility Collections Offices and the Wichita Falls Library, the annual Consumer Confidence Report, press releases to the local media and public service announcements on the City's public access channel.

D. Drought Management Programs.

1. Permanent "Year Round" Restrictions:

The City of Wichita Falls has several restrictions that are effective year round, independent of the level of water in the lakes. Those restrictions include:

a. Ban on outside spray type irrigation between the hours of 11am and 6pm, on any day of the week.

b. If washing vehicles at home, the hose must be equipped with a positive shutoff nozzle.

c. All new irrigation installation must be designed by a licensed professional in the State of Texas.

d. Restaurants, Bars, Clubs, Cafeterias cannot serve water unless the customer requests such water.

2. Stage 1: "Drought Watch":

A **drought watch** will be initiated when

i) the combined storage of Lakes Kickapoo and Arrowhead declines to 60% of the conservation pool storage capacity.

The purpose of declaring a drought watch is to heighten public sensitivity. The following actions should occur under the direction of the Director of Public Works in this phase.

a. The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of water being used by 5%:

a. The City Council and other City Departments will be notified of the impending problem and the proposed immediate and future actions.

b. The City shall initiate an education program through all available media to:

i. Alert the public to the depletion of the reservoirs; current rate of withdrawals and the effect of such withdrawals; current treatment rates; current meteorological conditions; and the long-range weather forecast from the National Weather Service.

ii. Alert the public to the drought management program, the various stages and measures, and the possibility of implementation.

iii. Keep a constant flow of information to the public to condition them for more stringent measures.

c. Parks Department will reduce its watering schedule to twice per week.

d. The Public Works Department will coordinate with other departments on the structure of a program to implement voluntary and non-voluntary water restrictions.

e. The Public Works Department will conduct training necessary to implement the water restriction program.

f. The Public Works Department will prepare all administrative processes (forms, affidavits, maps, offices, etc.) for the restriction program.

Near 50 Percent Capacity

When the levels near a combined capacity of 50 percent, the city shall mail a copy of the Water Rationing Zone Map, with a cover letter describing the drought conditions, to each water account. Failure to mail or receive such warning shall not be a defense to any crime, restriction, or charge established in this division.

Stage 2: "Drought Warning":

(1) The Director of Public Works shall declare a Stage 2 Drought Warning when levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 50 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of water being used by 15%:

a. Form a Drought Emergency Task Force for guidance through the remainder of the drought and to interface with the public.

b. Suspend all non-essential operational use of water by City of Wichita Falls, such as flushing water mains, street sweeping, water jet cleaning of sanitary sewer mains, fire fighter training, etc.), except where such use of water is critical to the health and safety of the citizens.

c. Parks Department will reduce watering to once per week or only enough water to support their trees, whichever is less.

d. Notify all wholesale customers of the situation and inform them of the reduction goals for their systems in accordance with their individual contracts with the City of Wichita Falls. Pro rata curtailment by wholesale customers will be based upon their contractual limits as provided in Texas Water Code § 11.039.

(3) In Stage 2 drought, the following restrictions shall apply:

a. Irrigation:

i. It shall be unlawful to run outside irrigation systems (including sprinklers, automatic sprinkler systems and unattended hoses) except on the day of the week permitted for the area as identified on the Water Rationing Zone Map. An official copy of the Water Rationing Zone Map shall be kept on file in the office of the City Clerk.

ii. It shall be unlawful to utilize spray irrigation between the hours of 11:00 a.m. and 6:00 p.m.

iii. Landscape watering is permitted any day at any time with a hand-held hose, soaker hose, bucket (five gallons or less), watering can, bubbler or drip irrigation system.

iv. On days other than the day of the week permitted by the Water Rationing Zone Map, testing and troubleshooting of irrigation systems that involve the release of water is permissible any time, including between the hours of 11:00 a.m. to 6:00 p.m., as long as a licensed plumber or irrigator is present on location during testing (and visible to the ticket writer). Testing and troubleshooting of irrigation systems by other than a licensed plumber or irrigator that involves the release of water is otherwise permissible only on the day of week and time of day permitted by the Water Rationing Zone Map.

v. *New Landscape Waiver.* A waiver of this subsection may be granted for the irrigation of new landscaping plants whereby watering would be permitted to maintain adequate growth until the plants are established but not to exceed a 30-day time period. Any person wishing such a waiver must make application to the City Public Works Department and pay a $50.00 nonrefundable fee. The applicant must agree to pay a water rate that is three times the normal rate for that customer for all consumption over 10 CCF as registered by residential meters and all consumption as registered by Irrigation meters or commercial meters.

vi. *Public and Private Golf Courses.*

Greens: Golf Courses may utilize Spray Irrigation on greens at any time for the purpose of cooling golf course greens when warranted by weather conditions and only with run cycles of less than 5 minutes every 60 minutes. Golf course greens are exempt from the Spray Irrigation days established in (d) (3) a., and greens may be Spray Irrigated any day of the week, but will be subject to the prohibition of spray irrigation during the daylight hours between 11a.m. & 6 p.m..

Tee Boxes: It shall be unlawful for golf courses to Spray Irrigate Tee-Boxes, except on the day of the week permitted for the area as identified on the Water Rationing Zone map, but will be subject to the prohibition of spray irrigation during the daylight hours between 11a.m. & 6 p.m.

Fairways: It shall be unlawful for golf courses to Spray Irrigate Fairways, except on the day of the week permitted for the area as identified on the Water Rationing Zone map, , but will be subject to the prohibition of spray irrigation during the daylight hours between 11a.m. & 6 p.m..

<u>All other Golf Course Features:</u> It shall be unlawful for golf courses to Spray Irrigate any other landscape features, such as roughs, trees, shrubs, etc.

vii. Nursery plant stock is exempt from the irrigation and landscape watering restrictions of this subsection.

b. Carwashing:

i. It shall be unlawful to wash a vehicle at any location other than a commercial car wash, car dealership, detail shop or automotive shop.

ii. The washing of a vehicle for health and safety reasons, sufficient to remove the hazard, is permitted any time.

iii. Washing a vehicle with a bucket, on the day to water or on the lawn while watering, other than at a commercial car wash, car dealership, detail shop or automotive shop, is prohibited.

iv. Fundraising car washes are prohibited.

c. Restaurants / Bars / Clubs / School Cafeterias. It shall be unlawful to provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.

d. Washing sidewalks, driveways, or concrete slabs: It shall be unlawful to wash sidewalks, driveways, or concrete slabs unless an immediate health or safety risk is present.

(5) During a Stage 2 Drought Warning, the following surcharges will be applied to all applicable accounts:

a. For Residential Water Meters;

$0.50 per hundred cubic feet (CCF) between 10 CCF and 20 CCF,

$1.00 per CCF between 20 CCF and 40 CCF, and

$2.00 per CCF over 40 CCF.

b. For Irrigation Water Meters;

$0.50 per CCF between 0 CCF and 10 CCF,

$1.00 per CCF between 10 CCF and 20 CCF,

$2.00 per CCF between 20 CCF and 40 CCF, and

$4.00 for each CCF over 40 CCF.

4. **Stage 3: "Drought Emergency":**

(1) The Director of Public Works shall declare a Stage 3 Drought Emergency when the levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 40 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of water being used by 35%:

a. monitor all Fire Hydrant Meters that are for contractor use, to determine what conservation can be achieved through this type of water usage,

b. specify and impose mandatory reductions on wholesale (raw & treated) water customers in accordance with Texas Water Code § 11.039, and

c. begin establishing a program for a Drought Disaster, which will allow restriction on the essential uses of water and prepare for implementation.

(3) In Stage 3 drought, the following restrictions shall apply:

a. *Irrigation*:

i. It shall be unlawful to run outside irrigation systems (including sprinklers, automatic sprinkler systems and unattended hoses) except on the day of the week permitted for the area as identified on the Water Rationing Zone Map.

ii. It shall be unlawful to utilize spray irrigation during the day specified in (d)(4)a.i., except for the following hours:

2:00 a.m. to ~~5~~ 7:00 a.m. for Automatic Sprinkler Systems

8:00 p.m. to 12 midnight for Hose-End Sprinkler Systems

iii. It shall be unlawful to operate a soaker hose, bubbler or drip irrigation system in a manner that causes the delivery of more water than the hose, bubbler, or system was intended by the manufacturer to deliver.

iv. It shall be unlawful to operate a soaker hose, bubbler or drip irrigation system in a manner that causes water to run down the curb.

v. New Landscape Waiver: The Public Works Department will not issue any waivers during a Stage 3 Drought Emergency.

vi. *Public and Private Golf Courses.*

Greens: Golf Courses may utilize Spray Irrigation on greens at any time for the purpose of cooling golf course greens when warranted by weather conditions and only with run cycles of less than 5 minutes every 60 minutes. Golf course greens are exempt from the Spray Irrigation times, and greens may be Spray Irrigated any day of the week, but will continue to be subject to the prohibition of spray irrigation during the daylight hours between 11a.m. and 6 p.m..

Tee Boxes: It shall be unlawful for golf courses to Spray Irrigate Tee-Boxes, except on the day of the week permitted for the area as identified on the Water Rationing Zone map, but will continue to be subject to the prohibition of spray irrigation during the daylight hours between 11a.m. and 6 p.m.

Fairways: It shall be unlawful for golf courses to Spray Irrigate Fairways.

All other Golf Course Features: It shall be unlawful for golf courses to Spray Irrigate any other landscape features, such as roughs, trees, shrubs, etc.

v. Nursery Plant Stock is exempt from the irrigation and landscape watering restrictions of this subsection.

b. Car washes / Detail Shops:

i. It shall be unlawful to wash a vehicle at any location other than a commercial car wash, car dealership, detail shop or automotive shop.

ii. The washing of a vehicle for health and safety reasons, sufficient to remove the hazard, is permitted any time.

iii. Washing a vehicle with a bucket, on the day to water or on the lawn while watering, other than at a commercial car wash, car dealership, detail shop or automotive shop, is prohibited.

iv. Fundraising car washes are prohibited.

v. All self-serve and full-service carwashes and detail shops will be required to close the car washing portion of their business on one day each week. The scheduled day of closure shall coincide with the day that car wash is allowed to irrigate, in accordance with the Water Rationing Zone map.

vi.. It shall be unlawful for a car wash or detail shop to use a nozzle that discharges more than 3.0 gallons per minute.

vii. It shall be unlawful for a car wash to wash any of its bays with water, except on Sundays.

c. Car Dealers / Fleets.

i. It shall be unlawful for a car dealer or an entity that maintains a fleet of motor vehicles to wash its inventory of cars on any day other than the day the property is authorized to spray irrigate in accordance with the Water Rationing Zone Map in effect.

ii. The washing of any vehicle in a fleet may take place only at a commercial car wash or at a location owned by the fleet's owner and that is used solely for commercial uses.

iii. Fleets may not be washed at any location used for residential purposes.

iv. It is an affirmative defense to prosecution that if a car dealer or car rental is preparing a car for pickup, it washed that vehicle (and only that vehicle) on the day of pick up by the customer. Otherwise, all vehicles are subject to (e)(3)c. above.

d. Restaurants / Bars / Clubs / School Cafeterias:

i. It shall be unlawful to provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.

ii. It shall be unlawful for a food establishment to thaw food with water. Food must be thawed by another legal method, such Refrigeration or Cooking Process.

iii. It shall be unlawful for a food establishment to clean kitchen or food handling areas with spray hoses.

e. Pools:

i. It shall be unlawful to operate a water feature on a Residential Pool, including, but not limited to, fountains, waterfalls, descents, arcs, and slides.

ii. If repairing a pool, it shall only be drained to a level necessary to affect the repair, and no further. Owners of pools that follow this restriction will be allowed to re-fill their pool after the repair.

iii. Owners Operators of pools that are restricted from draining the pool once it closed for the season.

f. Washing sidewalks, driveways, or concrete slabs: It shall be unlawful to wash sidewalks, driveways, or concrete slabs unless an immediate health or safety risk is present.

(4) During a Stage 3 Drought Emergency, the following surcharges will be applied to all applicable accounts:

a. For Residential Water Meters;

$1.00 per CCF between 10 CCF and 20 CCF,

$2.00 per CCF between 20 CCF and 40 CCF, and

$4.00 per CCF over 40 CCF.

b. For Irrigation Water Meters;

$1.00 per CCF between 0 CCF and 10 CCF,

$2.00 per CCF between 10 CCF and 20 CCF,

$4.00 per CCF between 20 CCF and 40 CCF, and

$8.00 per CCF over 40 CCF.

5. Stage 4: Drought Disaster.

(1) The Director of Public Works shall declare a Stage 4 Drought Disaster when the levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 30 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of potable water being provided by the City to less than 17 MGD:

a. Impose further mandatory restrictions on non-essential uses of water and essential uses of water.

b. Pull Hydrant Meters and suspend service thereon until conditions return to a Drought Emergency status.

c. Continue the aggressive public relations and education program.

(3) In Stage 4 drought, the following restrictions shall apply:

a. Irrigation:

i. *Irrigation Prohibited.* It shall be unlawful to utilize any type of irrigation using potable water produced by the City of Wichita Falls that is distributed through the City's distribution system on any day at any time. This restriction includes all forms of irrigation, including, spray, bubbler, drip, hand-watering, etc.

ii. *Public and Private Golf Courses.* It shall be unlawful to irrigate any and all vegetated landscape areas on the golf course including greens, tee boxes, fairways, roughs, trees, shrubs, etc.. Golf Courses will be allowed to utilize the remaining water within their pond system, as they see fit; but, will not be allowed to refill the ponds from the City system, while in a Stage 4 Drought Disaster.

iii. *Nursery Plant Stock.* Nursery Plant Stock is exempt from the irrigation and landscape watering restrictions of this subsection.

b. Car washes / Detail Shops:

i. It shall be unlawful to wash a vehicle at any location other than a commercial car wash, car dealership, detail shop or automotive shop.

ii. The washing of a vehicle for health and safety reasons, sufficient to remove the hazard, is permitted any time.

iii. Washing a vehicle with a bucket, on the day to water or on the lawn while watering, other than at a commercial car wash, car dealership, detail shop or automotive shop, is prohibited.

iv. Fundraising car washes are prohibited.

v. All self-serve and full-service carwashes and detail shops will be required to close the car washing portion of their business on one day each week. The scheduled day of closure shall coincide with the day that car wash is allowed to spray irrigate, in accordance with the Water Rationing Zone map.

vi.. It shall be unlawful for a car wash or detail shop to use a nozzle that discharges more than 3.0 gallons per minute.

vii. It shall be unlawful for a car wash to wash any of its bays with water, except on Sundays.

c. Car Dealers / Fleets.

i. It shall be unlawful for a car dealer or an entity that maintains a fleet of vehicles to wash its inventory of cars on any day other than the day the property was authorized to Spray Irrigate in accordance with the Water Rationing Zone Map.

ii. The washing of any vehicle in a fleet may take place only at a commercial car wash or at a location owned by the fleet's owner and that is used solely for commercial uses.

iii. Fleets may not be washed at any location used for residential purposes.

iv. It is an affirmative defense to prosecution that if a car dealer or car rental is preparing a car for pickup, it washed that vehicle (and only that vehicle) on the day of pick up by the customer. Otherwise, all vehicles are subject to (f)(3)c. above.

d. Restaurants / Bars / Clubs / School Cafeterias:

i. It shall be unlawful to provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.

ii. It shall be unlawful for a food establishment to thaw food with water. Food must be thawed by another legal method, such as Refrigeration or Cooking Process.

iii. It shall be unlawful for a food establishment to clean kitchen or food handling areas with spray hoses.

e. Pools:

i. It shall be unlawful to operate a water feature on a Residential Pool, including, but not limited to, fountains, waterfalls, descents, arcs, and slides.

ii. If repairing a pool, it shall only be drained to a level necessary to affect the repair, and no further. Owners of pools that follow this restriction will be allowed to re-fill their pool after the repair.

iii. Owners / Operators of pools are restricted from draining the pool once it closed for the season.

f. Large Industries

i. Large Industries will be notified by the City to initiate a Water Audit of their facilities.

ii. The Water Audit will include where water is being used within the facilities and where reductions in water usage can be made.

iii. Large Industries will have 60 days to conduct the Water Audit and submit a written report to the Director of Public Works detailing the findings of the Water Audit and the percent reduction in water consumption that can be achieved.

iv. Each Large Industry will be required to have all internal modifications to implement the water reduction completed and functioning by the time a Combined Lake Level of 20% is reached.

g. Watering Structures

i. The watering of Home Foundations is restricted to once a week, on the day the property was authorized to irrigate in accordance with the Water Rationing Zone Map.

Foundations may only be watered between the hours of 8:00 p.m. and 12:00 a.m. (midnight).

Foundations may only be watered with Soaker Hoses.

ii. It shall be unlawful to wash sidewalks, driveways, concrete slabs, any structure or any part of a structure during Stage 4 restrictions.

(4) During a Stage 4 Drought Disaster the following surcharges will be applied to all applicable accounts:

a. For Residential Water Meters;

$3.00 per CCF between 10 CCF and 20 CCF,

$6.00 per CCF between 20 CCF and 40 CCF, and

$12.00 per CCF over 40 CCF.

b. For Irrigation Water Meters;

$3.00 per CCF between 0 CCF and 10 CCF,

$6.00 per CCF between 10 CCF and 20 CCF,

$12.00 per CCF between 20 CCF and 40 CCF, and

$24.00 per CCF over 40 CCF.

6. Stage 5: Drought Catastrophe.

(1) The Director of Public Works shall declare a Stage 5 Drought Catastrophe when the levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 25 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of potable water being provided by the City to less than 14 MGD:

a. Impose further mandatory restrictions on non-essential uses of water and essential uses of water.

b. Continue the aggressive public relations and education program.

(3) In Stage 5 drought, the following restrictions shall apply:

a. Irrigation:

i. *Irrigation Prohibited.* It shall be unlawful to utilize any type of irrigation using potable water produced by the City of Wichita Falls that is distributed through the City's distribution system on any day at any time. This restriction includes all forms of irrigation, including, spray, bubbler, drip, hand-watering, etc.

ii. *Public and Private Golf Courses.* It shall be unlawful to irrigate any and all vegetated landscape areas on the golf course including greens, tee boxes, fairways, roughs, trees, shrubs, etc. The Golf Courses will be allowed to utilize the remaining water within their pond system, as they see fit; but, will not be allowed to refill the ponds from the City system, while in a Stage 5 Drought Disaster.

iii. *Nursery Plant Stock.* Nursery Plant Stock is exempt from the irrigation and landscape watering restrictions of this subsection.

b. Washing Cars when Lakes Arrowhead & Kickapoo are between 20% and 25%:

i. *Location of Washing Cars Limited to Reduce Runoff.* It shall be unlawful for any person to wash a vehicle at any location other than a commercial car wash, car dealership, detail shop, automotive shop, or commercial property that is owned by the owner of a Fleet of vehicles.

a. It shall be an affirmative defense to prosecution pursuant to this subsection i. that a person was washing a vehicle for health and safety reasons, only to an extent sufficient to remove the hazard, is permitted any time.

b. It shall be an affirmative defense to prosecution pursuant to this subsection i. that a car dealer or car rental company was preparing a vehicle for pickup and washed that vehicle on the day of pick up by the customer.

ii. *Allowable Times for Washing Vehicles Limited to Reduce Evaporation.* It shall be unlawful for any person to use potable water to wash a vehicle at any time on Sunday or Monday.

iii. *Nozzles.* It shall be unlawful for any car wash or detail shop to use a nozzle that discharges more than 3.0 gallons per minute.

iv. *Bays.* It shall be unlawful for a car wash to wash any of its bays with water, except on Fridays.

c. Washing vehicles when Lakes Arrowhead and Kickapoo are below 20%: It shall be unlawful for any person to use potable water to wash a vehicle at any time when the levels of Lakes Arrowhead and Kickapoo are at a combined capacity of less than 20%.

d. Restaurants / Bars / Clubs / School Cafeterias:

i. It shall be unlawful to provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.

ii. It shall be unlawful for a food establishment to thaw food with water. Food must be thawed by another legal method, such as Refrigeration or Cooking Process.

iii. It shall be unlawful for a food establishment to clean kitchen or food handling areas with spray hoses.

e. Pools:

i. It shall be unlawful to operate a water feature on any pool, including, but not limited to, fountains, water falls, descents, arcs, and slides.

ii. It shall be unlawful to fill, refill or add potable water to a private or public swimming or wading pool that is not located entirely within a fully-enclosed, climate-controlled structure.

iii. Indoor pools are exempt from the restrictions of (g)(3)e.

f. Watering Structures:

i. The watering of Home Foundations is restricted to once a week, on the day the property was authorized to irrigate in accordance with the Water Rationing Zone Map.

a. Foundations may only be watered between the hours of 8:00 p.m. and 12:00 a.m. (midnight).
b. Foundations may only be watered with Soaker Hoses.

ii. It shall be unlawful to wash sidewalks, driveways, concrete slabs, any structure or any part of a structure.

(4) During a Stage 5 Drought Catastrophe the following surcharges will be applied to all applicable accounts:

a. <u>For Residential Water Meters;</u>

$6.00 per CCF between 10 CCF and 20 CCF,

$12.00 per CCF between 20 CCF and 40 CCF, and

$24.00 per CCF over 40 CCF.

b. For Irrigation Water Meters;

$6.00 per CCF between 0 CCF and 10 CCF,

$12.00 per CCF between 10 CCF and 20 CCF,

$24.00 per CCF between 20 CCF and 40 CCF, and

$48.00 per CCF over 40 CCF.

E. System Priorities

During the planning portions of Stages 2, 3, 4 & 5 the following system priorities will be established and utilized in decision making processes during drought conditions. Those users with the highest priority will be the last to have their water use restricted. The system priority is as follows:

1. Hospitals and essential Health Care Facilities
2. Residential
3. Educational Institutions (Schools, Colleges, Universities, etc.)
4. Industrial
5. Commercial
6. Irrigation
7. Recreational

F. Initiation and Termination of Drought Stages

The Director of Public Works shall declare that each "trigger level" has been reached and that the water use restrictions for each respective stage are in effect. The water restrictions will remain in effect until the lakes fill to a level that when combined with the long-term forecast, assures the City an adequate supply of water.

Once an adequate supply of water is available, the City Council, by majority vote, and after consultation with the Director of Publics Works, shall announce the end to each respective stage of the restrictions.

G. Goals for Use Reduction

The goals for water use reduction vary according to the stage of the drought condition and have been detailed in Section VI – D, above.

If circumstances warrant, the City Manager or his/her official designee can set a goal for greater water use reduction.

H. Procedures for Granting Variances/Exemptions

There are exemptions/variances from water restrictions provided for in the City's Code of Ordinances (see Appendix 11). These exemptions primarily apply to the commercial home building for the installation of new yards. To qualify for the waiver, a new yard is defined as turf (not trees, shrubs or flowers) that has been installed within the last 60 days.

The applicant must follow a permitting process that includes;

1. Making application to the City Public Works Department (see Appendix 14).
2. Pay a $50.00 non-refundable fee.
3. Agree to pay a water rate three (3) times the normal rate.
4. Display the brightly colored permit in a location that is easily seen from the street.

Permitees are still bound by certain requirements to assist in water conservation, such as;

a. The irrigation cannot occur between 11am and 6pm.

Patrolling employees are provided a list of permits, so they are not issued a citation for restricted water usage.

I. Procedures for Enforcement

Adoption of the Plan and Drought Contingency Ordinance has enabled the City to implement and carry out enforcement of enacted ordinances to make the Plan effective and workable. The Ordinance adopting the Water Conservation Plan/Drought Contingency Plan and the Ordinance allowing for enforcement of the Plan are included in Appendix 11. Users of City water who do not comply with the requirements of the drought contingency measures will be subject to a penalty and fine as described in the City Code of Ordinances for each day of non-compliance. These users will also be subject to disconnection or discontinuance of City water services.

VII. SUMMARY AND CONCLUSIONS

The demand for water, as for other natural resources, has grown substantially. The per capita consumption in the City of Wichita Falls has doubled in the past fifty years. This increase, coupled with the increase in population and sales to local towns and communities, has required the construction of new lakes, water treatment plants, water distribution systems, elevated and ground storage tanks, wastewater collection lines, and wastewater treatment plants. The construction of water and wastewater facilities becomes more and more expensive each year as federal and state regulatory agencies increase the standards of performance of all of the facilities involved. These increased standards require increasingly expensive technology, maintenance and operation.

The City of Wichita Falls is fortunate that it has enough water to meet current demands and reasonable future demands. Nonetheless, the natural resource and various facilities necessary to produce high quality water are finite and expensive. It is in the interest of each citizen that all of these resources be managed and used as efficiently as possible.

Conservation makes sense. This Water Conservation & Drought Contingency Plan contains programs that can slow or even halt the growth of the per capita consumption of water, reduce the waste of water, and make better use of the water resources available to the citizens, and at the same time, allow the City to continue to progress in important projects of beautification and industrial development to improve the overall quality of life of its citizens.

APPENDIX 1

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY RULES ON WATER CONSERVATION PLANS FOR MUNICIPAL USES BY PUBLIC WATER SUPPLIERS

SUBCHAPTER A: WATER CONSERVATION PLANS
§§288.1 - 288.7
Effective December 6, 2012

§288.2. Water Conservation Plans for Municipal Uses by Public Water Suppliers.

(a) A water conservation plan for municipal water use by public water suppliers must provide information in response to the following. If the plan does not provide information for each requirement, the public water supplier shall include in the plan an explanation of why the requirement is not applicable.

(1) Minimum requirements. All water conservation plans for municipal uses by public water suppliers must include the following elements:

(A) a utility profile in accordance with the Texas Water Use Methodology, including, but not limited to, information regarding population and customer data, water use data (including total gallons per capita per day (GPCD) and residential GPCD), water supply system data, and wastewater system data;

(B) a record management system which allows for the classification of water sales and uses into the most detailed level of water use data currently available to it, including, if possible, the sectors listed in clauses (i) - (vi) of this subparagraph.

Any new billing system purchased by a public water supplier must be capable of reporting detailed water use data as described in clauses (i) - (vi) of this subparagraph;

(i) residential;

(I) single family;

(II) multi-family;

(ii) commercial;

(iii) institutional;

(iv) industrial;

(v) agricultural; and,

(vi) wholesale.

(C) specific, quantified five-year and ten-year targets for water savings to include goals for water loss programs and goals for municipal use in total GPCD and residential GPCD. The goals established by a public water supplier under this subparagraph are not enforceable;

(D) metering device(s), within an accuracy of plus or minus 5.0% in order to measure and account for the amount of water diverted from the source of supply;

(E) a program for universal metering of both customer and public uses of water, for meter testing and repair, and for periodic meter replacement;

(F) measures to determine and control water loss (for example, periodic visual inspections along distribution lines; annual or monthly audit of the water system to determine illegal connections; abandoned services; etc.);

(G) a program of continuing public education and information regarding water conservation;

(H) a water rate structure which is not "promotional," i.e., a rate structure which is cost-based and which does not encourage the excessive use of water;

(I) a reservoir systems operations plan, if applicable, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or river basin in order to optimize available water supplies; and

(J) a means of implementation and enforcement which shall be evidenced by:

(i) a copy of the ordinance, resolution, or tariff indicating official adoption of the water conservation plan by the water supplier; and

(ii) a description of the authority by which the water supplier will implement and enforce the conservation plan; and

(K) documentation of coordination with the regional water planning groups for the service area of the public water supplier in order to ensure consistency with the appropriate approved regional water plans.

(2) Additional content requirements. Water conservation plans for municipal uses by public drinking water suppliers serving a current population of 5,000 or more and/or a projected population of 5,000 or more within the next ten years subsequent to the effective date of the plan must include the following elements:

(A) a program of leak detection, repair, and water loss accounting for the water transmission, delivery, and distribution system;

(B) a requirement in every wholesale water supply contract entered into or renewed after official adoption of the plan (by either ordinance, resolution, or tariff), and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements in this chapter. If the customer intends to resell the water, the contract between the initial supplier and customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures in accordance with the provisions of this chapter.

(3) Additional conservation strategies. Any combination of the following strategies shall be selected by the water supplier, in addition to the minimum requirements in paragraphs (1) and (2) of this subsection, if they are necessary to achieve the stated water conservation goals of the plan. The commission may require that any of the following strategies be implemented by the water supplier if the commission determines that the strategy is necessary to achieve the goals of the water conservation plan:

(A) conservation-oriented water rates and water rate structures such as uniform or increasing block rate schedules, and/or seasonal rates, but not flat rate or decreasing block rates;

(B) adoption of ordinances, plumbing codes, and/or rules requiring water-conserving plumbing fixtures to be installed in new structures and existing structures undergoing substantial modification or addition;

(C) a program for the replacement or retrofit of water-conserving plumbing fixtures in existing structures;

(D) reuse and/or recycling of wastewater and/or graywater;

(E) a program for pressure control and/or reduction in the distribution system and/or for customer connections;

(F) a program and/or ordinance(s) for landscape water management;

(G) a method for monitoring the effectiveness and efficiency of the water conservation plan; and

(H) any other water conservation practice, method, or technique which the water supplier shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

(b) A water conservation plan prepared in accordance with 31 TAC §363.15 (relating to Required Water Conservation Plan) of the Texas Water Development Board and substantially meeting the requirements of this section and other applicable commission rules may be submitted to meet application requirements in accordance with a memorandum of understanding between the commission and the Texas Water Development Board.

c) A public water supplier for municipal use shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. The public water supplier for municipal use shall review and update the next revision of its water conservation plan every five years to coincide with the regional water planning group.

Adopted November 14, 2012 Effective December 6, 2012

APPENDIX 2

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY RULES ON WATER CONSERVATION PLANS FOR INDUSTRIAL/MINING WATER SUPPLIERS

SUBCHAPTER A: WATER CONSERVATION PLANS
§§288.1 - 288.7
Effective December 6, 2012

(a) A water conservation plan for industrial or mining uses of water must provide information in response to each of the following elements. If the plan does not provide information for each requirement, the industrial or mining water user shall include in the plan an explanation of why the requirement is not applicable.

(1) a description of the use of the water in the production process, including how the water is diverted and transported from the source(s) of supply, how the water is utilized in the production process, and the estimated quantity of water consumed in the production process and therefore unavailable for reuse, discharge, or other means of disposal;

(2) specific, quantified five-year and ten-year targets for water savings and the basis for the development of such goals. The goals established by industrial or mining water users under this paragraph are not enforceable;

(3) a description of the device(s) and/or method(s) within an accuracy of plus or minus 5.0% to be used in order to measure and account for the amount of water diverted from the source of supply;

(4) leak-detection, repair, and accounting for water loss in the water distribution system;

(5) application of state-of-the-art equipment and/or process modifications to improve water use efficiency; and

(6) any other water conservation practice, method, or technique which the user shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

(b) An industrial or mining water user shall review and update its water conservation pan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. The industrial or mining water user shall review and update the next revision of its water conservation plan every five years to coincide with the regional water planning group.

APPENDIX 3

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
FORM 10218

TCEQ

Texas Commission on Environmental Quality

UTILITY PROFILE AND WATER CONSERVATION PLAN REQUIREMENTS FOR MUNICIPAL WATER USE BY RETAIL PUBLIC WATER SUPPLIERS

This form is provided to assist retail public water suppliers in water conservation plan development. If you need assistance in completing this form or in developing your plan, please contact the conservation staff of the Resource Protection Team in the Water Availability Division at (512) 239-4691.

Name:	City of Wichita Falls	
Address:	P.O. Box 1431	
Telephone Number:	(940) -6911153	Fax: (940) -6914121
Water Right No.(s):	5122,5144,5150,	
Regional Water Planning Group:	B	
Form Completed by:	Daniel K. Nix	
Title:	Utilities Operations Manager	
Person responsible for implementing conservation program:	Daniel K. Nix	Phone: (940) 691-1153
Signature:		Date: / /

NOTE: If the plan does not provide information for each requirement, include an explanation of why the requirement is not applicable.

UTILITY PROFILE

I. POPULATION AND CUSTOMER DATA

A. *Population and Service Area Data*

1. Attach a copy of your service-area map and, if applicable, a copy of your Certificate of Convenience and Necessity (CCN).

2. Service area size (in square miles): 71.77

   (Please attach a copy of service-area map)

3. Current population of service area: 136,314

4. Current population served for:

   a. Water 136,314

   b. Wastewater 103,931

5. Population served for previous five years:

Year	*Population*
2009	140,230
2010	136,363
2011	136,363
2012	136,314
2013	136,314

6. Projected population for service area in the following decades:

Year	*Population*
2020	152,687
2030	155,679
2040	
2050	
2060	

7. List source or method for the calculation of current and projected population size.

   Wichita Falls Planning Department, 2006 Growth and Trends Report, VISION 20/20 Research, Socioeconomic Forecast Study (BWR)

B. *Customers Data*

Senate Bill 181 requires that uniform consistent methodologies for calculating water use and conservation be developed and available to retail water providers and certain other water use sectors as a guide for preparation of water use reports, water conservation plans, and reports on water conservation efforts. A water system must provide the most detailed level of customer and water use data available to it, however, any new billing system purchased must be capable of reporting data for each of the sectors listed below. http://www.tceq.texas.gov/assets/public/permitting/watersupply/water_rights/sb181_guidance.pdf

1. Current number of active connections. Check whether multi-family service is counted as ☒ Residential or ☐ Commercial?

Treated Water Users	*Metered*	*Non-Metered*	**Totals**
Residential	30,290		30,290
Single-Family			
Multi-Family			
Commercial	4,260		4,260
Industrial/Mining			
Institutional			
Agriculture			
Other/Wholesale	10,794		10,794

2. List the number of new connections per year for most recent three years.

Year	2011	2012	2013
Treated Water Users			
Residential	-90	0	-49
Single-Family			
Multi-Family			
Commercial	+24	-13	0
Industrial/Mining			
Institutional			
Agriculture			
Other/Wholesale	N/A	N/A	N/A

3. List of annual water use for the five highest volume customers.

	Customer	*Use (1,000 gal/year)*	*Treated or Raw Water*
1.	Allred Prison	213,307	Treated
2.	PPG	106,516	Treated
3.	Alcoa/Howmet	27,695	Treated
4.	Admiral Linen	26,678	Treated
5.	Midwestern State University	22,371	Treated

II. WATER USE DATA FOR SERVICE AREA

A. *Water Accounting Data*

1. List the amount of water use for the previous five years (in 1,000 gallons).
   Indicate whether this is ☒ diverted or ☐ treated water.

Year	2009	2010	2011	2012	2013
Month					
January	533,764	530,289	521,482	492,310	491,576
February	477,630	444,401	580,034	471,137	398,410
March	599,312	492,211	636,554	514,739	443,551
April	605,583	539,326	764,091	557,267	450,394
May	594,299	613,675	826,611	804,558	557,828
June	731,074	808,998	1,114,476	726,309	548,084
July	908,658	744,978	1,284,073	888,600	561,654
August	916,368	988,601	1,221,630	848,278	581,205
September	711,132	648,980	907,574	640,874	527,338
October	554,129	660,078	695,862	578,471	462,445
November	523,512	569,745	546,228	542,495	358,718
December	512,041	522,116	531,803	483,772	413.256
Totals	7,667,502	7,563,398	9,630,418	7,548,810	5,794,459

Describe how the above figures were determine (e.g, from a master meter located at the point of a diversion from the source, or located at a point where raw water enters the treatment plant, or from water sales).

Master Meter at entry point to the Treatment Plants.

2. Amount of water (in 1,000 gallons) delivered/sold as recorded by the following account types for the past five years.

Year	2009	2010	2011	2012	2013
Account Types					
Residential	2,580,094	2,755,292	3,571,573	2,891,042	1,828,666
Single-Family					
Multi-Family					
Commercial	2,388,432	2,956,215	2,687,435	2,783,124	2,171,255
Industrial/Mining					
Institutional					
Agriculture					
Other/Wholesale	1,571,416	1,553,670	1,938,588	1,616,614	1,236,014

3. List the previous records for water loss for the past five years (the difference between water diverted or treated and water delivered or sold).

Year	*Amount (gallons)*	*Percent %*
2013	558,524	9.6
2012	258,030	3.4
2011	1,432,822	14.9
2010	298,221	3.9
2009	1,127,560	14.7

B. Projected Water Demands

If applicable, attach or cite projected water supply demands from the applicable Regional Water Planning Group for the next ten years using information such as population trends, historical water use, and economic growth in the service area over the next ten years and any additional water supply requirements from such growth.

III. WATER SUPPLY SYSTEM DATA

A. Water Supply Sources

List all current water supply sources and the amounts authorized (in acre feet) with each.

Water Type	*Source*	*Amount Authorized*
Surface Water	Arrowhead, Kickapoo, Kemp	45,000, 40,000, 31,000
Groundwater	N/A	N/A
Contracts	N/A	N/A
Other	N/A	N/A

B. Treatment and Distribution System

1. Design daily capacity of system (MGD):74.0

2. Storage capacity (MGD):
   a. Elevated 6.5
   b. Ground 36.0

3. If surface water, do you recycle filter backwash to the head of the plant?

☒ Yes ☐ No If yes, approximate amount (MGD): 3.0

IV. WASTEWATER SYSTEM DATA

A. *Wastewater System Data (if applicable)*

1. Design capacity of wastewater treatment plant(s) (MGD): 21.41

2. Treated effluent is used for ☒ on-site irrigation, ☒ off-site irrigation, for ☒ plant wash-down, and/or for ☒ chlorination/dechlorination.

   If yes, approximate amount (in gallons per month): 1,321,227.917 gallons/month

3. Briefly describe the wastewater system(s) of the area serviced by the water utility. Describe how treated wastewater is disposed. Where applicable, identify treatment plant(s) with the TCEQ name and number, the operator, owner, and the receiving stream if wastewater is discharged.

   Wichita Falls has 2 Wastewater Treatment Plants. The smaller of the two (Northside) is located north of the City and was built principally to attract and serve major industries. The plant treats about 40% of the Sheppard Air Force Base sewage. The Plant utilizes oxidation ditches for treatment, and has a capacity of 1.5 MGD.
   The latest, state-of-the-art technology was incorporated into a major renovation and expansion of the River Road Wastewater Treatment Plant in 1992. This renovation brought the plant capacity to 19.91 MGD.
   Treated effluent from the Northside Plant is utilized by the SAFB Golf Course and the River Road effluent is used on-site and off-site for irrigation, and the reaminder is discharged to the Big Wichita River.

B. *Wastewater Data for Service Area (if applicable)*

1. Percent of water service area served by wastewater system: 76.3 %

2. Monthly volume treated for previous five years (in 1,000 gallons):

Year / *Month*	2009	2010	2011	2012	2013
January	313,830	353,360	294,170	316,870	287,820
February	274,430	397,760	293,700	304,120	251,410
March	294,270	407,810	320,500	370,540	277,010
April	323,250	418,930	307,880	361,910	284,520
May	323,250	457,420	323,170	347,350	276,040
June	343,170	388,540	314,180	328,300	275,740
July	328,620	405,530	312,980	307,160	266,510
August	328,620	355,390	310,870	323,420	280,330
September	320,020	382,160	299,870	312,910	285,190
October	324,720	335,050	344,420	311,530	277,110

November	313,600	297,690	314,880	278,230	263,950
December	333,530	268,980	314.270	288,890	279,430
Totals	3,498,060	4,468,620	3,750,890	3,851,230	3,305,060

V. ADDITIONAL REQUIRED INFORMATION

In addition to the utility profile, please attach the following as required by Title 30, Texas Administrative Code, §288.2. Note: If the water conservation plan does not provide information for each requirement, an explanation must be included as to why the requirement is not applicable.

A. *Specific, Quantified 5 & 10-Year Targets*

The water conservation plan must include specific, quantified five-year and ten-year targets for water savings to include goals for water loss programs and goals for municipal use in gallons per capita per day. Note that the goals established by a public water supplier under this subparagraph are not enforceable

B. *Metering Devices*

The water conservation plan must include a statement about the water suppliers metering device(s), within an accuracy of plus or minus 5.0% in order to measure and account for the amount of water diverted from the source of supply.

C. *Universal Metering*

The water conservation plan must include and a program for universal metering of both customer and public uses of water, for meter testing and repair, and for periodic meter replacement.

D. *Unaccounted- For Water Use*

The water conservation plan must include measures to determine and control unaccounted-for uses of water (for example, periodic visual inspections along distribution lines; annual or monthly audit of the water system to determine illegal connections; abandoned services; etc.).

E. *Continuing Public Education & Information*

The water conservation plan must include a description of the program of continuing public education and information regarding water conservation by the water supplier.

F. *Non-Promotional Water Rate Structure*

The water supplier must have a water rate structure which is not "promotional," i.e., a rate structure which is cost-based and which does not encourage the excessive use of water. This rate structure must be listed in the water conservation plan.

G. *Reservoir Systems Operations Plan*

The water conservation plan must include a reservoir systems operations plan, if applicable, providing for the coordinated operation of reservoirs owned by the applicant within a common watershed or river basin. The reservoir systems operations plan shall include optimization of water supplies as one of the significant goals of the plan.

H. Enforcement Procedure and Plan Adoption

The water conservation plan must include a means for implementation and enforcement, which shall be evidenced by a copy of the ordinance, rule, resolution, or tariff, indicating official adoption of the water conservation plan by the water supplier; and a description of the authority by which the water supplier will implement and enforce the conservation plan.

I. Coordination with the Regional Water Planning Group(s)

The water conservation plan must include documentation of coordination with the regional water planning groups for the service area of the wholesale water supplier in order to ensure consistency with the appropriate approved regional water plans.

J. Plan Review and Update

A public water supplier for municipal use shall review and update its water conservation plan, as appropriate, based on an assessment of previous five-year and ten-year targets and any other new or updated information. The public water supplier for municipal use shall review and update the next revision of its water conservation plan not later than May 1, 2009, and every five years after that date to coincide with the regional water planning group. The revised plan must also include an implementation report.

VI. ADDITIONAL REQUIREMENTS FOR LARGE SUPPLIERS

Required of suppliers serving population of 5,000 or more or a projected population of 5,000 or more within ten years

A. *Leak Detection and Repair*

The plan must include a description of the program of leak detection, repair, and water loss accounting for the water transmission, delivery, and distribution system in order to control unaccounted for uses of water.

B. *Contract Requirements*

A requirement in every wholesale water supply contract entered into or renewed after official adoption of the plan (by either ordinance, resolution, or tariff), and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using the applicable elements in this chapter. If the customer intends to resell the water, the contract between the initial supplier and customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures in accordance with the provisions of this chapter.

VII. ADDITIONAL CONSERVATION STRATEGIES

A. *Conservation Strategies*

Any combination of the following strategies shall be selected by the water supplier, in addition to the minimum requirements of this chapter, if they are necessary in order to achieve the stated water conservation goals of the plan. The commission may require by commission order that any of the following strategies be implemented by the water supplier if the commission determines that the strategies are necessary in order for the conservation plan to be achieved:

1. Conservation-oriented water rates and water rate structures such as uniform or increasing block rate schedules, and/or seasonal rates, but not flat rate or decreasing block rates;

2. Adoption of ordinances, plumbing codes, and/or rules requiring water conserving plumbing fixtures to be installed in new structures and existing structures undergoing substantial modification or addition;

3. A program for the replacement or retrofit of water-conserving plumbing fixtures in existing structures;

4. A program for reuse and/or recycling of wastewater and/or graywater;

5. A program for pressure control and/or reduction in the distribution system and/or for customer connections;

6. A program and/or ordinance(s) for landscape water management;

7. A method for monitoring the effectiveness and efficiency of the water conservation plan; and

8. Any other water conservation practice, method, or technique which the water supplier shows to be appropriate for achieving the stated goal or goals of the water conservation plan.

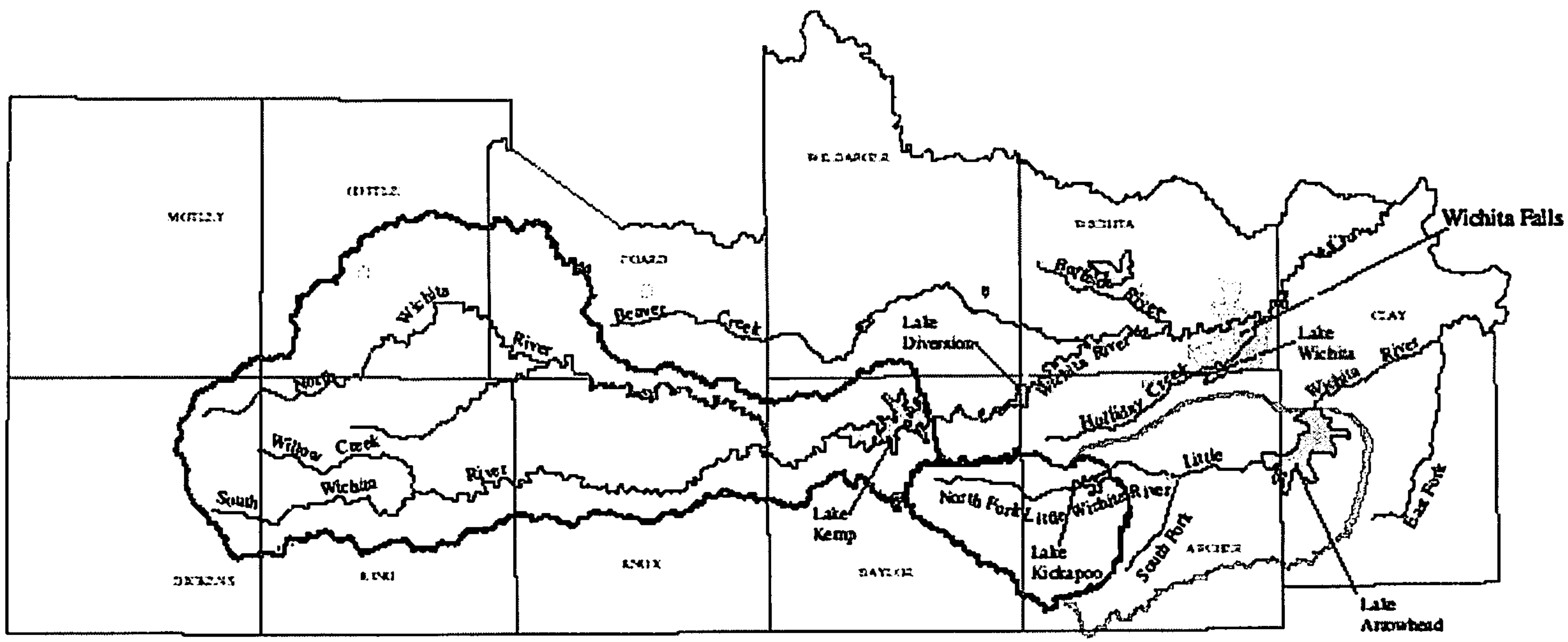
Best Management Practices

The Texas Water Developmental Board's (TWDB) Report 362 is the Water Conservation Best Management Practices (BMP) guide. The BMP Guide is a voluntary list of management practices that water users may implement in addition to the required components of Title 30, Texas Administrative Code, Chapter 288. The Best Management Practices Guide broken out by sector, including Agriculture, Commercial, and Institutional, Industrial, Municipal and Wholesale along with any new or revised BMP's can be found at the following link on the Texas Water Developments Board's website: http://www.twdb.state.tx.us/conservation/bmps/index.asp

Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact 512-239-3282.

APPENDIX 4

WATER RESOURCES MAP


Wichita Falls
Lake Wichita
Lake Diversion
Lake Kemp
Lake Kickapoo
Lake Arrowhead
Wichita River
Holliday Creek
Beaver Creek
North Fork Little Wichita River
Little
South Fork
East Fork
North
South
Wichita
Willow Creek
River
CLAY

APPENDIX 5
WHOLESALE WATER CUSTOMERS

Wholesale Water Customers

Customer Name	TWO	TWT	RWO	RWT
Sheppard Air Force Base	X	X		
Archer County MUD #1		X		
City of Burkburnett		X		
Dean Dale Special Utility District		X		
Friburg-Cooper WSC		X		
City of Holliday		X		
City of Iowa Park	X	X		
City of Lakeside City		X		
Town of Pleasant Valley		X		
City of Scotland		X		
City of Olney			X	
Red River Authority			X	
City of Archer City			X	
Wichita Valley WSC		X	X	
Windthorst WSC			X	

RWO – Raw Water Only

RWT – Raw Water Transmitted

TWO – Treated Water Only

TWT – Treated Water Transmitted

APPENDIX 6

REGIONAL COORDINATION DOCUMENTS

May 9, 2014

Mr. Curtis Campbell
Chair, Region B Water Planning Group
Red River Authority of Texas
P.O. Box 240
Wichita Falls, Texas 76307

Dear Mr. Campbell,

The enclosed 2014 Water Conservation and Drought Contingency Plans for the City of Wichita Falls are provided to you to meet the requirements set forth by the Texas Administrative Code. These plans are being submitted to coordinate water conservation and drought planning with the Region B Water Planning Group, and ensure consistency with the approved regional water plans.

If you have any questions on the enclosed plans or would like additional conservation and planning information, please let me know.

Sincerely,

Russell Schreiber, P.E.
Director of Public Works
City of Wichita Falls

Cc: Daniel K. Nix; Utilities Operations Manager
Water Conservation/Drought Contingency Plan Appendix 6

Enclosure: City of Wichita Falls 2008 Water Conservation/Drought Contingency Plan

APPENDIX 7
TEXAS WATER CODE
§ 11.039

Texas Water Code Section 11.039

§ 11.039. DISTRIBUTION OF WATER DURING SHORTAGE.

(a) If a shortage of water in a water supply not covered by a water conservation plan prepared in compliance with Texas Natural Resource Conservation Commission or Texas Water Development Board rules results from drought, accident, or other cause, the water to be distributed shall be divided among all customers pro rata, according to the amount each may be entitled to, so that preference is given to no one and everyone suffers alike.

(b) If a shortage of water in a water supply covered by a water conservation plan prepared in compliance with Texas Natural Resource Conservation Commission or Texas Water Development Board rules results from drought, accident, or other cause, the person, association of persons, or corporation owning or controlling the water shall divide the water to be distributed among all customers pro rata, according to:

(1) the amount of water to which each customer may be entitled; or

(2) the amount of water to which each customer may be entitled, less the amount of water the customer would have saved if the customer had operated its water system in compliance with the water conservation plan.

(c) Nothing in Subsection (a) or (b) precludes the person, association of persons, or corporation owning or controlling the water from supplying water to a person who has a prior vested right to the water under the laws of this state.

Amended by Acts 1977, 65th Leg., p. 2207, ch. 870, § 1, eff. Sept. 1, 1977; Acts 2001, 77th Leg., ch. 1126, § 1, eff. June 15, 2001.

APPENDIX 8

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
FORM 10213

Texas Commission on Environmental Quality **INDUSTRIAL/MINING WATER CONSERVATION PLAN** This form is provided to assist entities in conservation plan development for industrial/mining water use. If you need assistance in completing this form or in developing your plan, please contact the conservation staff of the Resource Protection Team in the Water Availability Division at (512) 239-4691.

Name: City of Wichita Falls
Address: P.O. Box 1431
Telephone Number: (940) -6911153 Fax: (940) -6914121
Form Completed by: Daniel K. Nix
Title: Utilities Opertions Manager

Signature: Date:5/9/2014

NOTE: If the plan does not provide information for each requirement, include an explanation of why the requirement is not applicable.

I. BACKGROUND DATA

A. *Water Use*

1. Annual diversion appropriated or requested (in acre-feet): 1,200 acre feet per annum

2. Maximum diversion rate (cfs):

B. *Water Sources*

1. Please indicate the maximum or average annual amounts of water currently used and anticipated to be used (in acre-feet) for industrial/mining purposes:

Source	*Water Right No.(s)*	*Current Use*	*Anticipated Use*
Surface Water	02-5144, 02-5150	0.0	1,200
Groundwater			
Purchased			
Total		0.0	1,200

2. How was the surface water data and/or groundwater data provided above (B1) obtained?

Master meter ______; Customer meter Yes.; Estimated ______; Other No water was diverted since 2011, so there was no metering involved.

3. Was purchased water raw or treated?

If both, % raw N/A; % treated ______ and Supplier(s): ______

C. Industrial/Mining Information

1. Major product(s) or service(s) produced by applicant: Oilfield Exploration

2. North American Industry Classification System (NAICS):

211111 ______ ______ ______ ______ ______

II. WATER USE AND CONSERVATION PRACTICES

A. Water Use in Industrial or Mining Processes

Production Use	*% Groundwater*	*% Surface Water*	*% Saline Water*	*% Treated Water*	*Water Use (in acre-ft)*
Cooling, condensing, & refrigeration					
Processing, washing, transport					
Boiler feed					
Incorporated into product					
Other	0	100	0	0	1,200

Facility Use	*% Groundwater*	*% Surface Water*	*% Saline Water*	*% Treated Water*	*Water Use (in acre-ft)*
Cooling tower(s					
Pond(s)					
Once through					
Sanitary & drinking water					
Irrigation & dust control					

1. Was fresh water recirculated at this facility? ☐ Yes ☒ No

2. Provide a <u>detailed description</u> of how the water will be utilized in the industrial or mining process.

   Production of natural gas with fracing operations.

3. Estimate the quantity of water consumed in production and mining processes and is therefore unavailable for reuse, discharge or other means of disposal.

   N/A

4. Monthly water demand for previous year (in acre-feet).

Month	*Diversion Amount*	*% of Water Returned (If Any)*	*Monthly Demand*
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	0	0	0
June	0	0	0
July	0	0	0
August	0	0	0
September	0	0	0
October	0	0	0
November	0	0	0
December	0	0	0
Totals	0	0	0

5. Projected monthly water demand for next year (in acre-feet).

Month	*Diversion Amount*	*% of Water Returned*	*Monthly Demand*
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	0	0	0
June	0	0	0
July	0	0	0
August	0	0	0
September	0	0	0
October	0	0	0
November	0	0	0
December	0	0	0
Totals	0	0	0

B. Specific and Quantified Conservation Goal

Water conservation goals for the industrial and mining sector are generally established either for (1) the amount of water recycled, (2) the amount of water reused, or (3) the amount of water not lost or consumed, and therefore is available for return flow.

1. Water conservation goal (water use efficiency measure)

   Type of goal(s):

   X % reused water

   ______ % of water not consumed and therefore returned

   ______ Other (specify)

2. Provide specific and quantified five-year and ten-year targets for water savings and the basis for development of such goals for this water use/facility.

   2.5% by 2019

   5.0% by 2024

3. Describe the methods and/or device(s) within an accuracy of plus or minus 5% used to measure and account for the amount of water diverted from the supply source.

   Mechanical or Doopler meters will be used to measure flow within the required accuracy range. This will ensure adequate accounting of diversions.

4. Provide a description of the leak-detection and repair, and water-loss accounting measures used.

The City has a standard policy for leak detection and water loss accounting. This policy is part of the municiapl conservation plan and implementation of same. The City will utilize these same policies as it manages diversions of raw water for industrial pruposes.

5. Equipment and/or process modifications used to improve water use efficiency.

Industrial users will be encouraged to reclaim and reuse water.

6. Other water conservation techniques used.

Education and outreach related to conservation and the efficient use of water resources.

Best Management Practices

The Texas Water Developmental Board's (TWDB) Report 362 is the Water Conservation Best Management Practices (BMP) guide. The BMP Guide is a voluntary list of management practices that water users may implement in addition to the required components of Title 30, Texas Administrative Code, Chapter 288. The Best Management Practices Guide broken out by sector, including Agriculture, Commercial, and Institutional, Industrial, Municipal and Wholesale along with any new or revised BMP's can be found at the following link on the Texas Water Developments Board's website: http://www.twdb.state.tx.us/conservation/bmps/index.asp

Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact 512-239-3282.

APPENDIX 9

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY RULES ON DROUGHT CONTINGENCY PLANS FOR MUNICIPAL USES BY PUBLIC WATER SUPPLIERS

SUBCHAPTER B: DROUGHT CONTINGENCY PLANS
§288.20 - 288.22
Effective October 7, 2004

§288.20. Drought Contingency Plans for Municipal Uses by Public Water Suppliers.

(a) A drought contingency plan for a retail public water supplier, where applicable, must include the following minimum elements.

(1) Minimum requirements. Drought contingency plans must include the following minimum elements.

(A) Preparation of the plan shall include provisions to actively inform the public and affirmatively provide opportunity for public input. Such acts may include, but are not limited to, having a public meeting at a time and location convenient to the public and providing written notice to the public concerning the proposed plan and meeting.

(B) Provisions shall be made for a program of continuing public education and information regarding the drought contingency plan.

(C) The drought contingency plan must document coordination with the regional water planning groups for the service area of the retail public water supplier to ensure consistency with the appropriate approved regional water plans.

(D) The drought contingency plan must include a description of the information to be monitored by the water supplier, and specific criteria for the initiation and termination of drought response stages, accompanied by an explanation of the rationale or basis for such triggering criteria.

(E) The drought contingency plan must include drought or emergency response stages providing for the implementation of measures in response to at least the following situations:

(i) reduction in available water supply up to a repeat of the drought of record;

(ii) water production or distribution system limitations;

(iii) supply source contamination; or

(iv) system outage due to the failure or damage of major water system components (e.g., pumps).

(F) The drought contingency plan must include specific, quantified targets for water use reductions to be achieved during periods of water shortage and drought. The entity preparing the plan shall establish the targets. The goals established by the entity under this subparagraph are not enforceable.

(G) The drought contingency plan must include the specific water supply or water demand management measures to be implemented during each stage of the plan including, but not limited to, the following:

(i) curtailment of non-essential water uses; and

(ii) utilization of alternative water sources and/or alternative delivery mechanisms with the prior approval of the executive director as appropriate (e.g., interconnection with another water system, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.).

(H) The drought contingency plan must include the procedures to be followed for the initiation or termination of each drought response stage, including procedures for notification of the public.

(I) The drought contingency plan must include procedures for granting variances to the plan.

(J) The drought contingency plan must include procedures for the enforcement of mandatory water use restrictions, including specification of penalties (e.g., fines, water rate surcharges, discontinuation of service) for violations of such restrictions.

(2) Privately-owned water utilities. Privately-owned water utilities shall prepare a drought contingency plan in accordance with this section and incorporate such plan into their tariff.

(3) Wholesale water customers. Any water supplier that receives all or a portion of its water supply from another water supplier shall consult with that supplier and shall include in the drought contingency plan appropriate provisions for responding to reductions in that water supply.

(b) A wholesale or retail water supplier shall notify the executive director within five business days of the implementation of any mandatory provisions of the drought contingency plan.

(c) The retail public water supplier shall review and update, as appropriate, the drought contingency plan, at least every five years, based on new or updated information, such as the adoption or revision of the regional water plan.

Adopted September 15, 2004 Effective October 7, 2004

APPENDIX 10
RESTRICTION PROGRAM FOR OUTDOOR WATER USE

Restriction Program for Outdoor Water Uses

A. Introduction and Background

A water utility is susceptible to both temporary and long-term interruptions and reductions of water service to its customer. The utility cannot always prevent those interruptions that are mechanical, however those occurring because of a reduction of water resources can be controlled. A major component of this will be the control of outdoor water use. The City of Wichita Falls has a program in place that was initially developed during the high demand summer of 1986 and revised during the 1995-2000 drought, as well as the current drought of 2011-2014. A brief outline of the City's procedures is included in Appendix 11.

B. Legal Basis

The Code of Ordinances of the City of Wichita Falls provides the legal basis for the restrictions on the use of water. Section 106-186 of the Code is provided in Appendix 11.

C. Restrictions and Considerations

The type of restrictions on outdoor water use will depend whether the objective is to reduce the peak demand or to reduce the overall use of water. The City of Wichita Falls has opted not to use an alternate day or an "odd/even" system of restrictions. Historical data has shown that both peak demands and overall water use may increase using these types of systems.

The City has opted to create a once a week outdoor watering schedule by logically dividing the City into 5 zones. A map of the watering zones is included in Appendix 12. Watering is allowed Monday through Friday dependent upon the zone that the residence or business is located. No outdoor watering is allowed on Saturday or Sunday, except those uses allowed by the Code of Ordinances.

If necessary, the City of Wichita Falls can adopt stricter requirements to meet the requirements of a particular situation. These may include limiting the overall water use of the customer.

D. Public Information

Anytime restrictions are implemented, City staff will use all avenues available to them to provide pertinent information to the citizens. The primary conduit for this information is the City of Wichita Falls Public Information Office. All Press Releases and Conferences are coordinated with the Public Information Office. In addition, extensive use of the City's cable access channel and social media sights are utilized. City staff can be interviewed and that information disseminated to the public through these invaluable media resources.

E. Enforcement of Restrictions

The City does not use sworn peace officers for the enforcement of any restrictions. The City uses trained regular employees for this purpose. It is also possible for any citizen can file a complaint affidavit with the Municipal Court. City employees are used to file legal complaints on any person found violating the restrictions.

The employees patrol the areas that are not allowed to have outside watering based on the previously mentioned watering zone map. The employee, if witnessing a violation, takes photographs of the offense, prepares a probably cause affidavit and it is submitted to the Municipal Court. The occupant of the location of the violation is left a notification on their front door of the infraction and that they will be contacted by Municipal Court. (see attached Notification Form). The employees are trained to avoid confrontations with the customer.

Enforcement previously has been only as aggressive as necessary to achieve compliance. In cases, where a citizen calls and reports a neighbors or business violation and the water patrol does not make to the address in time to witness the infraction, the employee polite informs the customer that they were turned in by someone for violating the Ordinance and that they will be monitored for future compliance.

F. Exemptions from Restrictions

There are exemptions provided for in the Code of Ordinances. These exemptions generally apply to the installation of new turf. A permitting process for this is in place. (see Appendix 14)

Patrolling employees are provided a list of customers that have successfully applied for and received an exemption.

G. Management Controls

Utilities management staff need to receive data to determine the effect of the restrictions and to allow adjustments if necessary. Data analyzed may include pressure readings, production reports, billing reports, customer complaint reports and citation reports.

H. Coordination

All of these activities are to be coordinated with :

City Manager's Office

Public Works

Utility Collections

City Attorney's Office

Municipal Court Prosecutor

Municipal Court Administrator

Public Information

I. Restrictions of Wholesale Customers

All of the City of Wichita Falls wholesale customers are notified in writing when the City begins any implementation of water use restrictions. They are required by their contract with the City to comply with the goals of the City's restrictions. Periodically, through the restrictions, the wholesale customers are notified as to whether or not they are successfully attaining the goals or if they are falling short of the goal. This constant feedback is critical to the wholesale customers being able know if their conservation efforts are effective or if they need to be adjusted to achieve the desired conservation level.

APPENDIX 11

CITY OF WICHITA FALLS
WATER CONSERVATION ORDINANCE

DIVISION 6. WATER CONSERVATION / DROUGHT CONTINGENCY

Sec. 106-185. Definitions.

Unless otherwise expressly stated or the context clearly indicates a different intention, the following terms shall, for the purpose of this article, have the meanings indicated in this section:

Automatic Sprinkler System -- a system of irrigation components made up of permanently installed underground PVC lines and spray irrigation devices that are controlled from an automatic irrigation controller.

Car Wash – a place or business equipped for washing cars, trucks, motorbikes, boats, airplanes, other motor vehicles and trailers.

Drip Irrigation -- a method of irrigation that applies water in a dropwise fashion directly to the soil beneath rather than projecting the water in a stream away from its orifice. To be classified in this category, the maximum allowable flow is 6 gallons per hour per emitter.

Essential Water Use: water that is required by Federal, State or Local regulation and/or is attributed to the health and safety of the citizens of Wichita Falls.

Fleet – A group of commercial motor vehicles owned by a single entity that totals more than 5 vehicles.

Hose-end sprinkler system -- a device on the end of a garden hose that can be set in place and can periodically be moved from one location to another.

Indoor Pool –pool located entirely within a fully enclosed, climate controlled structure.

MGD: Million gallons per day

Non-Essential Water Use: water use that does not directly impact the health or safety of the citizens of Wichita Falls, or are a requirement of a Federal, State or Local regulation.

Owner/Operator of a pool – Fee title holder of the property upon which the pool is located, and/or business manager, complex manager, property owners, association manager, rental agent or other individual who is in charge of the day to day operation or maintenance of the property.

Residential Pool – A pool that is located on private property under the control of the property owner or the owner's tenant and that is intended for use by not more than two residential families and their guests. It includes a pool serving only a single-family home or duplex.

Soaker hose -- an irrigation device made of permeable rubber hose that allows water to be applied slowly and directly to the soil without being sprayed up into the air. Soaker hoses fall into the drip irrigation category. A soaker hose will not spray water regardless of its orientation.

Spa and/or Hot-Tub--a structure that is intended to be filled with water that circulates through an on-site filtration system and is not intended to be drained or refilled after each use.

Spray Irrigate or *Spray Irrigation* -- a category of irrigation method that utilizes devices that spray water away from the device orifice(s). These include, but are not limited to, pop-up sprays, rotors, oscillating sprinklers, and impact sprinklers. A hand held hose is not Spray Irrigation.

Vehicle – A motor vehicle, car, truck, motorcycle, bicycle, boat, trailer, or other conveyance.

Sec. 106-186. Water shortage; authority of department.

(a) *Water conservation restrictions effective at all times.* It shall be unlawful for any person, firm, corporation or other entity, at any time of the year, to:

(1) run outside spray-type irrigation on any day of the week between 11:00 a.m. and 6:00 p.m. unless one is using a hand-held hose, soaker hose, bucket, watering can, bubbler or drip irrigation system,

(2) wash a vehicle at any location other than a commercial car wash, car dealership, detail shop or automotive shop unless the hose is equipped with a nozzle that stops the flow of water through the hose when released by the operator, or

(3) provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.

(b) Discretionary drought restrictions. The Director of Public Works may declare any stage of drought restrictions described in this ordinance to be effective if:

(1) the system demand exceeds 90% design treatment capacity for three or more consecutive days,

(2) the water supply system is unable to deliver water due to mechanical failure or damage of major water system components which are expected to require more than 72 hours to repair, or

(3) the water system is contaminated either accidentally or intentionally, or the water system fails from acts of nature or man.

The establishment of a discretionary drought restriction will be effective when publicized in the media and the filing of a written declaration with the City Manager and City Clerk. Upon any declaration of such drought stage, it shall be unlawful for a person to fail to comply with the restrictions applicable to that stage. The Director of Public Works may terminate any of the aforementioned discretionary drought restrictions by filing a written notice of termination with the City Manager and City Clerk.

(c) *Stage 1 - Drought Watch*

(1) The Director of Public Works shall declare a Stage 1 Drought Watch when the levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 60 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of water being used by 5%:

a. The City Council and other City Departments will be notified of the impending problem and the proposed immediate and future actions.

b. The City shall initiate an education program through all available media to:

i. Alert the public to the depletion of the reservoirs; current rate of withdrawals and the effect of such withdrawals; current treatment rates; current meteorological conditions; and the long-range weather forecast from the National Weather Service.

ii. Alert the public to the drought management program, the various stages and measures, and the possibility of implementation.

iii. Keep a constant flow of information to the public to condition them for more stringent measures.

c. Parks Department will reduce its watering schedule to twice per week.

d. The Public Works Department will coordinate with other departments on the structure of a program to implement voluntary and non-voluntary water restrictions.

e. The Public Works Department will conduct training necessary to implement the water restriction program.

f. The Public Works Department will prepare all administrative processes (forms, affidavits, maps, offices, etc.) for the restriction program.

(3) *Near 50 Percent Capacity.* When the levels near a combined capacity of 50 percent, the city shall mail a copy of the Water Rationing Zone Map, with a cover letter describing the drought conditions, to each water account. Failure to mail or receive such warning shall not be a defense to any crime, restriction, or charge established in this division.

(d) *Stage 2 - Drought Warning.*

(1) The Director of Public Works shall declare a Stage 2 Drought Warning when levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 50 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of water being used by 15%:

e. Form a Drought Emergency Task Force for guidance through the remainder of the drought and to interface with the public.

f. Suspend all non-essential operational use of water by City of Wichita Falls, such as flushing water mains, street sweeping, water jet cleaning of sanitary sewer mains, fire fighter training, etc.), except where such use of water is critical to the health and safety of the citizens.

g. Parks Department will reduce watering to once per week or only enough water to support their trees, whichever is less.

h. Notify all wholesale customers of the situation and inform them of the reduction goals for their systems in accordance with their individual contracts with the City of Wichita Falls. Pro rata curtailment by wholesale customers will be based upon their contractual limits as provided in Texas Water Code § 11.039.

(3) In Stage 2 drought, the following restrictions shall apply:

e. Irrigation:

viii. It shall be unlawful to run outside irrigation systems (including sprinklers, automatic sprinkler systems and unattended hoses) except on the day of the week permitted for the area as identified on the Water Rationing Zone Map. An official copy of the Water Rationing Zone Map shall be kept on file in the office of the City Clerk.

ix. It shall be unlawful to utilize spray irrigation between the hours of 11:00 a.m. and 6:00 p.m.

x. Landscape watering is permitted any day at any time with a hand-held hose, soaker hose, bucket (five gallons or less), watering can, bubbler or drip irrigation system.

xi. On days other than the day of the week permitted by the Water Rationing Zone Map, testing and troubleshooting of irrigation systems that involve the release of water is permissible any time, including between the hours of 11:00 a.m. to 6:00 p.m., as long as a licensed plumber or irrigator is present on location during testing (and visible to the ticket writer). Testing and troubleshooting of irrigation systems by other than a licensed plumber or irrigator that involves the release of water is otherwise permissible only on the day of week and time of day permitted by the Water Rationing Zone Map.

xii. *New Landscape Waiver.* A waiver of this subsection may be granted for the irrigation of new landscaping plants whereby watering would be permitted to maintain adequate growth until the plants are established but not to exceed a 30-day time period. Any person wishing such a waiver must make application to the City Public Works Department and pay a $50.00 nonrefundable fee. The applicant must agree to pay a water rate that is three times the normal rate for that customer for all consumption over 10 CCF as registered by residential meters and all consumption as registered by Irrigation meters or commercial meters.

xiii. *Public and Private Golf Courses.*

Greens: Golf Courses may utilize Spray Irrigation on greens at any time for the purpose of cooling golf course greens when warranted by weather conditions and only with run cycles of less than 5 minutes every 60 minutes. Golf course greens are exempt from the Spray Irrigation days established in (d) (3) a., and greens may be Spray Irrigated any day of the week, but will be subject to the prohibition of spray irrigation during the daylight hours between 11a.m. & 6 p.m..

Tee Boxes: It shall be unlawful for golf courses to Spray Irrigate Tee-Boxes, except on the day of the week permitted for the area as identified on the Water Rationing Zone map, but will be subject to the prohibition of spray irrigation during the daylight hours between 11a.m. & 6 p.m.

Fairways: It shall be unlawful for golf courses to Spray Irrigate Fairways, except on the day of the week permitted for the area as identified on the Water Rationing Zone map, , but will be subject to the prohibition of spray irrigation during the daylight hours between 11a.m. & 6 p.m..

All other Golf Course Features: It shall be unlawful for golf courses to Spray Irrigate any other landscape features, such as roughs, trees, shrubs, etc.

xiv. Nursery plant stock is exempt from the irrigation and landscape watering restrictions of this subsection.

f. Carwashing:

v. It shall be unlawful to wash a vehicle at any location other than a commercial car wash, car dealership, detail shop or automotive shop.

vi. The washing of a vehicle for health and safety reasons, sufficient to remove the hazard, is permitted any time.

vii. Washing a vehicle with a bucket, on the day to water or on the lawn while watering, other than at a commercial car wash, car dealership, detail shop or automotive shop, is prohibited.

viii. Fundraising car washes are prohibited.

g. Restaurants / Bars / Clubs / School Cafeterias. It shall be unlawful to provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.

h. Washing sidewalks, driveways, or concrete slabs: It shall be unlawful to wash sidewalks, driveways, or concrete slabs unless an immediate health or safety risk is present.

(5) During a Stage 2 Drought Warning, the following surcharges will be applied to all applicable accounts:

c. For Residential Water Meters;
$0.50 per hundred cubic feet (CCF) between 10 CCF and 20 CCF,
$1.00 per CCF between 20 CCF and 40 CCF, and
$2.00 per CCF over 40 CCF.

d. For Irrigation Water Meters;
$0.50 per CCF between 0 CCF and 10 CCF,
$1.00 per CCF between 10 CCF and 20 CCF,
$2.00 per CCF between 20 CCF and 40 CCF, and
$4.00 for each CCF over 40 CCF.

(e) *Stage 3 – Drought Emergency*:

(1) The Director of Public Works shall declare a Stage 3 Drought Emergency when the levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 40 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of water being used by 35%:

a. monitor all Fire Hydrant Meters that are for contractor use, to determine what conservation can be achieved through this type of water usage,

b. specify and impose mandatory reductions on wholesale (raw & treated) water customers in accordance with Texas Water Code § 11.039, and

c. begin establishing a program for a Drought Disaster, which will allow restriction on the essential uses of water and prepare for implementation.

(3) In Stage 3 drought, the following restrictions shall apply:

g. *Irrigation*:

iii. It shall be unlawful to run outside irrigation systems (including sprinklers, automatic sprinkler systems and unattended hoses) except on the day of the week permitted for the area as identified on the Water Rationing Zone Map.

ii. It shall be unlawful to utilize spray irrigation during the day specified in (d)(4)a.i., except for the following hours:
2:00 a.m. to ~~5~~ 7:00 a.m. for Automatic Sprinkler Systems
8:00 p.m. to 12 midnight for Hose-End Sprinkler Systems

iii. It shall be unlawful to operate a soaker hose, bubbler or drip irrigation system in a manner that causes the delivery of more water than the hose, bubbler, or system was intended by the manufacturer to deliver.

vii. It shall be unlawful to operate a soaker hose, bubbler or drip irrigation system in a manner that causes water to run down the curb.

viii. New Landscape Waiver: The Public Works Department will not issue any waivers during a Stage 3 Drought Emergency.

ix. *Public and Private Golf Courses.*

Greens: Golf Courses may utilize Spray Irrigation on greens at any time for the purpose of cooling golf course greens when warranted by weather conditions and only with run cycles of less than 5 minutes every 60 minutes. Golf course greens are exempt from the Spray Irrigation times, and greens may be Spray Irrigated any day of the week, but will continue to be subject to the prohibition of spray irrigation during the daylight hours between 11a.m. and 6 p.m..

Tee Boxes: It shall be unlawful for golf courses to Spray Irrigate Tee-Boxes, except on the day of the week permitted for the area as identified on the Water Rationing Zone map, but will continue to be subject to the prohibition of spray irrigation during the daylight hours between 11a.m. and 6 p.m.

Fairways: It shall be unlawful for golf courses to Spray Irrigate Fairways.

All other Golf Course Features: It shall be unlawful for golf courses to Spray Irrigate any other landscape features, such as roughs, trees, shrubs, etc.

v. Nursery Plant Stock is exempt from the irrigation and landscape watering restrictions of this subsection.

h. Car washes / Detail Shops:

vi. It shall be unlawful to wash a vehicle at any location other than a commercial car wash, car dealership, detail shop or automotive shop.

vii. The washing of a vehicle for health and safety reasons, sufficient to remove the hazard, is permitted any time.

viii. Washing a vehicle with a bucket, on the day to water or on the lawn while watering, other than at a commercial car wash, car dealership, detail shop or automotive shop, is prohibited.

ix. Fundraising car washes are prohibited.

x. All self-serve and full-service carwashes and detail shops will be required to close the car washing portion of their business on one day each week. The scheduled day of closure shall coincide with the day that car wash is allowed to irrigate, in accordance with the Water Rationing Zone map.

vi.. It shall be unlawful for a car wash or detail shop to use a nozzle that discharges more than 3.0 gallons per minute.

vii. It shall be unlawful for a car wash to wash any of its bays with water, except on Sundays.

i. Car Dealers / Fleets.

iv. It shall be unlawful for a car dealer or an entity that maintains a fleet of motor vehicles to wash its inventory of cars on any day other than the day the property is authorized to spray irrigate in accordance with the Water Rationing Zone Map in effect.

v. The washing of any vehicle in a fleet may take place only at a commercial car wash or at a location owned by the fleet's owner and that is used solely for commercial uses.

vi. Fleets may not be washed at any location used for residential purposes.

iv. It is an affirmative defense to prosecution that if a car dealer or car rental is preparing a car for pickup, it washed that vehicle (and only that vehicle) on the day of pick up by the customer. Otherwise, all vehicles are subject to (e)(3)c. above.

j. Restaurants / Bars / Clubs / School Cafeterias:

i. It shall be unlawful to provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.

iv. It shall be unlawful for a food establishment to thaw food with water. Food must be thawed by another legal method, such Refrigeration or Cooking Process.

iii. It shall be unlawful for a food establishment to clean kitchen or food handling areas with spray hoses.

k. Pools:

i. It shall be unlawful to operate a water feature on a Residential Pool, including, but not limited to, fountains, waterfalls, descents, arcs, and slides.

ii. If repairing a pool, it shall only be drained to a level necessary to affect the repair, and no further. Owners of pools that follow this restriction will be allowed to re-fill their pool after the repair.

iii. Owners Operators of pools that are restricted from draining the pool once it closed for the season.

l. Washing sidewalks, driveways, or concrete slabs: It shall be unlawful to wash sidewalks, driveways, or concrete slabs unless an immediate health or safety risk is present.

(5) During a Stage 3 Drought Emergency, the following surcharges will be applied to all applicable accounts:

a. For Residential Water Meters;
$1.00 per CCF between 10 CCF and 20 CCF,
$2.00 per CCF between 20 CCF and 40 CCF, and
$4.00 per CCF over 40 CCF.

b. For Irrigation Water Meters;
$1.00 per CCF between 0 CCF and 10 CCF,
$2.00 per CCF between 10 CCF and 20 CCF,
$4.00 per CCF between 20 CCF and 40 CCF, and
$8.00 per CCF over 40 CCF.

(f) *Stage 4 - Drought Disaster*

(1) The Director of Public Works shall declare a Stage 4 Drought Disaster when the levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 30 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of potable water being provided by the City to less than 17 MGD:

d. Impose further mandatory restrictions on non-essential uses of water and essential uses of water.

e. Pull Hydrant Meters and suspend service thereon until conditions return to a Drought Emergency status.

f. Continue the aggressive public relations and education program.

(3) In Stage 4 drought, the following restrictions shall apply:

g. Irrigation:

i. *Irrigation Prohibited.* It shall be unlawful to utilize any type of irrigation using potable water produced by the City of Wichita Falls that is distributed through the City's distribution system on any day at any time.

This restriction includes all forms of irrigation, including, spray, bubbler, drip, hand-watering, etc.

ii. *Public and Private Golf Courses.* It shall be unlawful to irrigate any and all vegetated landscape areas on the golf course including greens, tee boxes, fairways, roughs, trees, shrubs, etc.. Golf Courses will be allowed to utilize the remaining water within their pond system, as they see fit; but, will not be allowed to refill the ponds from the City system, while in a Stage 4 Drought Disaster.

iii. *Nursery Plant Stock.* Nursery Plant Stock is exempt from the irrigation and landscape watering restrictions of this subsection.

h. Car washes / Detail Shops:

vi. It shall be unlawful to wash a vehicle at any location other than a commercial car wash, car dealership, detail shop or automotive shop.

vii. The washing of a vehicle for health and safety reasons, sufficient to remove the hazard, is permitted any time.

viii. Washing a vehicle with a bucket, on the day to water or on the lawn while watering, other than at a commercial car wash, car dealership, detail shop or automotive shop, is prohibited.

ix. Fundraising car washes are prohibited.

x. All self-serve and full-service carwashes and detail shops will be required to close the car washing portion of their business on one day each week. The scheduled day of closure shall coincide with the day that car wash is allowed to spray irrigate, in accordance with the Water Rationing Zone map.

vi.. It shall be unlawful for a car wash or detail shop to use a nozzle that discharges more than 3.0 gallons per minute.

vii. It shall be unlawful for a car wash to wash any of its bays with water, except on Sundays.

i. Car Dealers / Fleets.

iv. It shall be unlawful for a car dealer or an entity that maintains a fleet of vehicles to wash its inventory of cars on any day other than the day the property was authorized to Spray Irrigate in accordance with the Water Rationing Zone Map.

v. The washing of any vehicle in a fleet may take place only at a commercial car wash or at a location owned by the fleet's owner and that is used solely for commercial uses.

vi. Fleets may not be washed at any location used for residential purposes.

iv. It is an affirmative defense to prosecution that if a car dealer or car rental is preparing a car for pickup, it washed that vehicle (and only that vehicle) on the day of pick up by the customer. Otherwise, all vehicles are subject to (f)(3)c. above.

j. Restaurants / Bars / Clubs / School Cafeterias:

i. It shall be unlawful to provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.

iii. It shall be unlawful for a food establishment to thaw food with water. Food must be thawed by another legal method, such as Refrigeration or Cooking Process.

iii. It shall be unlawful for a food establishment to clean kitchen or food handling areas with spray hoses.

k. Pools:

i. It shall be unlawful to operate a water feature on a Residential Pool, including, but not limited to, fountains, waterfalls, descents, arcs, and slides.

ii. If repairing a pool, it shall only be drained to a level necessary to affect the repair, and no further. Owners of pools that follow this restriction will be allowed to re-fill their pool after the repair.

iii. Owners / Operators of pools are restricted from draining the pool once it closed for the season.

l. Large Industries

i. Large Industries will be notified by the City to initiate a Water Audit of their facilities.

ii. The Water Audit will include where water is being used within the facilities and where reductions in water usage can be made.

iii. Large Industries will have 60 days to conduct the Water Audit and submit a written report to the Director of Public Works detailing the findings of the Water Audit and the percent reduction in water consumption that can be achieved.

iv. Each Large Industry will be required to have all internal modifications to implement the water reduction completed and functioning by the time a Combined Lake Level of 20% is reached.

g. Watering Structures

ii. The watering of Home Foundations is restricted to once a week, on the day the property was authorized to irrigate in accordance with the Water Rationing Zone Map.

Foundations may only be watered between the hours of 8:00 p.m. and 12:00 a.m. (midnight).

Foundations may only be watered with Soaker Hoses.

ii. It shall be unlawful to wash sidewalks, driveways, concrete slabs, any structure or any part of a structure during Stage 4 restrictions.

(4) During a Stage 4 Drought Disaster the following surcharges will be applied to all applicable accounts:

a. For Residential Water Meters;
$3.00 per CCF between 10 CCF and 20 CCF,
$6.00 per CCF between 20 CCF and 40 CCF, and
$12.00 per CCF over 40 CCF.

b. For Irrigation Water Meters;
$3.00 per CCF between 0 CCF and 10 CCF,
$6.00 per CCF between 10 CCF and 20 CCF,
$12.00 per CCF between 20 CCF and 40 CCF, and
$24.00 per CCF over 40 CCF.

(g) *Stage 5: Drought Catastrophe*

(1) The Director of Public Works shall declare a Stage 5 Drought Catastrophe when the levels of Lakes Arrowhead and Kickapoo reach a combined capacity of 25 percent.

(2) The following actions shall occur under the direction of the Director of Public Works, with the goal of reducing the amount of potable water being provided by the City to less than 14 MGD:

c. Impose further mandatory restrictions on non-essential uses of water and essential uses of water.

d. Continue the aggressive public relations and education program.

(3) In Stage 5 drought, the following restrictions shall apply:

a. Irrigation:

i. *Irrigation Prohibited.* It shall be unlawful to utilize any type of irrigation using potable water produced by the City of Wichita Falls that is distributed through the City's distribution system on any day at any time. This restriction includes all forms of irrigation, including, spray, bubbler, drip, hand-watering, etc.

ii. *Public and Private Golf Courses.* It shall be unlawful to irrigate any and all vegetated landscape areas on the golf course including greens, tee boxes, fairways, roughs, trees, shrubs, etc. The Golf Courses will be allowed to utilize the remaining water within their pond system, as they see fit; but, will not be allowed to refill the ponds from the City system, while in a Stage 5 Drought Disaster.

iii. *Nursery Plant Stock.* Nursery Plant Stock is exempt from the irrigation and landscape watering restrictions of this subsection.

b. Washing Cars when Lakes Arrowhead & Kickapoo are between 20% and 25%:

i. *Location of Washing Cars Limited to Reduce Runoff.* It shall be unlawful for any person to wash a vehicle at any location other than a commercial car wash, car dealership, detail shop, automotive shop, or commercial property that is owned by the owner of a Fleet of vehicles.

a. It shall be an affirmative defense to prosecution pursuant to this subsection i. that a person was washing a vehicle for health and safety reasons, only to an extent sufficient to remove the hazard, is permitted any time.

b. It shall be an affirmative defense to prosecution pursuant to this subsection i. that a car dealer or car rental company was preparing a vehicle for pickup and washed that vehicle on the day of pick up by the customer.

ii. *Allowable Times for Washing Vehicles Limited to Reduce Evaporation.* It shall be unlawful for any person to use potable water to wash a vehicle at any time on Sunday or Monday.

iii. *Nozzles.* It shall be unlawful for any car wash or detail shop to use a nozzle that discharges more than 3.0 gallons per minute.

iv. *Bays.* It shall be unlawful for a car wash to wash any of its bays with water, except on Fridays.

c. Washing vehicles when Lakes Arrowhead and Kickapoo are below 20%: It shall be unlawful for any person to use potable water to wash a vehicle at any time when the levels of Lakes Arrowhead and Kickapoo are at a combined capacity of less than 20%.

d. Restaurants / Bars / Clubs / School Cafeterias:

iii. It shall be unlawful to provide drinking water to customers of restaurants, bars, or clubs unless the customer requests such water.

iv. It shall be unlawful for a food establishment to thaw food with water. Food must be thawed by another legal method, such as Refrigeration or Cooking Process.

iii. It shall be unlawful for a food establishment to clean kitchen or food handling areas with spray hoses.

e. Pools:

i. It shall be unlawful to operate a water feature on any pool, including, but not limited to, fountains, water falls, descents, arcs, and slides.

ii. It shall be unlawful to fill, refill or add potable water to a private or public swimming or wading pool that is not located entirely within a fully-enclosed, climate-controlled structure.

iii. Indoor pools are exempt from the restrictions of (g)(3)e.

f. Watering Structures:

i. The watering of Home Foundations is restricted to once a week, on the day the property was authorized to irrigate in accordance with the Water Rationing Zone Map.

c. Foundations may only be watered between the hours of 8:00 p.m. and 12:00 a.m. (midnight).
d. Foundations may only be watered with Soaker Hoses.

ii. It shall be unlawful to wash sidewalks, driveways, concrete slabs, any structure or any part of a structure.

(2) During a Stage 5 Drought Catastrophe the following surcharges will be applied to all applicable accounts:

a. For Residential Water Meters;
$6.00 per CCF between 10 CCF and 20 CCF,
$12.00 per CCF between 20 CCF and 40 CCF, and
$24.00 per CCF over 40 CCF.

b. For Irrigation Water Meters;
$6.00 per CCF between 0 CCF and 10 CCF,
$12.00 per CCF between 10 CCF and 20 CCF,
$24.00 per CCF between 20 CCF and 40 CCF, and
$48.00 per CCF over 40 CCF.

(h) Surcharges will remain in effect until the City Council announces the end to the restrictions. Water utilized by commercial nurseries for plant stock production shall not be subject to the surcharges specified herein.

(i) *Triggering & Terminating Drought Stages.*

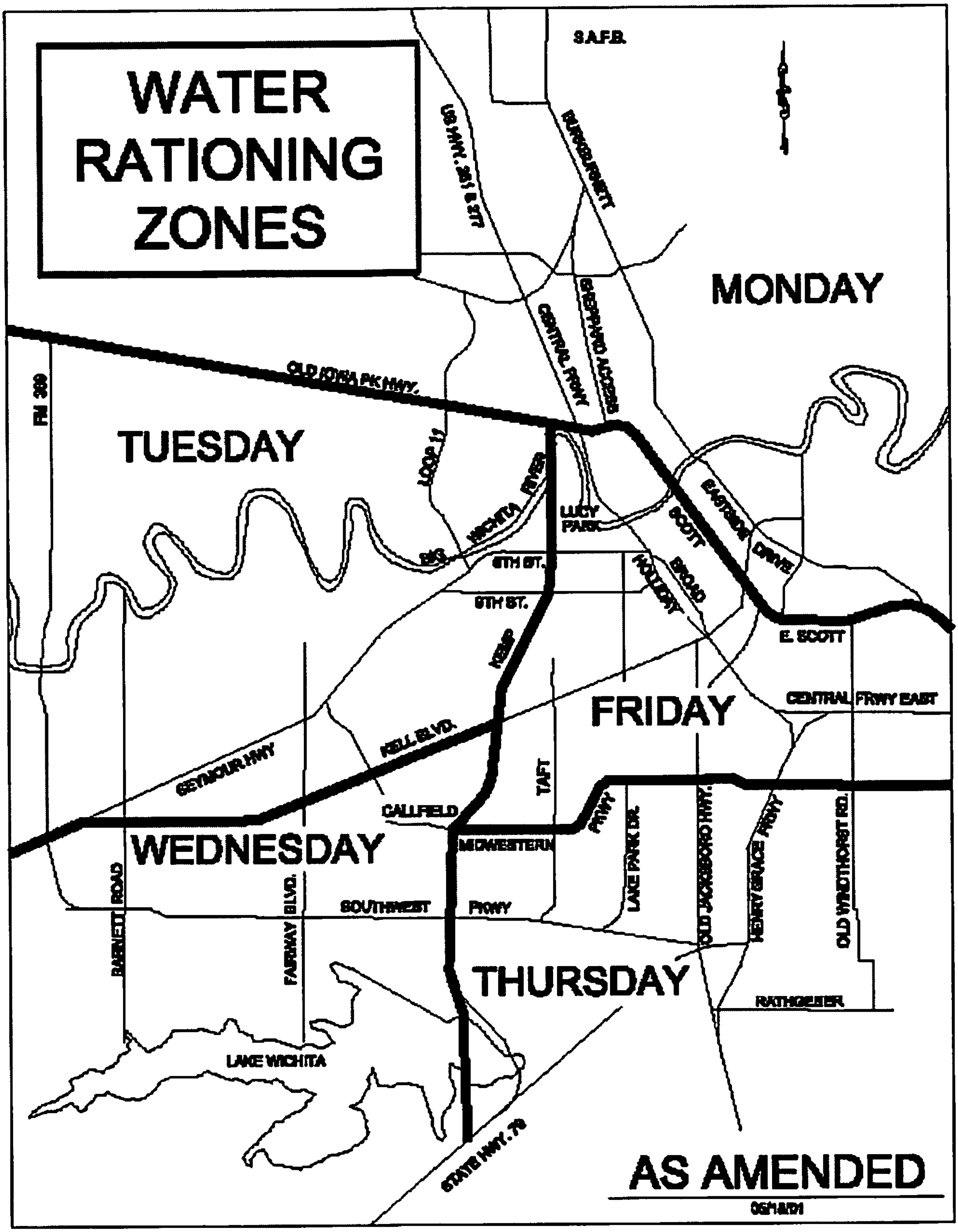
(1) The Director of Public Works shall declare that each "trigger level" has been reached and that the water use restrictions for each respective stage are in effect. The water restrictions will remain in effect until the lakes rise to a level that, when combined with the long-term forecast, assures the city an adequate supply of water.

(2) When an adequate supply of water is available, the City Council, by majority vote, and after consultation with the Director of Public Works, shall announce the termination of each respective stage of the restrictions that are triggered by lake levels.

(j) *Drought Restrictions only apply to City-supplied Water.* Water supplied from sources other than the City's potable water delivery system, including private water wells, aerobic septic systems, wastewater effluent, and potable water imported from other areas, is intended to be exempt from the restrictions of this section. Accordingly, it shall be an affirmative defense to prosecution for violation of any provision of this section that the water used in the alleged violation was not from the City's potable water delivery system.

(k) *Violation; penalty.* Any person, firm, corporation or other entity found in violation of any provision of this section shall be punished by a fine of $25.00 for the first offense; not more than $500.00 for the second offense; and not more than $2,000.00 for each offense thereafter. Each day of violation of this section shall constitute a separate offense. Proof of a culpable mental state shall not be required for the first or second offense. In the event that this section is violated by repeated offenses, the Director of Public Works is authorized to order the locking or removal of the customer's meter until all fees and fines are paid.

APPENDIX 12
CITY OF WICHITA FALLS
WATER RATIONING
ZONE MAP


WATER
RATIONING
ZONES
S.A.F.B.
MONDAY
TUESDAY
WEDNESDAY
THURSDAY
FRIDAY
OLD IOWA PK HWY.
CENTRAL FRWY
SHEPPARD ACCESS
BURKBURNETT
US HWY. 281 & 277
FM 369
LOOP 11
BIG WICHITA RIVER
LUCY PARK
SCOTT
BROAD
HOLLIDAY
EASTSIDE DRIVE
6TH ST.
9TH ST.
E. SCOTT
KEMP
CENTRAL FRWY EAST
SEYMOUR HWY
KELL BLVD.
TAFT
CALLFIELD
MIDWESTERN
PKWY
LAKE PARK DR.
OLD JACKSBORO HWY.
HENRY GRACE FRWY
OLD WINDTHORST RD.
BARNETT ROAD
FAIRWAY BLVD.
SOUTHWEST PKWY
RATHGEBER
LAKE WICHITA
STATE HWY. 79
AS AMENDED

APPENDIX 13

A HUNDRED WAYS TO SAVE WATER

100 Ways to Save Water

Water Saving Tips: Outdoors

Lawns, Plants and Watering

Adjust sprinklers so only the lawn is watered and not the house, sidewalk or street.

Choose shrubs and groundcover instead of turf for hard-to-water areas such as steep slopes and isolated strips. Trees and shrubs can also reduce the amount of lawn in general areas of the yard.

When watering sloped areas or areas where water runs off easily, water slow and in short five minute increments to ensure effective absorption and less runoff.

Plant in the fall, if supported by the planting instructions of your product, when conditions are cooler and rainfall is more plentiful.

Water the lawn and garden in the morning or evening when temperatures are cooler to minimize evaporation.

When using soaker hoses make sure the holes face down to avoid evaporation.

Spread a layer of organic mulch around plants, trees and flower beds. The mulch retains moisture, saves water, time and money and reduces the growth of weeds which compete for water.

Set an annual time to check outdoor faucets, sprinklers and hoses for leaks.

Adjust the lawn mower to a higher setting. A taller lawn shades roots and holds soil moisture better than if it is closely clipped.

Water small patches of grass by hand and use sprinklers for large areas to avoid waste.

Collect water from the roof and rain gutters for use on indoor and outdoor plants. Direct the rain gutters toward dry areas on the yard or plants with high water needs.

Rather than following a set watering schedule, check for soil moisture two to three inches below the surface with a spade or trowel before watering. If there is moisture watering can be delayed.

Install a rain sensor on automatic irrigation controllers so the system won't run when it's raining.

Use drip irrigation for shrubs and trees to apply water directly to the roots where it is needed.

Don't water the lawn on windy days. Most of the water blows away or evaporates.

Water plants deeply but less frequently to encourage deep root growth and drought tolerance.

Group plants with the same watering needs together to avoid over-watering some while under-watering others.

Use a minimum amount of organic or slow release fertilizer to promote a healthy and drought tolerant landscape with a strong root system. A lawn with a good root system requires less watering.

Use a rain gauge, or empty tuna can, to track rainfall on your lawn. Then reduce your watering accordingly.

Replace flowers and shrubs with low water use plants for year-round landscape color and savings of up to 550 gallons of water each year.

Consult with local nurseries for information on plant selection and placement for optimum outdoor water savings.

Winterize outdoor spigots when temperatures dip below freezing to prevent pipes from leaking or bursting.

Leave lower branches on trees and shrubs and allow leaf litter to accumulate on the soil. This keeps the soil cooler and reduces evaporation.

Let the lawn go dormant during the summer. Dormant grass only needs to be watered every three weeks or less if it rains.

Use sprinklers that deliver big drops of water close to the ground. Smaller water drops and mist often evaporate before they hit the ground.

Consider using an automatic watering system set for times between 4:00 a.m. and 6:00 a.m.

Over-watering can kill plants just as well as under-watering. Over-watering overloads the soil and encourages plant disease.

Wash pets outdoors in an area of the lawn that needs water.
Aerate the lawn at least once a year so water can reach the roots rather than run off the surface.

Know exactly how long it takes to put one inch of water on the lawn. One inch of water on one square foot of grass equals two-thirds of a gallon of water. Measure how long it takes to reach this level by placing a tuna can under the spray of the sprinkler; start a timer, once the level of water in the can reaches one inch the testing is complete. You now know how long it takes to put an inch of water on your lawn. The recommended amount of water for most lawns in Texas is an inch to an inch-and-a-half per week.

Decorate areas of the yard that do not use water or won't grow grass with rocks, gravel, wood chips or other materials.

Pools

Install covers on pools and spas to reduce evaporation and check for leaks around pumps.

If the pool has an automatic refilling device, check the pool periodically for leaks.

Avoid recreational water toys that require a constant flow of water.

Check for leaks in a pool by using a grease pencil to mark the water level of the pool at the skimmer. Check the mark 24 hours later to see if there is a leak.

When installing or replacing a lawn select a turf mix or blend that matches the climate and site conditions of the area.

Make sure swimming pools, fountains, and ponds are equipped with re-circulating pumps.

Car Washing

Use a commercial car wash that recycles water.

Wash the car on the lawn, and the lawn get's watered at the same time.

When washing your car use a hose nozzle with a shut off valve. This will save up to 100 gallons with every washing.

General Outdoor Tips

Save more water and money by using a broom instead of a hose to clean the driveway or sidewalk.

Walkways and patios provide spaces that don't require watering. Installing these areas can save water and add value to your property.

Trickling or cascading fountains lose less water to evaporation than those spraying water into the air.

Water Saving Tips: Bathrooms and Laundry

Bathrooms

Bathroom water use accounts for 75% of water used in the home. These water saving tips will also save you money.

If the shower fills a one-gallon bucket in less than 20 seconds, replace the showerhead with a water-efficient model or install an aeration filter in the showerhead. These changes can save up to 750 gallons of water a month.

Shortening shower time by one to two minutes can save up to 150 gallons of water per month.

Showers generally use less water than baths. To compare the difference prepare a bath and note the final water level before you enter the bathtub. The next day plug the drain and take a shower. Exit the tub when you are done and compare the water level of the shower to the bath.

Upgrade older toilets with water efficient models.

When running a bath, plug the tub before turning the water on then adjust the temperature as the tub fills up.

Brushing your teeth without the water running saves 25 gallons a month.

If the toilet flapper doesn't seal completely after flushing, replace it. A leaking flapper can cost from $50-$500.00 a year in wasted water. A new flapper is only $3-$10.00.

If a toilet was installed before 1992, reduce the amount of water used for each flush by inserting a displacement device in the tank.

Turn off the water while you wash your hair to save up to 150 gallons a month.

Turn off the water while you shave and save up to 300 gallons a month.

Save water and time by brushing your teeth while in the shower.

Use towels more than once. Hang them up to dry and use them again rather than throwing them in the wash.

Keep a bucket in the shower to catch water as it warms up or runs. Use this water to flush toilets or water plants.

When washing your hands, don't let the water run while you lather.

Don't use the toilet to get rid of trash. This wastes water and increases the work load at the wastewater treatment plant.

Laundry

Of total household water use the washing machine, accounts for approximately 14%.

Run the washing machine only when it is full. This can save up to 1,000 gallons a month.

When doing laundry, match the water level to the size of the load.

When buying a new washer choose one that is significantly more water and energy efficient than the minimum government standards. Also, make sure the washer has adequate wash cycle size adjustments to ensure the most efficient use of water.

Washing dark clothes in cold water saves on water and energy while it helping clothes to keep their colors.

Water Saving Tips: Kitchen

Approximately 11% of in home water use occurs in the kitchen. Most of the water ends up down the drain but with a little modification to traditional kitchen processes you can save hundreds of gallons of water a year.

When washing dishes by hand, don't let the water run while rinsing. Fill one sink with wash water and the other with rinse water.

Repair dripping faucets as soon as possible.

Some refrigerators and ice-makers are cooled with wasted flows of water. Consider upgrading with air-cooled appliances for significant water savings.

Wash your fruits and vegetables in a pan of water instead of running water from the tap. Use the leftover water for watering indoor or outdoor plants.

Designate one glass for your drinking water each day or refill a water bottle. This will cut down on the number of glasses to wash.

Don't use running water to thaw food. Defrost food in the refrigerator for water efficiency and food safety.

Teach your children to turn off faucets tightly after each use. Dripping faucets can waste hundreds of gallons of water.

Soak pots and pans instead of letting the water run while you scrape them clean.

Install an instant water heater near your kitchen sink so you don't have to run the water while it heats up. In addition to saving water it will also reduce energy costs.

If your dishwasher is new, cut back on rinsing. Newer models clean more thoroughly than older ones>

Never run your dishwasher without a full load. A full load will save water, energy and detergent.

Don't pre-rinse dishes before loading them in the dishwasher. This will save 20 gallons per load.

Listen for dripping faucets. Fixing a leak can save 300 gallons a month or more.

When cooking food items in water use the least amount of water possible and keep the lid on the pan or pot. Use the leftover water as a start to soups, stews or watering plants.

If you accidentally drop ice cubes when filling your glass from the freezer, don't throw them in the sink. Drop them in a house plant instead.

Use your disposal sparingly. Consider composting your food waste with yard waste to create rich, fertile compost for trees and plants.

Keep a container of water in the refrigerator. Running water from the tap until it cools wastes water.

Use water-saving aerators on all faucets.

Water Saving Tips: General

Check for a suspected water leak in your home by making sure all water is shut off and checking the water meter. If the meter is running you may have a leak. The leak may be a running toilet or damaged pipe beneath the home or in the yard.

Approximately 50% of the water used in a home is hot water. Providing energy to heat the water is a major drain on utility bills. Cutting down on hot water use will save water and money.

Monitor water bills and water meters for unusually high use. Higher than usual totals can indicate a water leak, which can cost hundred of dollars a year.

When cleaning out fish tanks, give the nutrient-rich water to your plants.

Know where the master water shut-off valve is located at your home. This can save water and prevent damage to the home should a leak occur

Work aggressively with the local government and school system to encourage, develop and promote water conservation.

When the kids want to cool off, use a sprinkler in an area where the lawn needs it the most.

Insulate hot water pipes for more immediate hot water at the faucet and for energy savings.

Setting cooling systems and water softeners for a minimum number of refills saves water, chemicals and energy costs.

When replacing a pet's water, don't throw the old water out. Use it to water trees, shrubs or indoor plants.

Insulate all hot water pipes to avoid long delays while waiting for hot water when running a bathroom or kitchen faucet.

When replacing a hot water heater consider a "tankless" heater. Tankless heaters provide instant hot water, saving time, water and upwards of 60% on water heating bills.

Report all significant water losses (broken pipes, open hydrants, errant sprinklers, abandoned free-flowing wells, etc.) to the property owner, local authorities or your water agency.

Get involved in water management issues. Voice your questions and concerns at public meetings conducted by your local, county and state government.

Be aware of and follow all water conservation and water shortage rules in effect in Wichita Falls. Goo water conservations efforts by everyone benefit the entire community.

Encourage employers to promote water conservation in the workplace. See if water conservation can be put into employee orientation and training programs.

Encourage businesses to practice and promote water conservation such as only serving water upon request.

APPENDIX 14

CITY OF WICHITA FALLS
LANDSCAPING WAIVER APPLICATION & PERMIT

House Number

Name of Street

City of Wichita Falls

IRRIGATION PERMIT

This Irrigation is Conducted Under
Permit Number________________

Valid From ______________to ______________

Director of Public Works

Note: This permit must be displayed while irrigating

APPENDIX 15
CITY OF WICHITA FALLS
RESOLUTION ADOPTING THE PLAN

RESOLUTION NO. 55-2014

Resolution adopting the Water Conservation and Drought Contingency Plan for the City of Wichita Falls

WHEREAS, state law requires specified water providers to adopt water conservation and drought contingency plans at Texas Water Code §§ 11.1271 and 11.1272, and the rules of the Texas Commission on Environmental Quality (TCEQ) require adoption of water conservation and drought contingency plans at 30 TAC §§ 288.2 & 288.20;

WHEREAS, water conservation and drought contingency plans must be updated on a 5-year interval; and

WHEREAS, the City Council finds the attached **Water Conservation and Drought Contingency Plan** complies with all state laws and regulations relating thereto, including, but not limited to Texas Water Code §§ 11.1271 & 11.127 and 30 TAC §§ 288.2 & 288.20.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF WICHITA FALLS, TEXAS, THAT:

The City of Wichita Falls hereby adopts the attached **Water Conservation and Drought Contingency Plan** for the City of Wichita Falls. The Director of Public Works is authorized to modify formatting and pagination prior to submission to the TCEQ.

PASSED AND APPROVED this 20th day of May, 2014.

Glenn Barham

MAYOR

ATTEST:

City Clerk

APPENDIX 16

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY 210 REAUTHORIZATIONS TO USE DOMESTIC RECLAIMED WATER

AUTHORIZATION FOR RECLAIMED WATER

Authorization No. R10509-001
This authorization supersedes and replaces No. R10509-001, approved April 30, 2009

Producer:	City of Wichita Falls P.O. Box 1431 Wichita Falls, Texas 76307
Provider:	City of Wichita Falls P.O. Box 1431 Wichita Falls, Texas 76307
User:	Any user within the service area authorized by the provider.
Location:	The City of Wichita Falls River Road Wastewater Treatment Facility is located immediately south of River Road and approximately 1000 feet northeast of the intersection of River Road and Rosewood Street in the City of Wichita Falls in Wichita County, Texas.
Authorization:	Type I and Type II reclaimed water from the River Road Wastewater Treatment Facility (TPDES Permit No.WQ0001050900l) to be used for Type 1 irrigation on sport complexes, athletic fields, school yards, parks, hospital grounds, industrial centers, apartment complexes, commercial, industrial manufactures, residential, properties, food crops, pasture land for milking animals, roadway right-of-ways, fire protections, maintenance of off channel impoundments (where activities such as wading or fishing are anticipated), and toilet and urinal flush water and for Type II irrigation of golf courses and pasture land for non-milking animals, road construction, construction activities, dust control, industrial, commercial, and manufacturing process water, and uses at government and military facilities. The service areas include all of the following counties: Archer, Baylor, Clay, Jack, Throckmorton, Wichita, Wilbarger, and Young.

This authorization contains the conditions that apply for the use of reclaimed water. The approval of reclaimed water use under Chapter 210 does not affect any existing water rights. If applicable, a reclaimed water use authorization in no way affects the need of a producer, provider, or user to obtain a separate water right authorization from the commission. This authorization does not allow irrigation of any area authorized for irrigation under a Texas Land Application Permit.

This action is taken under authority delegated by the Executive Director of the Texas Commission on Environmental Quality.

Issue Date: September 2, 2011

Mark Vickery, Executive Director

I. General Requirements

A. No producer or provider may transfer reclaimed water to a user without first notifying the commission.

B. Reuse of untreated wastewater is prohibited.

C. Food crops that may be consumed raw by humans must not be spray irrigated. Food crops including orchard crops that will be substantially processed prior to human consumption may be spray irrigated. Other types of irrigation that avoid contact of reclaimed water with edible portions of food crops are acceptable.

D. There must be no nuisance conditions resulting from the distribution, the use, or storage of reclaimed water.

E. Reclaimed water must not be used in a way that degrades groundwater quality to a degree adversely affecting its actual or potential uses.

F. Reclaimed water stored in ponds must be prevented from discharging into waters in the state, except for discharges directly resulting from rainfall events or in accordance with a permit issued by the commission. All other discharges are unauthorized.

G. If an overflow of a holding pond occurs causing discharge into or adjacent to water in the state, the user or provider, as appropriate, shall report the noncompliance. A written submission of pertinent information must be provided to the TCEQ Region 3 office in Abilene and to the TCEQ Enforcement Division (MC-149) in Austin, within five (5) working days after becoming aware of the overflow. The submission must contain:

1. a description of the noncompliance and its cause;
2. the potential danger to human health or safety, or the environment;
3. the period of noncompliance, including exact dates and times;
4. if the noncompliance has not been corrected, the anticipated time it is expected to continue; and,
5. steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance, and to mitigate its adverse effects.

H. Unless otherwise provided in this authorization, there must be no off-site discharge, either airborne or surface runoff, of reclaimed water from the user's property except to a wastewater treatment collection system or wastewater treatment facility unless the reclaimed water user applies for and obtains a permit from the commission that authorizes discharge of the water.

I. All reclaimed water piping must be separated from potable water piping when trenched by a distance of at least nine feet. All buried pipe must be manufactured in purple, painted purple, taped with purple metallic tape or bagged in purple. All exposed piping, hose bibs and faucets must be painted purple, designed to prevent connection to a standard water hose, and stenciled with a warning reading "NON-POTABLE WATER."

J. The design of any new distribution system that will convey reclaimed water to a user requires the approval of the executive director. Materials must be submitted to the executive director in accordance with the Texas Engineering Practice Act (Article 3271a, Vernon's Annotated Texas Statutes). The plans and specifications for any new distribution system constructed pursuant to this authorization must be approved by the executive director. Failure to secure approval before commencing construction or making a transfer of reclaimed water is a violation of this authorization. Each day of a transfer is a separate violation until approval has been secured.

K. Nothing in this authorization modifies any requirements in 30 TAC Chapter 290, Public Drinking Water.

L. A major change from a prior notification for use of reclaimed water must be approved by the executive director before it can be implemented. A major change includes:

1. a change in the boundary of the approved service area, not including the conversion of individual lots within a subdivision to reclaimed water use;
2. the addition of a new proivder;
3. a major change in the intended use, such as conversion from irrigation of a golf course to residential irrigation; or
4. a change from either Type I or Type II use to the other.

M. The reclaimed water producer, provider, and user shall maintain current operation and maintenance plans on the sites over which they have operational control. The operation and maintenance plan must contain the following, as a minimum:

1. a copy of the signed contract between the user and provider and a copy of the signed contract between the provider and the producer, as applicable;
2. a labeling and separation plan for the prevention of cross connections between reclaimed water distribution lines and potable water lines;
3. the measures that will be implemented to prevent unauthorized access to reclaimed water facilities (e.g., secured valves);
4. procedures for monitoring reclaimed water;
5. a plan for how reclaimed water use will be scheduled to minimize the risk of inadvertent human exposure;
6. schedules for routine maintenance;
7. a plan for worker training and safety; and
8. contingency plan for system failure or upsets.

N. One of the following requirements must be met by the user or provider, for any area where reclaimed water is stored or where there are hose bibs or faucets:

1. Signs having a minimum size of eight inches by eight inches must be posted at all storage areas and on all hose bibs and faucets reading, in both English and Spanish, "Reclaimed Water, Do Not Drink" or similar warning.
2. The area must be secured to prevent access by the public.

O. Where a reclaimed water line parallels a sewer line, the reclaimed water line must be constructed in accordance with subsection (p) or (q) of this section. The horizontal separation distance must be three feet (outside to outside) with the reclaimed water line at the level of or above the sewer line. Reclaimed water lines that parallel sewer lines may be placed in the same benched trench. Where a reclaimed water line crosses a sewer line, the requirement of 30 TAC §290.44(e)(4)(B), Water Line Installation—crossing lines, must be followed with the reclaimed water line substituted for the water line.

P. Reclaimed water pipes must meet the following requirements:

1. lines that transport reclaimed water under pressure must be sized according to acceptable engineering practices for the needs of the reclaimed water users.
2. prevent high velocity scouring and maintain adequate fluid velocity to prevent the deposition of solids in the lines.
3. reclaimed water force mains must have an expected life of at least as long as that of the associated lift station and must be suitable for the reclaimed water being pumped and operating pressure to which it will be subjected.
4. must be identified in the technical specifications with appropriate American Society for Testing and Materials, American National Standard Institute, or American Water Works Association standard numbers for both quality control (dimensions, tolerance, and installation such as bedding or backfill).
5. pipes and fittings must have a minimum working pressure rating of 150 pounds per square inch.
6. Final plans and specifications must describe required pressure testing for all installed reclaimed water force mains.
7. Minimum test pressure must be 1.5 times the maximum design pressure. Allowable leakage rates must be determined as described in 30 TAC §217.97, Pressure Sewer Systems.
8. Gravity flow reclaimed water lines must meet the requirements of 30 TAC Chapter 217, Subchapter C, Conventional Collection Systems. The provider shall prevent high velocity scouring and maintain adequate fluid velocity to prevent the deposition of solids in the lines.

Q. All exposed piping and piping within a building must be either purple pipe or painted purple. All exposed piping should be stenciled in white with a warning reading "NON-POTABLE WATER. All exposed or buried reclaimed water piping constructed at a wastewater treatment facility is exempt from the color-coding requirement of this section.

R. When applicable, in accordance with 30 TAC Chapter 217, Design Criteria for Domestic Wastewater Systems, the design of the distribution systems that will convey reclaimed water to a user must be submitted to the executive director and must receive an approval before the distribution system may be constructed. The design of the distribution systems must meet the criteria of 30 TAC Chapter 217, Design Criteria for Domestic Wastewater Systems. When a municipality is the plan review authority for certain sewer systems that transport primarily domestic waste, in lieu of the commission, design submittal will not be subject to submittal to the commission and instead must be approved by the municipality.

S. All ground level and elevated storage tanks must be designed, installed, and constructed in accordance with current AWWA standards with reference to materials to be used and construction practices to be followed, except for health-based standards strictly related to potable water storage and contact practices, where appropriately less restrictive standards may be applied.

II. Storage Requirements for Reclaimed Water

A. Storage facilities for retaining reclaimed water prior to use must not be located within a floodway.

B. Storage ponds must be hydraulically separated from waters in the state.

C. Any holding pond designed to contain Type I or Type II effluent that is located within a DRASTIC Pollution Potential Index Zone of less than 110, must comform to the following requirements:

1. Ponds with an earthen liner must meet the following requirements

   a. A permeability of greater than 1×10^{-4} cm/sec

   b. The ponds must be designed and constructed to prevent groundwater contamination;

   c. Soils used for pond lining must be free from foreign material such as paper, brush, trees, and large rocks; and

   d. All soil liners must be of compacted material, at least 24 inches thick, compacted in lifts no greater than 6 inches thick and compacted to 95% of Standard Proctor Density.

   e. Soil liners must meet the following particle size gradation and Atterberg limits:

      i. 30% or more passing a number 200 mesh sieve; and
      ii. a liquid limit of 30% or greater; and
      iii. a plasticity index of 15 or greater .;

   f. In situ liners at least 24 inches thick meeting a permeability less than or equal to $1 \text{ X } 10^{-4}$ cm/sec are acceptable alternatives; In-situ clay soils meeting the soils liner requirements must be excavated and re-compacted a minimum of 6 inches below planned grade to assure a uniformly compacted finished surface.

D. Any holding pond designed to contain Type II effluent and located within a DRASTIC Pollution Potential Index Zone of 110 or greater, must comform to the following requirements:

1. Ponds with an earthen liner must meet the following requirements:

   1. permeability of greater than 1×10^{-7} cm/sec;

   2. The ponds must be designed and constructed to prevent groundwater contamination;

   3. Soils used for pond lining must be free from foreign material such as paper, brush, trees, and large rocks; and

   4. All soil liners must be of compacted material, at least 24 inches thick, compacted in lifts no greater than 6 inches thick and compacted to 95% of Standard Proctor Density.

   5. Soil liners must meet the following particle size gradation and Atterberg limits:

      i. 30% or more passing a number 200 mesh sieve; and
      ii. a liquid limit of 30% or greater; and
      iii. a plasticity index of 15 or greater;

6. In situ liners at least 24 inches thick meeting a permeability less than or equal to 1×10^{-7} cm/sec are acceptable alternatives; In-situ clay soils meeting the soils liner requirements must be excavated and re-compacted a minimum of 6 inches below planned grade to assure a uniformly compacted finished surface.

E. Synthetic membrane linings must have a minimum thickness of 40 mils and have a leak detection system;

F. Certification by a Texas licensed professional engineer must be furnished stating that the pond liner meets the appropriate criteria prior to use of the facilities;

G. Soil embankment walls must have a top width of at least five feet. The interior and exterior slopes of soil embankment walls must be no steeper than one foot vertical to three feet horizontal unless alternate methods of slope stabilization are used. All soil embankment walls must be protected by a vegetative cover or other stabilizing material to prevent erosion. Erosion stops and water seals must be installed on all pipe penetrating the embankments; and

H. An alternative method of pond lining that provides equivalent or better water quality protection than provided under this section may be utilized with the prior approval of the executive director; and

I. Reclaimed water may be stored in leak-proof, fabricated tanks;

J. Subsequent holding ponds utilized for the receipt and storage of reclaimed water of a quality that could cause or causes a violation of a surface water quality standard or impairment of groundwater for its actual or intended use will be also subject to the storage requirements of this section.

III. Specific Uses and Quality Standards for Reclaimed Water

A. Numerical parameter limits pertaining to specific reclaimed water use categories are contained in this section. These limits apply to reclaimed water before discharge to initial holding ponds or a reclaimed water distribution system.

B. The reclaimed water producer shall establish that the reclaimed water meets the quality limits at the sample point for the intended use in accordance with the monitoring requirements identified in Section IV, Sampling and Analysis.

C. Types and quality standards for reclaimed water.

1. Type II Reclaimed Water Use. The use of Type II reclaimed water is for situations where the public will not be exposed to the reclaimed water. The uses allowed by this authorization are: irrigation of golf courses and pasture land for non-milking animals; road construction; construction activities; dust control; industrial, commercial, and manufacturing process water; and uses at government and military facilities.

2. The following conditions apply to Type II use of reclaimed water. At a minimum, the reclaimed water producer shall transfer only reclaimed water of the following quality. Type II reclaimed water on a 30-day average must have a quality of no more than:

Table 1. Type II Quality Requirements

Parameter	Limit	Limit Type
$CBOD_5$	15 mg/l	30-day average
Fecal coliform *or* *E. coli*	200/100 ml	30-day geometric mean (MPN or CFU)
Fecal coliform *or* *E. coli*	800/100 ml	maximum single grab sample (MPN or CFU)

3. Type I Reclaimed Water Use. The use of Type I reclaimed water is for situations where the public may come in contact with the reclaimed water. The uses allowed by this authorization are: irrigation sport complexes, athletic fields, school yards, parks, hospitals grounds, industrial centers, apartment complexes, commercial, industrial manufactures, residential, properties, food crops, pasture land for milking animal, roadway right-of-ways; fire protections; maintenance of off channel impoundments (where activities such as wading or fishing are anticipated); and toilet and urinal flush water.

4. The following conditions apply to Type I use of reclaimed water. At a minimum, the reclaimed water producer shall transfer only reclaimed water of the following quality as described for Type I reclaimed water use. Type I reclaimed water on a 30-day average must have a quality of no more than:

Table 2. Type I Quality Requirements

Parameter	Limit	Limit Type
Turbidity	3 NTUs	30-day average
$CBOD_5$	5 mg/l	30-day average
Fecal coliform *or* *E. coli*	20/100 ml	30-day geometric mean (MPN or CFU)
Fecal coliform *or* *E. coli*	75/100 ml	maximum single grab sample (MPN or CFU)

D. Test Procedures

1. Test procedures for the analysis of pollutants must comply with procedures specified in 30 TAC §§319.11 - 319.12. Measurements, tests, and calculations must accurately represent the reclaimed water.

2. All laboratory tests submitted to demonstrate compliance with this authorization must meet the requirements of 30 TAC Chapter 25, *Environmental Testing Laboratory Accreditation and Certification.*

IV. Sampling and Analysis

A. The reclaimed water producer shall sample the reclaimed water prior to distribution to the entity that first received the reclaimed water after it leaves the wastewater treatment facility (provider or user) to assure that the water quality meets the standard for the contracted use.

B. Analytical methods must be in compliance with 30 TAC Chapter 319, *Monitoring and Reporting.*

C. The minimum sampling and analysis frequency for Type II reclaimed water is once per week when reclaimed water is being produced.

D. The minimum sampling and analysis frequency for Type I reclaimed water is twice per week when reclaimed water is being produced.

E. The monitoring must be done after the final treatment unit.

F. The records of the monitoring must be kept on a monthly basis and be available at the facility site for inspection by representatives of the Commission for at least five years.

V. Record Keeping and Reporting

A. The reclaimed water provider and user shall maintain records on site for a period of at least five years.

B. The producer shall maintain the following records:

1. copies of notifications made to the commission concerning reclaimed water projects;
2. as applicable, copies of contracts with each reclaimed water user (this requirement does not include reclaimed water users at residences that have separate distribution lines for potable water);
3. records of the volume of water delivered to each reclaimed water user per delivery (this requirement does not apply to reclaimed water users at residences that have separate distribution lines for potable water); and
4. reclaimed water quality analyses.

C. The reclaimed water provider or producer shall report to the commission on a monthly basis the following information on forms furnished by the executive director. The reports are due by the 20th day of the month following the reporting period.

1. volume of reclaimed water delivered to each user; and
2. quality of reclaimed water delivered to a user or provider reported as a monthly average for each quality criteria, except those listed as "not to exceed" that must be reported as individual analyses.

VI. Transfer of Reclaimed Water

A. Reclaimed water must transferred from a provider to a user on a demand only basis. A reclaimed water user may refuse delivery of reclaimed water at any time.

B. All reclaimed water transferred to a user must be of at least the quality specified in Section IV, *Sampling and Analysis*.

C. Transfer must be by pipes or tank trucks.

D. The transfer of reclaimed water must be terminated immediately if a provider becomes aware of the misuse of the reclaimed water by the user, regardless of contract provisions.

VII. Restrictions

A. This authorization does not convey any property right and does not grant any exclusive privilege.

B. This authorization does not allow the use of reclaimed water on land that is authorized as a disposal site under either a Texas Pollutant Discharge Elimination System (TPDES) permit or a Texas Land Application Permit (TLAP).

VIII. Responsibilities and Contracts

A. The producer of reclaimed water is not liable for misapplication of reclaimed water by users, except as provided in this section. Both the reclaimed water provider and user have at least but are not limited to the following responsibilities:

1. The reclaimed water producer shall:

   a. transfer reclaimed water of at least the minimum quality required by this chapter at the point of delivery to the user;

   b. sample and analyze the reclaimed water and report the analyses in accordance with Section IV, Sampling and Analysis, and Section V, Recordkeeping and Reporting; and

   c. notify the executive director in writing within five (5) days after obtaining knowledge of reclaimed water use not authorized by the executive director.

2. The reclaimed water provider shall:

   a. ensure construction of reclaimed water distribution lines systems in accordance with 30 TAC Chapter 217, Design of Domestic Wastewater Systems, and in accordance with approved plans and specifications;

   b. transfer reclaimed water of at least the minimum quality required by this authorization at the point of delivery to the user;

   c. notify the executive director in writing within five (5) days after obtaining knowledge of reclaimed water use not authorized by the executive director; and

   d. not be found in violation of this chapter for the misuse of the reclaimed water by the user if transfer of such water is shut off promptly upon knowledge of misuse regardless of contract provisions.

3. The reclaimed water user shall:

   a. use the reclaimed water in accordance with this authorization; and

   b. maintain and provide records as required by Section V, Record Keeping and Reporting.

IX. Enforcement

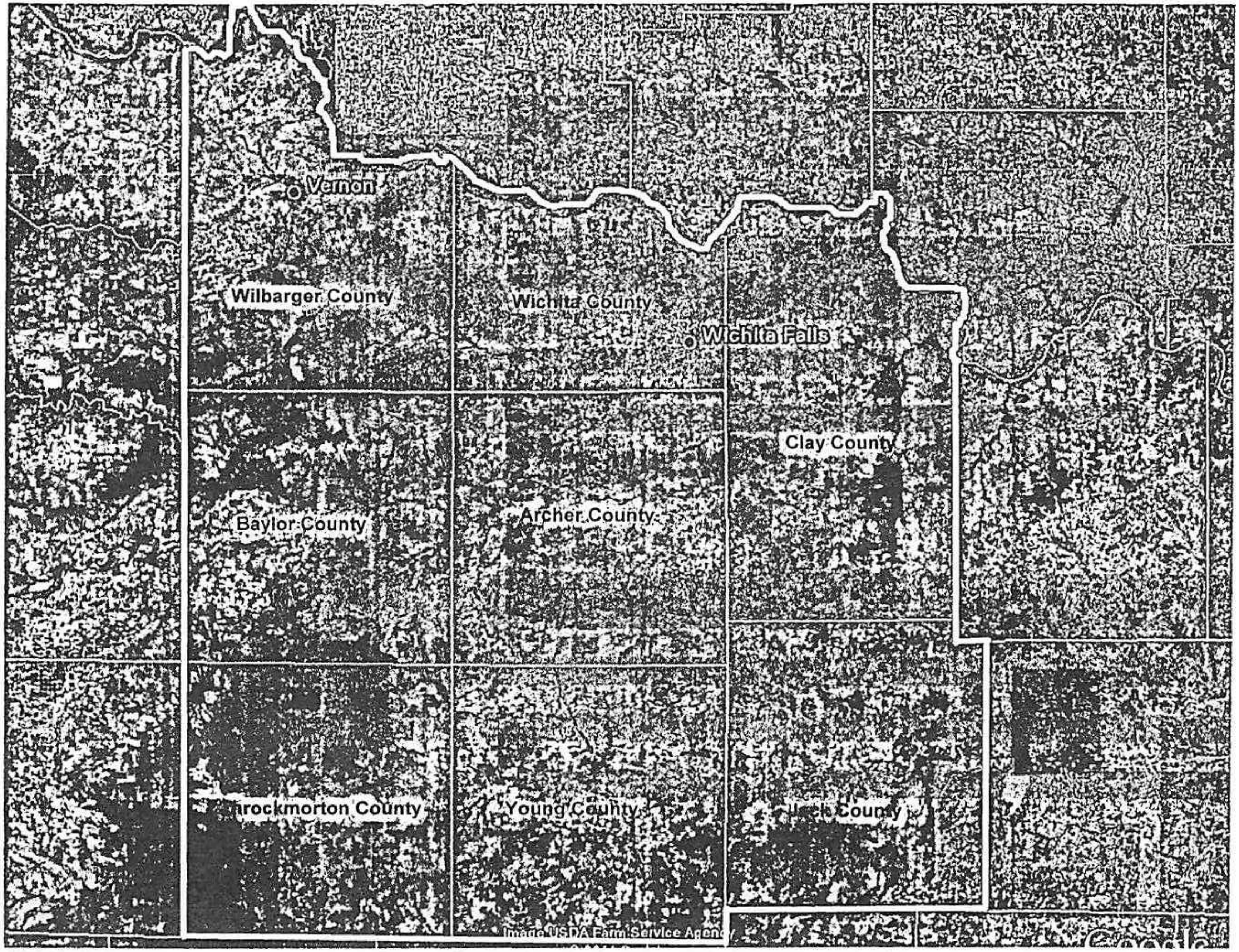
If the producer, provider, or user fail to comply with the terms of this authorization, the executive director may take enforcement action provided by the Texas Water Code §26.019 and §26.136.

X. Standard Provisions

A. This authorization is granted in accordance with the rules and orders of the commission and the laws of the state of Texas.

Acceptance of this authorization constitutes an acknowledgment and agreement that the producer, provider and user will comply with all the terms, provisions, conditions, limitations and restrictions embodied in this authorization and with the rules and other orders of the commission and the laws of the state of Texas. Agreement is a condition precedent to the granting of this authorization.

Attachment A



City of Wichita Falls Reclaimed Water Authorization R10509-001

Exhibit D

Application Fees

LLOYD GOSSELINK ROCHELLE & TOWNSEND, P.C.
GENERAL ACCOUNT

Texas Commission on Environmental Qualit

33451

DATE	INVOICE NUMBER	MEMO	BALANCE
06/26/2017		2813- 7 Application filing fee	100.00

CHECK DATE 06/26/2017
CHECK NUMBER 000033451

TOTAL 100.00

ORIGINAL DOCUMENT PRINTED ON CHEMICAL REACTIVE PAPER WITH MICROPRINTED BORDER

33451

LLOYD GOSSELINK
ROCHELLE & TOWNSEND, P.C.
GENERAL ACCOUNT
816 CONGRESS AVENUE, STE 1900
AUSTIN, TEXAS 78701

FROST NATIONAL BANK

30-9/1140

PAY: *One Hundred and 00/100 Dollars*

NUMBER	DATE	AMOUNT
000033451	06/26/2017	********100.00

TO THE ORDER OF

Texas Commission on Environmental Qualit
P. O. Box 13088
Austin, TX 78711-3089

AUTHORIZED SIGNATURE

Security Features Included. Details on back.

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MP

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Exhibit E

Electronic Copy of Application and Accounting Plan (USB)