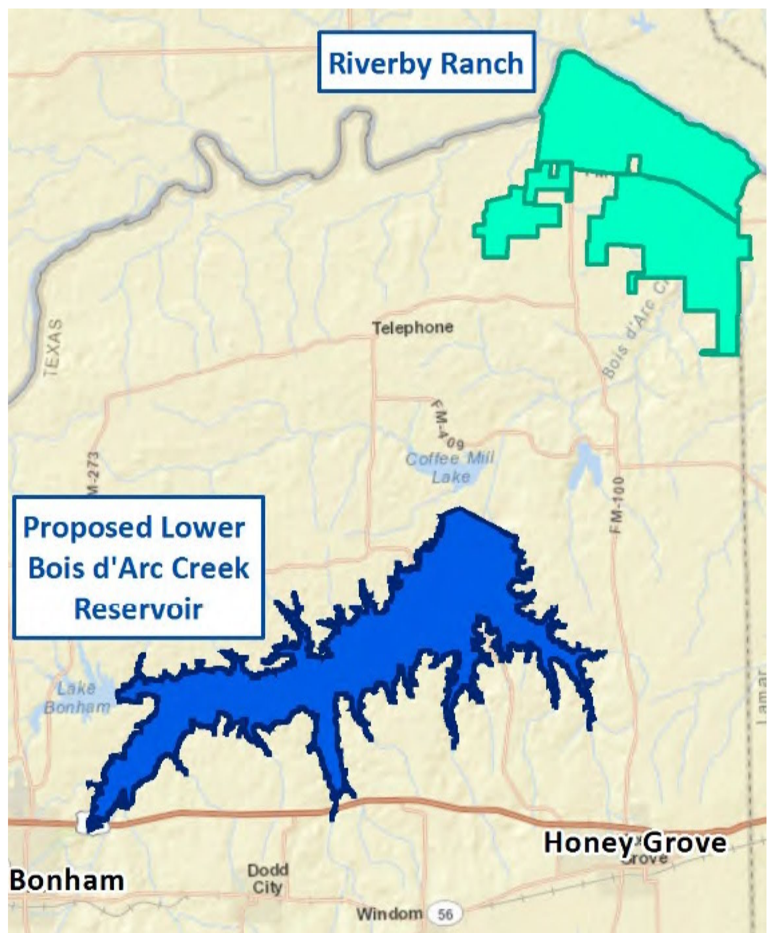
LOWER BOIS D'ARC CREEK RESERVOIR
Fannin County, Texas
SECTION 404 PERMIT APPLICATION

Revised Draft Environmental Impact Statement
Volume I – Revised DEIS

U.S. Army Corps of Engineers
Tulsa District



March 2017

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ABSTRACT

The Tulsa District of the U.S. Army Corps of Engineers (USACE) received an application for a Department of the Army Permit under Section 404 of the Clean Water Act (CWA) from the North Texas Municipal Water District (NTMWD) to construct Lower Bois d'Arc Creek Reservoir (LBCR) and related facilities (e.g., pipeline, water treatment plant, terminal storage reservoir) in Fannin County, Texas. The Proposed Action consists of a regional water supply project intended to provide up to 175,000 acre-feet/year (AFY) of new water, with an estimated firm yield of 120,665 AFY, for NTMWD's member cities and direct customers in all or portions of nine counties in northern Texas. A dam approximately 10,400 feet (about two miles) long and up to 90 feet high would be constructed, and much of the reservoir footprint would be cleared of trees and built structures. The total "footprint" of the proposed project site, including the dam, is 17,068 acres, and the reservoir, with a surface area of 16,641 acres at normal pool, would have a total storage capacity of approximately 367,609 acre-feet.

In accordance with the National Environmental Policy Act (NEPA), the USACE determined that issuance of such a permit may have a significant impact on the quality of the human environment and therefore prepared a Draft Environmental Impact Statement (DEIS). The DEIS examined the Proposed Action and the No Action Alternative in detail. The DEIS was issued in February 2015. The DEIS public and agency comment period extended for 60 days and closed on April 21, 2015. During the comment period, the USACE received nearly 600 comments on the DEIS. The comments ranged from questions regarding the technical analysis to the NEPA process including development of the proposed action, purpose and need, and alternatives.

Based on careful consideration of the issues raised during the DEIS public and agency comment period and new information developed since the release of the DEIS, the USACE has decided to revise the DEIS and recirculate it for review. The Revised Draft Environmental Impact Statement (RDEIS) includes an additional action alternative (Alternative 2) as well as revisions based on comments received on the DEIS.

In the RDEIS, the original Applicant's Proposed Action is called Alternative 1, while a downsized version of the dam and reservoir at the same site is called Alternative 2. The footprint of the Alternative 2 reservoir falls entirely within the footprint of the Alternative 1 reservoir. The smaller dam and reservoir of Alternative 2 would encompass a combined area of 9,305 acres (slightly more than half the size of the Alternative 1 dam and reservoir footprint), of which the reservoir itself would comprise approximately 8,600 acres, with a storage capacity of 135,200 acre-feet and a firm yield of 86,100 AFY. Under Alternative 2, in order to meet the purpose and need of the proposed action – at least 105,804 AFY of new

water supply by 2025 – 28,700 AFY of water from Lake Texoma, to which NTMWD already has permit rights, would be blended with LBCR water at a new water treatment plant near Leonard, Texas for a combined reliable supply of 114,800 AFY from Alternative 2.

The proposed LBCR site is located in an area of largely rural countryside with scattered residences. Approximately 38 percent of the larger reservoir footprint is cropland and 37 percent consists of bottomland hardwoods and riparian woodlands, with the remaining 25 percent mostly upland deciduous forest. Under Alternative 1, construction of the reservoir and related facilities would result in permanent impacts to approximately 4,602 acres of forested wetlands, 1,223 acres of emergent wetlands, 49 acres of scrub shrub wetlands, 78 acres of open waters, and 123.3 miles of intermittent and ephemeral streams, in addition to impacts on upland habitats. Under Alternative 2, construction of the reservoir and related facilities would result in permanent impacts to approximately 2,909 acres of forested wetlands, 684 acres of emergent wetlands, 27 acres of scrub shrub wetlands, 78 acres of open waters, and 66.1 miles of intermittent and ephemeral streams, in addition to impacts on upland habitats.

The applicant (NTMWD) has prepared a mitigation plan to compensate for impacts to aquatic and terrestrial resources associated with the proposed LBCR project. Specific plan objectives are to mitigate for unavoidable adverse impacts to waters of the United States in the project area, which include forested wetlands, emergent wetlands, scrub shrub wetlands, open water, and streams, that would occur as a result of constructing the proposed LBCR. This mitigation would be achieved through wetland restoration and enhancement and stream restoration and enhancement at the nearby mitigation sites, Riverby Ranch and the Upper Bois d'Arc Creek (BDC) Mitigation Site. On the reservoir site, the creation of the lake would offset impacts to open waters and some of the stream impacts, and it would allow for establishment of emergent wetlands in shallow areas around the lake (littoral wetlands). The development of the reservoir also would enhance Bois d'Arc Creek downstream of the proposed reservoir site through reductions in the frequency of destructive high flow events and the passage of sustainable environmental flows to maintain and enhance existing downstream habitats.

USACE's decision whether to issue a Section 404 permit will be based on an evaluation of the probable impacts, including cumulative impacts, of Alternative 1 and Alternative 2 on the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefits that reasonably may be expected to accrue from the proposal must be balanced against the reasonably foreseeable detriments. All factors that may be relevant to the proposal will be considered, including the cumulative effects thereof; among those are conservation, economics, aesthetics, wetlands, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shoreline erosion and accretion, recreation, water supply and conservation, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people. In addition, the evaluation of the impact of the work on the public interest will include application of the guidelines promulgated by the Administrator, Environmental Protection Agency, under authority of Section 404(b) of the Clean Water Act (40 C.F.R. Part 230).

Comments on the RDEIS may be sent to:

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1645 South 101st East Avenue, Tulsa, OK 74128-4609
or via e-mail: ceswt-ro@usace.army.mil

Comments must be received within 45 days of publication of the Notice of Availability in the *Federal Register*.

Revised Draft Environmental Impact Statement
Proposed Lower Bois d'Arc Creek Reservoir

Executive Summary

Introduction

The U.S. Army Corps of Engineers, Tulsa District (USACE) has received an application for a Department of the Army Permit under Section 404 of the Clean Water Act (CWA) from the North Texas Municipal Water District (NTMWD) to construct Lower Bois d'Arc Creek Reservoir (LBCR). NTMWD is a conservation and reclamation district and political subdivision of the state of Texas. A 1975 amendment to the State Legislature Act, which created the NTMWD, authorizes it to acquire, treat, and distribute potable water, and to collect, treat and dispose of wastes, both liquid and solid, in order to reduce pollution, conserve, and develop the natural resources of Texas.

In accordance with the National Environmental Policy Act (NEPA), the USACE determined that issuance of such a permit may have a significant impact on the quality of the human environment and therefore prepared a Draft Environmental Impact Statement (DEIS). The DEIS examined the Proposed Action and the No Action Alternative in detail. It was issued in February 2015. The DEIS public and agency comment period extended for 60 days and closed on April 21, 2015. During the comment period, the USACE received nearly 600 comments on the DEIS. Comments were provided related to the technical analysis and the NEPA process, including development of the Proposed Action, purpose and need, and alternatives.

Based on careful consideration of the comments provided during the DEIS public and agency comment period and new information developed since the release of the DEIS, the USACE has decided to revise the DEIS and recirculate the revised document for review. This Revised Draft Environmental Impact Statement (RDEIS) includes an additional action alternative as well as revisions based on comments received on the DEIS.

Cooperating Agencies

A number of federal, state, and tribal agencies have cooperated or participated in studies, surveys, investigations and meetings related to the preparation of the DEIS and RDEIS. These agencies include:

- U.S. Environmental Protection Agency (Region 6, Dallas, TX) – cooperating agency
- U.S. Forest Service (Caddo National Grasslands) – cooperating agency
- U.S. Fish and Wildlife Service (Ecological Services) – cooperating agency
- USDA Natural Resources Conservation Service
- Texas Commission on Environmental Quality (TCEQ)
- Texas Water Development Board
- Texas Parks and Wildlife Department – cooperating agency
- Texas Historical Commission (THC)
- Red River Authority of Texas

- Native American Tribes (in particular the Caddo Nation of Oklahoma, signatory to a Programmatic Agreement on Archeological Resources with USACE, NTMWD, and the THC)

Purpose and Need

The purpose of the Proposed Action is to develop an additional supply of water to address the growing demand of NTMWD's customers. State population projections show the NTMWD service area population increasing from about 1.75 million in 2020 to 3.7 million by 2070. The LBCR would provide a new water supply to help meet this increasing demand. Even with aggressive efforts by NTMWD to promote water conservation, encourage efficiency, and develop water reuse projects, aggregate demand for new potable water supply will grow substantially over the coming 50 years.

NTMWD provides wholesale treated water, wastewater treatment, and regional solid waste services to member cities and customers in a service area covering parts of nine counties in North Central Texas. This service area is one of the fastest growing in the state of Texas. The growing population and the location of the growth are the impetus behind increased demands for water and the need to develop new sources of water supply. To meet these projected needs, the NTMWD will have to construct a new northern water treatment plant by 2020 to serve the fast-growing northern sectors of its service area. The LBCR would provide new supply to the proposed northern plant to help meet this increasing demand.

The USACE Tulsa District is responsible for defining the basic purpose of the proposed project. Under the guidelines governing the USACE's evaluation of a CWA Section 404 permit application, the basic purpose must be identified to determine if the proposed project in question is "water dependent" and requires access or proximity to or siting within a special aquatic site such as wetlands in order to fulfill its basic purpose. The USACE has determined that the basic project purpose in the present case is to develop an additional, reliable water supply for the applicant (NTMWD) and its member cities and customers. Access or proximity to or siting within special aquatic sites is not required to fulfill the basic project purpose in this case; therefore, the basic purpose is not water dependent.

Proposed Action – Alternative 1

The proposed dam and reservoir would be located on Bois d'Arc Creek, in the Red River watershed, approximately 15 miles northeast of the City of Bonham, between Farm-to-Market (FM) Road 1396 and FM Road 409, in Fannin County, Texas. The total "footprint" of the proposed project site, or the area it encompasses, is 17,068 acres. The project site is in an area of largely rural countryside with scattered residences. Approximately 38 percent is cropland and 37 percent consists of bottomland hardwoods and riparian woodlands, with the remaining 25 percent consisting of mostly upland deciduous forest.

The purpose of the proposed project is to impound the waters of Bois d'Arc Creek and its tributaries to create a new 16,641-acre (26-square mile) water supply reservoir for the NTMWD. An additional 427 acres would be required for the construction of the dam and spillways, for a total project footprint of 17,068 acres. NTMWD has requested the right to impound up to 367,609 acre-feet of water and divert up to 175,000 acre-feet/year, with an estimated firm yield of 126,200 acre-feet of water per year (AFY). State population projections show the population of the NTMWD service area increasing from 1.75 million in 2020 to 3.7 million by 2070. The LBCR would provide a new source of supply to help meet the increasing water demands of this growing population. It could be available by 2020-2021.

The LBCR dam would be approximately 10,400 feet (about two miles) in length and would have a maximum height of approximately 90 feet. The design top elevation of the embankment would be at 553.5 feet above mean sea level (MSL) with a conservation pool elevation of 534.0 feet MSL, controlled by a service spillway at elevation 534.0 feet MSL with a crest length of 150 feet. The service spillway would be located at the right abutment of the dam. Required low-flow releases would be made through a 36-inch diameter low-flow outlet. An emergency spillway would also be located in the right abutment of the dam. The emergency spillway would be a 1,400-foot wide uncontrolled broad crested weir structure with a crest elevation of 541 feet MSL. This elevation was selected to contain the 100-year storm such that no flows pass through the emergency spillway during this event.

Raw water from the reservoir would then be transported by approximately 35 miles of new pipeline 90 to 96 inches in diameter to a proposed new terminal storage reservoir and water treatment plant – the "North Water Treatment Plant" – just west of the City of Leonard in southwest Fannin County. A number of rural roads within the footprint and in the vicinity of the proposed reservoir would have to be closed or relocated; the most significant of these is FM 1396, which would be relocated to cross the reservoir in a different alignment on an entirely new bridge that would need to be constructed.

Construction of the dam and impoundment of water within the normal pool elevation of 534 feet MSL would result in direct fill impact or inundation of waters of the United States, including wetlands. Approximately 120 acres (54.2 linear miles) of existing intermittent streams, 99 acres (69.1 miles) of intermittent/ephemeral streams, 78 acres of open water, 4,602 acres of forested wetlands, 1,223 acres of emergent (herbaceous) wetlands, and 49 acres of scrub shrub (shrub) wetlands would be impacted. Additionally, construction of the raw water pipeline, new terminal storage reservoir, and water treatment plant, in combination, would temporarily impact 0.44 acre (4,335 linear feet) of streams and 0.1 acre of open waters. The impacts of constructing and operating the Proposed Action are summarized below.

Alternative 2 – Downsized LBCR with Blending

Alternative 2 consists of a smaller reservoir constructed within the footprint of the Proposed Action. The smaller LBCR would produce an estimated yield of 86,100 AFY. Water from the smaller reservoir would then be blended with water supplied from Lake Texoma. The combination of the water from the smaller LBCR with water from Lake Texoma would be of sufficient quantity to meet the purpose and need. The NTMWD estimates that 2025 would be the earliest that the water would be available from Alternative 2.

The alternative would consist of the following primary elements: 1) a smaller dam and reservoir at the LBCR site; 2) a 25-mile long raw water pipeline from Lake Texoma to an existing 96-inch pipeline, and an 8-mile segment from that pipeline to the WTP; 3) new raw water pipeline from the smaller LBCR to the WTP, and 4) the WTP and TSR. The reservoir would have a conservation pool elevation of 515 feet MSL and maximum storage capacity of 135,200 AF. The reservoir would have a maximum surface area of 8,600 acres.

The dam's footprint would be about the same size as that required for the Proposed Action. However, the construction footprint of the dam and reservoir would total approximately 9,390 acres, about half the size of the construction footprint of the Proposed Action. Other facilities, including the service spillway, outlet works, emergency spillway, and pumping station would be similar, but slightly smaller than the Proposed Action.

Operation of the smaller reservoir would be controlled by the terms specified in a modified version of the Texas water rights permit already held by NTMWD for Alternative 1. It is assumed that these terms would be similar to those specified in the water rights permit for the Proposed Action and would include Bois d'Arc Creek flow requirements.

Construction of the reservoir and associated facilities would result in impacts similar to the Proposed Action. Impacts to waters of the U.S. would include loss of perennial streams, intermittent streams, forested wetlands, herbaceous wetlands, and shrub wetlands. The impacts of constructing and operating Alternative 2 are summarized below.

No Action Alternative

NEPA requires the consideration of a No Action Alternative. In this case, "no action" consists of not building the proposed dam and reservoir, pipelines, and WTP, eliminating the need for a Section 404 permit. For purposes of comparison of impacts in the EIS and as summarized below, it was assumed that NTMWD would not move forward with an alternative water supply project as they do not have a viable back-up plan to the proposed reservoir. The USACE has also assumed that the environmental conditions under the No Action Alternative would be broadly similar to existing conditions.

Mitigation Plan

An aquatic resources mitigation plan has been prepared by the NTMWD to comply with the federal policy of "no overall net loss of wetlands" and to provide compensatory mitigation, to the extent practicable, for impacts to other waters of the United States from construction of the proposed reservoir. This mitigation would be achieved through restoration actions planned for sites near the location of the proposed project. Mitigation would occur on-site and off-site at the 15,000-acre Riverby Ranch and the 1,900-acre Upper Bois d'Arc Creek site. The mitigation plan includes site protection, management, and financial assurances.

NTMWD has purchased the Riverby Ranch, which borders the Red River. This working ranch is located downstream of the proposed project within both the same watershed (Bois d'Arc Creek) and the same county (Fannin). NTMWD acquired the Riverby Ranch specifically because its biophysical features have the potential to provide appropriate mitigation for the proposed project. Additional mitigation would be provided upstream of the proposed reservoir within the Bois d'Arc Creek floodplain, within the reservoir itself, and on Bois d'Arc Creek downstream of the reservoir as a result of an operations plan and flow regime established in consultation with the TCEQ, and stipulated in the Water Use Permit issued by TCEQ to NTMWD in June 2015. Appendix C of the RDEIS contains the detailed Revised Mitigation Plan and Appendix D, the Reservoir Operation Plan, also includes additional mitigation measures.

Section 404 Permit

This RDEIS furnishes important information about the Tulsa District Regulatory Office's decision-making process. The USACE's decision whether to issue a Section 404 permit will be based on an evaluation of the probable impacts including cumulative impacts of the Proposed Action on the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefit which reasonably may be expected to accrue from the described activity must be balanced against the reasonably foreseeable detriments. All factors that may be relevant to the described activity will be considered, including the cumulative effects; among those are conservation, economics, aesthetics, general environmental concerns, wetlands, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shoreline erosion and accretion, recreation, water supply and conservation, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people. The activity's impact on the public interest will include application of the Section 404(b)(1) guidelines promulgated by the Administrator, Environmental Protection Agency (40 CFR Part 230).

Alternatives Dismissed From Detailed Consideration

Other alternatives were evaluated, but were not carried forward for detailed consideration in the RDEIS. These include alternatives that do not require a Section 404 permit, alternatives that were not available to the applicant, and other alternatives available to the applicant. Details of each alternative and the reasons for not carrying these alternatives forward for assessment in the EIS are included in Appendix O.

Alternatives that Do Not Require a Section 404 Permit

The alternatives considered that would not require a Section 404 permit included developing new groundwater supplies, constructing and operating desalination facilities, or implementing additional water conservation measures. Developing new groundwater supplies was not carried forward for detailed consideration because quantities potentially available are insufficient to meet the purpose and need, these quantities may be subject to reduction to conform with Managed Available Groundwater (MAG) values, and there is growing competition among users for these constrained groundwater supplies. Developing a desalination project at the scale needed to meet NTMWD needs is expected to be cost-prohibitive, face limitations on disposal of brine, and have prohibitively high energy requirements resulting from the desalination process and transporting product water.

Alternatives Unavailable to the Applicant

Potential alternatives that were identified, but determined to be not available to the applicant included importing water from Oklahoma and additional water supply provided by Lake O' the Pines. These alternatives were not carried for detailed consideration in the EIS because the current moratorium on water exported from Oklahoma may not be resolved in time to meet the NTMWD supply demand, and because water from Lake O' the Pines may not be accessible to NTMWD due to contracting issues with existing water rights holders.

Other Alternatives Available to the Applicant

Alternatives that may be available to the applicant include water supplied from new (undeveloped) reservoirs, including Upper Bois d'Arc Creek Reservoir, Marvin Nichols Reservoir, Marvin Nichols Reservoir (Site 1A), George Parkhouse Lake South, and George Parkhouse Lake North; transporting water from existing reservoirs including Lake Lavon and Lake Jim Chapman; reallocation of storage at other reservoirs in the region including Ray Hubbard, Ray Roberts, Lewisville, Tawakoni, and Fork Lakes; securing supplies from Lake Texoma, Toledo Bend Reservoir, Wright Patman Lake, and Sam Rayburn Reservoir; and purchase of water from the City of Texarkana. These potential alternatives were not carried forward for detailed consideration in the EIS because of the inability to meet purpose and need, unacceptable environmental impacts, poor water quality, reliability, cost, and/or institutional constraints including the need to secure agreements with other wholesale water providers.

Environmental Consequences of Alternative 1, Alternative 2, and No Action Alternative

This section provides a summary of the environmental consequences of Alternative 1 (Applicant's Proposed Action), Alternative 2, and the No Action Alternative which are evaluated in detail in this RDEIS. A more detailed discussion of the impacts can be found in Chapter 4.

Land Use

Construction of the dam and reservoir under Alternative 1 would permanently affect approximately 17,000 acres of land primarily classified as agricultural and open space. Alternative 2 would result in the conversion of approximately 9,300 acres or about 42 percent of the area converted under Alternative 1. Although loss of open space and agricultural lands under Alternative 2 would be less than under Alternative 1, the amount of land converted under each alternative is considered substantial and adverse.

Although changes in land may occur under the No Action Alternative, none of those changes would be attributable to the construction and operation of LBCR (because it would not be built under this alternative). Changes in land use may occur as the result of other planned developments due to projected population growth in Fannin County.

Topography, Geology, and Soils

Construction of the dam and reservoir and the water transmission and treatment facilities under Alternative 1 would permanently affect approximately 17,000acres of land with resulting loss or disturbance to soils and geological resources. Alternative 2 would result in the conversion of approximately 9,300 acres or about 42 percent of the area converted under Alternative 1. Although loss of or disturbance to soils under Alternative 2 would be less than under Alternative 1, the loss of soils and disturbance to geological resources under both alternatives is considered to be moderate.

Under the No Action Alternative, there would be no short- or long-term effects on geology. Ongoing erosion and downcutting associated with channelization of Bois d'Arc Creek would continue to cause slight to moderate long-term changes to topography and soils. None of those changes would be attributable to the construction and operation of LBCR because it would not be built under this alternative.

Water Resources

Constructing and operating the dam, reservoir, water transmission, water treatment, and other ancillary facilities would result in changes in surface water hydrology, stream channels, water quality, existing reservoirs, and groundwater. Effects on these resources were assessed for both the construction (3 to 4 years) and operational (100+ years) phases for both Alternatives 1 and 2. Impacts on water resources were also assessed for the No Action Alternative.

Surface Hydrology

Constructing Alternatives 1 and 2 would result in the loss of less than one mile of Bois d'Arc Creek and Honey Grove Creek stream channels. Both streams would be affected by the footprint of the dam embankment and spillway. Because the footprint of these facilities would be essentially the same for both Alternatives 1 and 2, the resulting impacts on surface hydrology would also be the same. This loss would be permanent and is considered severe.

Reservoir operations under Alternatives 1 and 2 are not expected to result in an adverse effect on navigation occurring on the Red River. Changes in discharges from Bois d'Arc Creek to the Red River under both Alternatives would not be of the magnitude to have an appreciable effect on the flows required to support navigation.

Existing water rights within the Red River watershed would not be affected by operation of either Alternative 1 or 2. The TCEQ water use permit issued for the full-scale LBCR determined that existing water rights holders that could be affected by project operations would not be injured.

Long-term operation of the LBCR under both Alternatives 1 and 2 would be affected by sediments deposited in the reservoirs that originate from upstream sources. Sedimentation would reduce the storage capacity of the LBCR of Alternative 1 by approximately 7.5 percent after a century of operation. The storage capacity of the smaller LBCR (Alternative 2) would be reduced by about 21 percent after a century. The effect on the reservoir storage capacity from sedimentation is considered moderate under both alternatives.

The characteristics of the surface hydrology within the Bois d'Arc Creek watershed are not expected to change under the No Action Alternative.

Stream Channels

Constructing Alternative 1 and 2 would result in the loss of less than one-mile of stream channel in Bois d'Arc Creek and Honey Grove Creek. Both streams would be affected by the footprint of the dam embankment and spillway. Because the footprint of these facilities would be essentially the same for both Alternatives 1 and 2, the resulting impacts on surface hydrology would be similar. The loss would be permanent and is considered severe.

Operation of both Alternatives 1 and 2 would result in the loss of stream channels within the reservoir inundation zone. These channels are classified as intermittent and intermittent/ephemeral. Operation of Alternative 1 would result in the loss of approximately 123 miles of stream channels. Operation of Alternative 2 would result in the loss of approximately 66 miles of stream channels, reflecting the smaller size of the reservoir. The loss of stream channels is considered a moderate adverse effect under both alternatives.

The existing characteristics of stream channels within the Bois d' Arc Creek watershed are not expected to change under the No Action Alternative.

Surface Water Quality

The quality of surface waters is not expected to be adversely affected during the construction phase of either Alternative 1 or 2. The quality of surface water stored in and discharged from LBCR would be influenced by the quality of surface water entering the reservoir in combination with reservoir storage and climatic conditions. The primary impact on water quality that would result from building the proposed reservoir would be a reduction in the variability of water quality in Bois d'Arc Creek downstream from the reservoir. The expected chloride, sulfate, and total dissolved solids concentrations in the LBCR would be amenable to conventional water treatment processes to produce drinking water that meets state and federal standards.

The quality of surface water within the project area might be adversely affected under the No Action Alternative. The magnitude of this effect would be driven by the extent of development occurring within the project area as a result of projected population growth in Fannin County and resulting impacts to water quality.

Existing Reservoirs

Existing reservoirs in the Bois d'Arc Creek watershed would not be affected by the construction phase of Alternatives 1 or 2. The Lake Bonham reservoir would be impacted by the operation phase of Alternative 1 because the Lake Bonham dam would be partially submerged by the LBCR at its normal pool elevation. However, mitigation measures would be implemented to protect the Lake Bonham dam, spillways, and outlet works so that no adverse impacts would occur. There would be no adverse impacts to the Lake Bonham dam from operation of Alternative 2 because the Lake Bonham dam would not be submerged by the downsized reservoir of Alternative 2. Under Alternative 2, up to 28,700 AFY of water would be withdraw from Lake Texoma for blending with water from the downsized reservoir, but NTMWD already has a water right to withdraw this water, so Alternative 2 would not have any impact on Lake Texoma.

Groundwater

Groundwater resources are not expected to be adversely affected during the construction phases for either Alternatives 1 or 2. Operation of Alternative 1 or 2 would also not affect groundwater resources as groundwater extraction is not an element of either alternative.

Under the No Action Alternative, groundwater resources may be affected as a result of increased demand for water supplies associated with new development within the project area that may occur as a result of projected population growth in Fannin County. The magnitude of this effect would be driven by the rate of development occurring within the project area and the amount of water demand met by groundwater resources.

Biological Resources

Constructing and operating the LBCR dam, reservoir, water transmission, water treatment, and other ancillary facilities may result in impacts on wetlands, aquatic habitat, upland habitat, terrestrial wildlife, threatened and endangered species, and invasive species. These impacts were assessed for both the construction (3 to 4 years) and operational (100+ years) phases for Alternatives 1 and 2. Impacts on biological resources were also assessed for the No Action Alternative, which would be primarily driven by future development occurring within the project area due to projected population growth or ongoing fluvial processes. The impacts of each alternative on biological resources are summarized below.

Wetlands

Constructing Alternatives 1 and 2 would result in the loss of forested wetlands, emergent wetlands, and shrub scrub wetlands. The loss of these wetland types would be greater under Alternative 1 (5,874 acres) than Alternative 2 (3,620 acres). Forested wetlands would account for the greatest loss under both Alternatives 1 (4,602 acres) and 2 (2,909 acres) followed by emergent wetlands, and shrub scrub wetlands. The loss of these wetland types was also reported as functional capacity units (FCUs) for forested wetlands and habitat units (HUs) for emergent wetlands and shrub scrub wetlands (refer to Section 3.4 of the RDEIS for more information related to this topic). The assessments applying these classification systems also indicated that impacts on wetland resources would be greater under Alternative 1 than Alternative 2.

The operation phase of Alternatives 1 and 2 would result in the long-term loss of the forested wetlands, emergent wetlands, and shrub scrub wetlands discussed above. The loss of wetland resources during the construction phase would continue through the operation phase of each alternative and the acreage totals for each wetland type would remain the same.

The loss of forested wetlands, emergent wetlands, and scrub wetlands is considered a moderate adverse effect under both Alternatives 1 and 2. Under Alternative 1, the loss of these wetland types would be compensated through the mitigation plan. Although the mitigation plan was developed to offset the effects of Alternative 1, it is expected that the plan would be scaled down to compensate for the adverse effects on wetlands that would occur if Alternative 2 was selected.

Loss of wetlands would also occur under the No Action Alternative although not to the level indicated under Alternatives 1 or 2. These losses would be attributable to the continued channelization of streambeds within the project area.

Aquatic Habitats and Biota

The effects of dam and reservoir construction activities under Alternatives 1 and 2 to open water, streams, and associated aquatic life would be both adverse and beneficial. Overall effects of construction and operation under Alternatives 1 and 2 would be long-term (more than 50 to over 100 years) in duration with a high likelihood of occurrence and slight to moderate severity. Impounding Bois d'Arc Creek and converting riparian bottomland hardwood forests and stream habitats to open water, marsh, and mudflats would have both beneficial and adverse indirect effects on aquatic species.

In general, diversity and relative abundance of aquatic fauna (both vertebrates and invertebrates) within the reaches that would be permanently inundated are expected to change as a result of the reservoir, which would provide a permanent water source and create both shallow and deep water lentic habitat for a variety of aquatic species. The effect of reservoir impoundment on many fish species would likely be beneficial due to the increased acreage of deep open water for foraging and reproducing. Aquatic species more adapted to lacustrine or lentic environments would benefit while those with a preference for stream habitats would be disadvantaged. The abundance of species that are more generalist or versatile are expected to experience little change.

Effect to the aquatic biota downstream of the dam would be mitigated through periodic, regulated releases of reservoir water to Bois d'Arc Creek below the dam (environmental flow releases). These releases would be performed to compensate for losses of stream function and wildlife habitat, and are expected to enhance instream uses below the dam.

Under the No Action Alternative, no direct and immediate impacts would occur to aquatic habitat or biota. However, continued downcutting and channelization of Bois d'Arc Creek would continue to support generalist species leading to low overall diversity.

Upland Habitats, Terrestrial Wildlife, and Threatened and Endangered Species

Constructing Alternatives 1 or 2 would result in the loss of upland habitats supporting terrestrial wildlife and threatened and endangered species. The loss of upland habitat and potential adverse effects on terrestrial wildlife and threatened and endangered species would occur on approximately 11,440 acres under Alternative 1 and approximately 6,390 acres under Alternative 2. As with other biological resources, the effects of Alternative 1 would be greater than Alternative 2 because of the larger construction footprint.

Loss of upland and terrestrial wildlife habitats would continue through the operation phase for both Alternatives 1 and 2. Approximately 11,230 acres would be adversely affected under Alternative 1 and 5,975 acres under Alternative 2. The difference in acreages between the construction and operation phases of each alternative represents recovery of upland habitats initially disturbed during construction of the water transmission pipelines and other temporary construction-related sites. The loss of upland habitat and resulting impacts on terrestrial wildlife are considered moderate for Alternatives 1 and 2.

The effect on threatened and endangered species in both aquatic and upland habitats is considered slight to moderate for Alternatives 1 and 2, reflecting the low presence of these species within the study area.

Loss of upland and terrestrial wildlife habitats would also occur under the No Action Alternative, although not to the level indicated under Alternatives 1 or 2. These losses would be attributable to future development within the project area that could result in the loss of the terrestrial wildlife and threatened and endangered species habitats. These effects are considered none to slight as development within the study area would not be of the scale or intensity expected under Alternatives 1 or 2.

Invasive Species

Land and ground surface disturbing activities associated with constructing Alternatives 1 and 2 may result in the spread of invasive species during the construction and operation phases. The potential for spread of invasive species would be greater under Alternative 1 because a larger land area would be disturbed. The severity of these effects would be considered moderate during the construction phase for both alternatives and slight to moderate during the operation phase. This change in severity is reflective of the expected recovery of disturbed lands to more natural states occurring over the operation phase.

For the No Action Alternative, future development within the project area could result in the spread of invasive species in disturbed areas. These effects are considered slight to moderate as development within the study area would not be of the scale or intensity expected under Alternatives 1 or 2.

Air Quality and Greenhouse Gas Emissions

Construction of the dam and reservoir and the water transmission and treatment facilities under Alternative 1 would affect air quality within Air Quality Control Region (AQCR) 215 as a result of air emissions occurring during construction (e.g., operation of heavy equipment, worker trips, land clearing). These emissions would be short-term and slight and would not substantially change AQCR 215 air quality. Air quality effects would be lower under Alternative 2 because the reservoir would be smaller, resulting in lower air emissions to complete construction.

Long-term negligible adverse and long-term minor beneficial impacts on air quality would occur from operation of the dam and reservoir. Long-term negligible adverse impacts would occur from recreational visitors (personal vehicles and watersport engines), increased development around the lake which could result in additional vehicles on roadways, and generators. Long-term minor beneficial impacts would be primarily due to the elimination of existing sources of air emissions (agricultural operations and biomass burning). Similar to the construction-related air quality effects, these impacts on air quality would be less under Alternative 2 because the reservoir is smaller, requiring less maintenance and supporting less development and fewer recreation-related visits.

The No Action Alternative is not expected to appreciably affect air quality within AQCR 215 because land uses at and within the vicinity of the proposed LBCR site are not expected to substantially change. However, due to overall expected population growth in the region and a commensurate increase in traffic and tailpipe emissions of criteria pollutants from vehicles, there may be a slight decrease in air quality in the region.

Both Alternative 1 and Alternative 2 would generate relatively small amounts of greenhouse gas (GHG) emissions during construction and operation (primarily from pumping raw water to the treatment plant), and would constitute incremental, but overall negligible, contributions to climate change. The No Action Alternative would not directly contribute to climate change.

Acoustic Environment (Noise)

Implementation of Alternatives 1 and 2 would have short-term slight adverse and long-term slight beneficial and adverse effects on the noise environment. Short-term slight increases in noise would result from the temporary use of heavy equipment during land clearing and construction, estimated to last 3 to 4 years. Beneficial effects would result from most of the existing sources of noise within the reservoir footprint, such as agricultural equipment, automobile traffic, and lawn maintenance equipment ending with acquisition of the land for the proposed dam and reservoir. However, there are likely to be long-term noise impacts from the increase in traffic associated with recreational and real estate development at and in the vicinity of the reservoir. Other long-term noise impacts would result from traffic passing over the new bridge, operation of the water pumping stations, and operation of the WTP.

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth. These changes would result in an increase in noise, although not to the degree attributable to the construction or operation of Alternatives 1 or 2.

Recreation

Under Alternative 1, construction of the reservoir would have slight to moderate, short-term adverse impacts. Recreational opportunities at the project site after construction are likely to be moderately beneficial, long term and medium to large in extent. Existing recreation on private lands within the reservoir footprint would be impacted by construction, but new recreation opportunities would arise once the new reservoir was in operation. Alternative 2 would result in the same impacts as Alternative 1, although the impacts would be somewhat less because of the smaller size of the reservoir in Alternative 2.

Under the No Action Alternative, there would be little to no direct impacts on existing recreation facilities. Private recreation and public recreation in the Caddo National Grasslands and other nearby public recreation lands would continue in their current state. It is likely that as the population of the region grows, demand for outdoor recreation would also increase, and this demand would increase use of recreational facilities within the region which could degrade the quality of the facilities and of the recreation experience.

Visual Resources

Construction of the dam and water transmission and treatment facilities and clearing of the reservoir inundation zone would alter the visual characteristics of the landscape at and near the project site. For both Alternatives 1 and 2, construction is expected to result in moderate alteration of the landscape as the dam embankment would be shielded from views by existing vegetation. Visual impacts from clearing of the reservoir footprint would be less for Alternative 2 than for Alternative 1 because of the smaller amount of land that would be cleared.

Due to its size and prominence, Alternative 1 (in particular, the dam and reservoir)would have a severe, long-term impact on visual resources; however, whether this impact would be regarded as adverse or beneficial would depend on the values of each individual observer. Compared to Alternative 1, the long-term adverse effect on the visual landscape occurring under Alternative 2 would be slightly less because the reservoir and embankment would be smaller.

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth and associated development pressure. This growth may result in a change in the visual character of the landscape, although not to the degree that is expected to occur under Alternatives 1 or 2.

Utilities

Under Alternative 1, construction activities would cause short-term, slight adverse impacts to utilities. Overhead power lines within the vicinity of the reservoir footprint would need to be raised or relocated. Electrical transmission lines, gas/petroleum pipelines, and other minor utilities within the footprint of the raw water pipeline would need to be crossed or bypassed. The impacts would end upon completion of construction. Operation of the proposed reservoir would cause moderate impacts to utilities for over 30 years. The demand for publicly-provided utilities would likely increase as a result of the potential increase in development that would be caused by operation of the proposed reservoir. The new LBCR would help to meet the water needs of the NTMWD service area.

Construction of Alternative 2 would also cause short-term, slight adverse impacts to utilities. The overhead power lines within the vicinity of the Alternative 1 reservoir footprint would be located almost entirely outside of the footprint of the Alternative 2 reservoir, so they would not need to be relocated. Alternative 2 includes two pipelines, so there would be additional impacts to utilities resulting from pipeline construction. The smaller reservoir of Alternative 2, with a smaller footprint and shorter length of developable shoreline, would lead to development at a reduced scope from that which may be anticipated for the larger reservoir, with a corresponding decrease in utility demands. Therefore, the impacts to utilities from operation of Alternative 2 would be slightly less than the impacts for Alternative 1.

Demand for utility services during construction is expected to increase but would be minimized because most construction activities would be accomplished through the use of fueled equipment or portable electric generators.

Demand on local or regional utility services as a result of operating Alternatives 1 or 2 would increase to meet pumping and water treatment needs. These moderate increases in electrical power demands are expected to be offset by the construction of new infrastructure sized to meet the water conveyance and treatment needs of each alternative.

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth and associated development pressure. This projected growth may result in an increase in demand for local and regional utility services. These future demands are expected to be met by local and regional utility providers.

Transportation

Constructing the LBCR dam, reservoir, water transmission, water treatment, and other ancillary facilities would result a moderate adverse impact on the local transportation network during the construction phase (3 to 4 years). These impacts would occur as materials and equipment are transported to the construction site along with construction workers commuting to and from the sites. These effects would be compounded since constructing the reservoir would require the permanent closure of some roadways that cross the reservoir inundation zone. However, these adverse effects would be offset by improving some existing roadways, which would enhance travel times and safety.

Because of the larger scale of the proposed project, Alternative 1 would result in slightly greater effects on the local transportation network including (permanent closure of five roadways) when compared to Alternative 2 (permanent closure of four roadways) and because more construction-related trips to and from the dam site are expected to occur. The scale of Alternatives 1 and 2 are such that transportation-related effects would be considered moderately severe under both. In addition, improvements to the local roadway system would occur under both Alternatives 1 and 2.

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth and associated development pressure. This growth would result in an increase in traffic on the local and regional transportation network. The existing roadway network is expected to be able to accommodate increases in traffic resulting from this long-term growth.

Environmental Contaminants and Toxic Wastes

The footprint of the proposed reservoir was assessed for environmental contaminants and toxic wastes because of concerns that contaminants and wastes could impact the water of the reservoir once the area was inundated. The assessment of the potential for such releases was based on a review of published data supplemented by information provided by the public.

An illegal dump site, primarily used for the disposal of tires, was located within the reservoir footprint on land owned by NTMWD. NTMWD remediated the site by collecting and properly disposing of tires along with soils mixed with debris. The Bonham County landfill was also identified as a potential source of contaminants in the Bois d' Arc Creek watershed. Upon additional investigation, the landfill was determined not be a source of contaminants and was not found to be adversely affecting water quality within the watershed.

The release of environmental contaminants and toxic wastes is not expected to occur during construction of either Alternative 1 or 2. In addition, releases of contaminants during operation of either Alternative 1 or 2 are considered slight. In the event a release did occur, it would be identified and addressed through periodic water quality testing.

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth and associated development pressure. No releases of environmental contaminants or toxic wastes are expected from this development.

Socioeconomics

Overall socioeconomic impacts of Alternative 1 on Fannin County and the region are multi-faceted and would be both short-term and long-term as well as adverse and beneficial. Both the adverse and beneficial impacts would be considered severe. Adverse fiscal and social impacts are more weighted toward the short-term and the fiscal impacts are largely mitigated through NTMWD's payments in lieu of taxes (PILT) to the county; at the same time, there would also be a major short-term economic stimulus associated with construction of the dam, reservoir and related facilities. Over time, socioeconomic impacts associated with Alternative 1 would become more positive or beneficial.

On net, over the long-term and the life of the proposed facility (50-100 years or more), socioeconomic effects would be positive for Fannin County. Most but not all Fannin County residents would welcome the short- and long-term economic stimulus provided by the project, in terms of direct added jobs, income, and induced economic activity. As a result of the project, in the future, Fannin County would be more populated, developed, and less rural than it is today (constituting a change in its existing predominantly rural character) or than it would be in the absence of the project. Residents would also enjoy a wider range of recreational and commercial opportunities than at present. Whether or not one sees this tradeoff as good or bad is a question of one's personal values and interests.

Overall, socioeconomic impacts of Alternative 2 on Fannin County and the region would be similar to those discussed under Alternative 1. Impacts would be both short- and long-term as well as adverse and beneficial. As under Alternative 1, Alternative 2 would result in a more populated, developed, and less rural Fannin County. The local economy would benefit from direct added jobs, income, and induced economic activity. A wider range of recreational and commercial opportunities would be available to residents, though economic benefits are not assumed to outweigh adverse impacts to the social or rural character of Fannin County; ultimately, this weighting is a question of one's personal values and interests.

Compared to Alternative 1, beneficial impacts from the additional short-term stimulus to construct the pipeline and transmission facilities would be greater under this alternative due to additional job creation, spending of those wages, and related increases in economic activity. Annual debt payments and operating and maintenance costs would increase the unit cost of water to NTMWD customers (before amortization) by 12 percent. In the long-term, impacts to economic resources would be beneficial since the price will drop drastically once the debt is paid off – and the cost per 1,000 gallons would ultimately be almost the same as under Alternative 1.

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth and associated development pressure. This growth may result an increase in regional economic activity which could benefit long-term employment, income, and tax revenues.

Environmental Justice and Protection of Children

Alternative 1 would not result in environmental justice impacts in the overall region. Census data identified Honey Grove, Ladonia, and Bonham as "pockets" of minority populations and Bonham as a "pocket" low-income population. Alternative 1 could create indirect, slightly adverse impacts for at least a portion of the construction phase, though not during the operational phase. Low-income populations could experience intermittent and temporary impacts on commuting from traffic or time delays. Youth minority populations living in Honey Grove could experience slightly disproportionate adverse impacts as they relate to noise disturbances and mobile source air pollutant emissions during the construction of the 35-mile pipeline to the North WTP. However, impacts would be temporary and intermittent and depend on the location and timing of specific construction activities. The size or physical extent of such impacts would be small (localized) and could affect the aforementioned "pockets" of environmental justice populations. The likelihood of all noise and air-quality related adverse impacts on environmental justice populations would be low given their distance(s) to the project area.

Beneficial impacts in the form of jobs would not impact low-income or minority populations disproportionately in the short-term or long-term. Long-term impacts of Alternative 1 on environmental justice populations would be moderately beneficial due to the replacement of FM 1396 with FM 897 and a major new recreational facility. Long-term impacts would last as long as the dam and reservoir's lifetime (50-100 years); impacts would occur throughout Fannin County and therefore the size or physical extent of impacts would be medium and localized; and the likelihood of beneficial impacts would be high.

Impacts from Alternative 2 would be similar to those described under Alternative 1, and would not create environmental justice impacts in the overall ROI because neither Fannin nor Grayson counties meet the regulatory definition of minority or low-income populations.

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth and associated development pressure. This projected growth is not expected to result in a disproportionate effect on minority or low income communities.

Cultural Resources

Construction of the dam, reservoir, water transmission, water treatment, and other ancillary facilities would result in adverse effects on cultural resources during the construction and operation phases for both Alternatives 1 and 2. The assessment of impacts on these resources under Alternative 1 was determined by the Area of Potential Effects (APE) as defined in the Programmatic Agreement (PA) and other areas that might be affected by construction of either alternative. Generally, the APE included the footprint of the proposed LBCR up to the top of the flood pool (elevation 541 ft. MSL), the planned location of the dam and all associated construction and staging areas, the new water treatment facility, and water transmission pipelines. Although outside the APE, potential effects were evaluated for the area that could be inundated by 545-foot flowage easement. The assessment of effects under Alternative 2 was established by an APE reduced in scale to reflect the smaller proposed reservoir.

Alternatives 1 and 2 would result in severe adverse effects on sites listed or potentially eligible for listing on the National Register of Historic Places (NRHP). Under Alternative 1, 61 sites have been identified within the APE. Of these sites, 39 have been determined not to be eligible for listing on the NRHP. The remaining 22 sites require further testing to determine eligibility for listing. Under Alternative 2, 32 sites have been identified within the reduced APE. Of these sites, 24 have been determined not to be eligible for listing on the NRHP. The remaining eight sites require further testing to determine eligibility for listing.

The PA establishes a process for treating cultural resources that are discovered as part of the construction of the water storage, water conveyance, and treatment facilities. This process is applicable to both Alternatives 1 and 2. The terms and conditions of the PA include ceasing work in the vicinity of a newly discovered site, conducting an assessment, and developing and implementing a treatment plan.

Under the No Action Alternative, land use changes within the study area are expected to occur as a result of long-term population growth and resulting development. This growth may result in adversely affecting unknown, but potentially significant cultural resources.

ACRONYMS AND ABBREVIATIONS

ABB	American burying beetle
ACHP	Advisory Council on Historic Preservation
AF	Acre-foot or acre-feet
AFY	Acre-feet per year
AIRFA	American Indian Religious Freedom Act
AJD	Approved Jurisdictional Determination
ANSI	American National Standard Institute
APE	Area of Potential Effects
AQCR	Air Quality Control Region
AQCR 215	Metropolitan Dallas Fort Worth Intrastate Air Quality Control Region
ARC	AR Consultants
ARPA	Archeological Resources Protection Act
ARRP	Aquatic Resource Relocation Plan
BEG	Bureau of Economic Geology
BLM	Bureau of Land Management
BMP	Best Management Practice
°C	Degrees Celsius or Centigrade
CAA	Clean Air Act
CADSWES	Center for Advanced Decision Support for Water and Environmental Systems
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second (volumetric flow rate of water)
CIP	Capital Improvement Plan
cmbs	Centimeters below the surface
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COCs	Chemicals of concern
CRP	Conservation Reserve Program
CSA	Confederate States of America
CWA	Clean Water Act
dB	Decibel
dBA	A-weighted decibel
dbh	diameter at breast height
DEIS	Draft Environmental Impact Statement
de minimus	of minimal importance
DFCs	Desired Future Conditions
DFW	Dallas-Fort Worth International Airport
DNL	Day-Night Sound Level
DOI	U.S. Department of the Interior
DWU	Dallas Water Utilities
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency

ERDC	Environmental Research and Development Center, U.S. Army Corps of Engineers
ESA	Endangered Species Act
ESA	Environmental Site Assessment
°F	Degrees Fahrenheit
FCAD	Fannin County Appraisal District
FCI	Functional Capacity Index
FCR	Fire-cracked rock
FCU	Functional Capacity Unit
FM	Farm-to-Market Road
FNI	Freese and Nichols, Inc.
Ft	Foot or feet
FTE	Full Time Equivalent
GHG	Greenhouse Gas
GIS	Geographic Information System
GCD	Groundwater Conservation District
GMA	Groundwater Management Area
GPCD	Gallons Per Capita Per Day
GTUA	Greater Texoma Utility Authority
GYI	North Texas Regional Airport
HAP	Hazardous Air Pollutant
HC	Hydrocarbon
HEP	Habitat Evaluation Procedure
HGM	Hydrogeomorphic
HPA	High Potential Area
HSI	Habitat Suitability Index
HUC	Hydrologic Unit Code
Hz	Hertz
I	Interstate
IBI	Index of Biological Integrity
IBT	Inter-Basin Transfer
ICEM	Incised Channel Evolution Model
IO	Isolated Object
IP	International Paper
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
km	kilometer
kWh	kilowatt hour
lbs	Pounds
LBCR	Lower Bois d'Arc Creek Reservoir
LBJ	Lyndon B Johnson
LEDPA	Least Environmentally Damaging Practical Alternative
LiDAR	Light Detection and Ranging
LOI	Limits of Investigation
LRH	Lake Ralph Hall

L_{eq}	Equivalent Sound Level
m	Meter
MAG	Managed Available Groundwater
MCLs	Maximum Contaminant Levels
mgd	million gallons per day
mg/L	milligrams per liter (equals parts per million)
mm	Millimeter
MOA	Memorandum of Agreement
MSA	Metropolitan Statistical Area
MSL	mean sea level (elevation in feet above mean sea level)
MSPS	Main Stem Pump Station
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAIP	National Agriculture Imagery Program
NCTCOG	North Central Texas Council of Governments
NEPA	National Environmental Policy Act of 1969
NETMWD	Northeast Texas Municipal Water District
NGO	Non-Governmental Organization
NHPA	National Historic Preservation Act
NOI	Notice of Intent
NOx	Nitrogen Oxides
N_2O	Nitrous Oxide
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRI	National Resources Inventory
NTMWD	North Texas Municipal Water District
NWI	National Wetlands Inventory
O_3	Ozone
OHWM	Ordinary High Water Mark
OSD	Office of the State Demographer
PA	Programmatic Agreement
PAH	polycyclic aromatic hydrocarbon
PET	Potential Evapotranspiration
PGMA	Priority Groundwater Management Area
PHDI	Palmer Hydrological Drought Index
PILT	Payment in Lieu of Taxes
PJD	Preliminary Jurisdictional Determination
PM	Particulate Matter
PM_{10}	Particulate Matter under 10 microns in diameter (fine)
$PM_{2.5}$	Particulate Matter under 2.5 microns in diameter (very fine)
PMF	Probable Maximum Flood
PSA	Public Service Announcement
RCRA	Resource Conservation and Recovery Act
RGA	Rapid Geomorphic Assessment

RGL	Regulatory Guidance Letter
ROD	Record of Decision
ROI	Region of Influence
RPW	Relatively Permanent Water
RRA	Red River Authority
RRC	Railroad Commission of Texas
RWPG	Regional Water Planning Group
SAL	State Antiquities Landmark
SB	Senate Bill
SCA	Sun-colored amethyst
SCS	Soil Conservation Service
SFASU	Stephen F. Austin State University
SH	State Highway
SHPO	State Historic Preservation Office
SQF	Stream Quality Factor
SQRU	Scenic Quality Rating Unit
SQU	Stream Quality Unit
SRA	Sabine River Authority
SRBA	Sulphur River Basin Authority
SUD	Special Utility District
TAC	Texas Administrative Code
TARL	Texas Archeological Research Laboratory
TAS	Texas Archeological Society
TASA	Texas Archeological Sites Atlas
T&E	Threatened and Endangered (species)
T&PR	Texas and Pacific Railroad
TCEQ	Texas Commission on Environmental Quality
TDA	Texas Department of Agriculture
TDS	Total Dissolved Solids
TRF	Total Fertility Rate
THC	Texas Historical Commission
THPO	Tribal Historic Preservation Officer
THSA	Texas Historic Sites Atlas
TPWD	Texas Parks and Wildlife Department
tpy	tons per year
TRA	Trinity River Authority
TRWD	Tarrant River Water District
TSR	Terminal Storage Reservoir
TWC	Texas Water Code
TWC	Texas Water Commission
TWDB	Texas Water Development Board
TX	Texas
TXRAM	Texas Rapid Assessment Method
TNW	Traditional Navigable Water

TRWD	Tarrant Regional Water District
TxDOT	Texas Department of Transportation
TXNDD	Texas Natural Diversity Database
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTRWD	Upper Trinity Regional Water District
VOC	Volatile Organic Compound
Vpd	vehicle trips per day
VRM	Visual Resource Management
VSI	variable subindex
WAA	wetlands assessment area
WAM	Water Availability Model
WCAC	Water Conservation Advisory Council
WCP	Water Conservation Plan
WMA	Wildlife Management Area
WOCMA	White Oak Creek Mitigation Area
WRP	Wetlands Reserve Program
WRPI	Water Resources Planning and Information
WTF	Water Treatment Facility
WTP	Water Treatment Plant
WUG	Water User Group
WWP	Wholesale Water Provider
WWTP	Wastewater Treatment Plant
ZPG	zero population growth

GLOSSARY AND TERMS

5-year floodplain: An area of low-lying ground adjacent to a river, formed mainly of river sediments and subject to flooding over a 5-year period.

3rd Order Streams: Stream order is a measure relative to the size of streams. An increase in stream order is an order of magnitude increase in size. 3^{rd} order streams are formed by the confluence of two second order streams, or of a second order stream and a third order stream.

4th Order Streams: Stream order is a measure relative to the size of streams. An increase in stream order is an order of magnitude increase in size. 4^{th} order streams are formed by the confluence of two third order streams.

Amortization: The paying off of debt in regular installments over a period of time.

Amortization: The paying off of debt in regular installments over a period of time.

Backwater flow: The backing up of water through a conduit or channel in the direction opposite to normal flow.

Basal area: Common term to describe the average amount of an area that is occupied by tree stems and is defined as the total cross-sectional areas of all stems in a stand measured at breast height, and is typically expressed as per unit of land area (typically square feet per acre).

Benthic: Of or pertaining to the bottom of a body of water.

Benthic macroinvertebrate: Organisms without backbones that inhabit the bottom substrates for at least part of their lifecycle.

Biotic diversity: A metric of how many calories from bacteria and plants are distributed among plants, bacteria, fungus, and animals.

Channelization: The act of straightening a stream, typically widening and deepening the stream as well as to improve the flow of water.

Channel Morphology: Form and structure that describes the shape of a stream or river bed.

Collector-gatherers: Macroinvertebrate functional feeding group which collect fine particulate organic matter from the stream bottom.

Colonizer species: Species that successfully spreads to new area and completes successful immigration where the population becomes integrated into a community, resisting initial local extinction.

Cost Synergy: A cost synergy refers to the opportunity of a combined corporate entity to reduce or eliminate expenses associated with running a business. Cost synergies are realized by eliminating positions that are viewed as duplicate within the merged entity.

Decibel: A unit used to measure the intensity of a sound.

Deciduous: Referring to a plant (usually a tree or shrub) that sheds its leaves at the end of the growing season.

Diameter at breast height: Standard method of expressing the diameter of the trunk or bole of a standing tree.

Easement: The right of a person, government, agency, or public utility company to use or restrict public or private land owned by another for a specific purpose.

Economies of Scale: Reductions in unit cost as the size of a facility and the usage levels of other inputs increase.

Eminent Domain: A power reserved by a government agency, usually at the state or local level, to use its legislatively-granted police power to condemn a piece of property for the public use.

Erosion: The removal of sediment or rock from a point in the landscape.

Facultative: Wetland indicator category equally likely to occur in wetlands or non-wetlands.

Facultative upland: Wetland indicator category that usually occurs in non-wetlands (estimated probability of 67% - 99%), but occasionally found in wetlands (estimated probability of 1% - 3%).

Filter feeders: An aquatic animal that feeds on particles or small organisms strained out of water by circulating them through its system.

Firm Yield: The maximum amount of water that can be diverted from a reservoir on an annual basis during a repeat of the historical drought of record without shortage, assuming that all of the water in the reservoir is available for use.

Geomorphic: Relating to the form of the landscape and other natural features of the earth's surface.

Geomorphological processes: Landscape altering system, such as water runoff or erosion that influences the movement and shape of the physical landscape.

Generalist species: A species that lives on a wide variety of food and can live in variety habitats.

Genetic Distribution: The total number of genetic characteristics in the genetic makeup of a species.

Herbivores: Animal that feeds on plants.

Hydrogeomorphic: Relating to the interaction and linkage of hydrologic processes with landforms or earth materials and the interaction of geomorphic processes with surface and subsurface water in temporal and spatial dimensions.

Interflow: The lateral movement of water in the unsaturated zone, or vadose zone, that first returns to the surface or enters a stream prior to becoming groundwater.

Knapping: The shaping of flint, chert, obsidian or other appropriate rocks to manufacture stone tools.

Lacustrine: Any large body of water that is greater than 8 hectares. Found in a topographic depression or is a dammed river channel.

Lateral migration: Streambank erosion process where the side-to-side movement of meander migration undercuts the streambank.

Leakage: A non-consumption use of income, including saving, taxes, and imports. The notion of leakage is best viewed through the circular flow, in which saving, taxes, and imports are "leaked" out of the main flow between output, factor payments, national income, and consumption.

Leaseback: An arrangement where the seller of an asset leases back the same asset from the purchaser. In a leaseback arrangement, the specifics of the arrangement are made immediately after the sale of the asset, with the amount of the payments and the time period specified. Essentially, the seller of the asset becomes the lessee and the purchaser becomes the lessor in this arrangement.

Lien: An official claim of debt against something, where the asset will be in hands of lender and the lender himself can adjusts the sale value of the asset to the debt without prior notice to the borrower.

Lithic Scatter: A scatter on the ground surface of cultural artifacts and debris consisting entirely of lithic – that is, rock – tools and chipped stone debris.

Market Saturation: A situation in which a product has become diffused (distributed) within a market; the actual level of saturation can depend on consumer purchasing power; as well as competition, prices, and technology.

Mainstem: The primary, and generally largest, branch of a river.

Mesohabitats: Medium sized habitats.

Overbanking: Flooding over the bank of a stream or river.

Overland flow: The flow of rainwater or snowmelt over the land surface toward stream channels. After it enters a watercourse it becomes runoff.

Parity Debt: Bonds and other debt securities that have an equal and ratable claim on the same underlying asset as collateral.

Particulate organic material: Soil organic matter between 0.052 millimeters (mm) and 2 mm in size.

Perennial: Lasting or existing for a long or apparently finite time; enduring or continually reoccurring.

Permitted diversion: The amount of water that can be legally withdrawn from a water source in accordance with a Texas water right.

Photosynthesis: Process by which green plants and some other organisms use sunlight to make food from carbon dioxide and water.

Planktivores: Aquatic organisms that feed on planktonic food.

Pledge: Transferring property as collateral for a debt. The lender cannot adjust the secured asset without having given prior notice and until the due date.

Polyphilic spawner: A type of spawning regarding eggs of a spawner such as bivalve, fish, or amphibians.

Pro-rata: Assigning an amount to a fraction, or a proportionate allocation, according to its share of the whole. For example, a pro-rata dividend means that every shareholder gets an equal proportion for each share he or she owns. Pro-rating also refers to the practice of applying interest rates to different time frames. If the interest rate was 12% per annum, you could pro-rate this number to be 1% a month (12percent/12 months).

Reliable Supply: Amount of water that is considered available 100 percent of the time during a repeat of the historical drought of record. This is commonly based on the firm yield of the water source and may differ from permitted diversions or contract amounts.

Riparian: Areas adjacent to rivers and streams. These areas often have a high density, diversity, and productivity of plants and animal species relative to nearby uplands.

Run and riffle habitats: Runs refer to an area where the water is flowing rapidly, generally located downstream from riffles. Riffle is an area of a stream where the water breaks over cobbles, boulders and ravel or where the water surface is visibly broken. Runs are typically deeper than riffles.

Scrapers: Macroinvertebrate functional feeding group which consume algae and associated materials.

Sherd: A fragment of broken ceramic material, especially one found at an archaeological site.

Shredder species: Macroinvertebrate functional feeding group which consumer leaf litter or coarse particulate organic matter.

Speleophilic: Species preferentially or exclusively inhibiting caves.

Step-up provision: The readjustment of the value of an appreciated asset for tax purposes upon inheritance. The value of the asset is determined to be the higher market value of the asset at the time of inheritance, not the value at which the original party purchased the asset.

Stratification: When water forms layers because of differences in salinity, oxygen levels, density, or temperature. These layers often act as a barrier to water mixing.

Tax Roll: A breakdown of all taxable property that can be taxed within a given jurisdiction, such as a city or county. The tax roll lists each property separately in addition to its assessed value, and is usually created by the taxing assessor or other authority within the jurisdiction.

Texas water right (Certificate of Adjudication or Permit): Legal instrument issued by the State of Texas to divert, use and/or store waters of the state.

Thermocline: A sudden temperature gradient in a body of water such as a lake, this area is marked by a layer above and below with waters of different temperatures.

Tributary: Stream or river that flows into a larger stream or main stem river or a lake.

Trophic structure: Referring to the way in which organizations use food resources to get energy for their growth and reproduction and is often referred to in simple terms as the food web or food chain.

Wetland obligates: Wetland indicator category that almost always occurs in wetlands under natural conditions.

Revised Draft Environmental Impact Statement
Lower Bois d'Arc Creek Reservoir

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1.0 INTRODUCTION

In June 2008, the U.S. Army Corps of Engineers (USACE), Tulsa District received an application for a Department of the Army Permit under Section 404 of the Clean Water Act (CWA) from the North Texas Municipal Water District (NTMWD) to construct Lower Bois d'Arc Creek Reservoir (LBCR). In accordance with the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 *et seq.*), the USACE determined that issuance of such a permit may have a significant impact on the quality of the human environment and, therefore, required the preparation of an Environmental Impact Statement (EIS). Accordingly, the USACE prepared a Draft EIS (DEIS) which was released to the public in February 2015 (USACE, 2015a). The USACE decided to prepare this Revised DEIS (RDEIS) as the best way to address substantive agency and public comments received on the original DEIS, disclose refinements to the project design, and provide updates to the analysis of environmental effects. Section 1.4 *NEPA Process* provides additional information on the steps the USACE will follow to complete the NEPA compliance process.

1.1 THE PROPOSED ACTION

1.1.1 New Reservoir, Raw Water Pipeline, and Water Treatment Plant

The proposed dam and reservoir for the LBCR project would be located in Fannin County, Texas, on Bois d'Arc Creek (Figure 1.1-1), in the Red River basin (Figure 1.1-2), approximately 15 miles northeast of the City of Bonham, between Farm-to-Market (FM) Road 1396 and FM Road 409. The total land area or "footprint" of the proposed project site is 17,068 acres. The project site is in an area of largely rural countryside with scattered residences. Approximately 38 percent is cropland and 37 percent consists of bottomland hardwoods and riparian woodlands, with the remaining 25 percent mostly upland deciduous forest.

Figure 1.1-1. Bois d'Arc Creek Within the Footprint of the Proposed Reservoir (Looking Upstream from Bridge at FM 1396 Crossing)

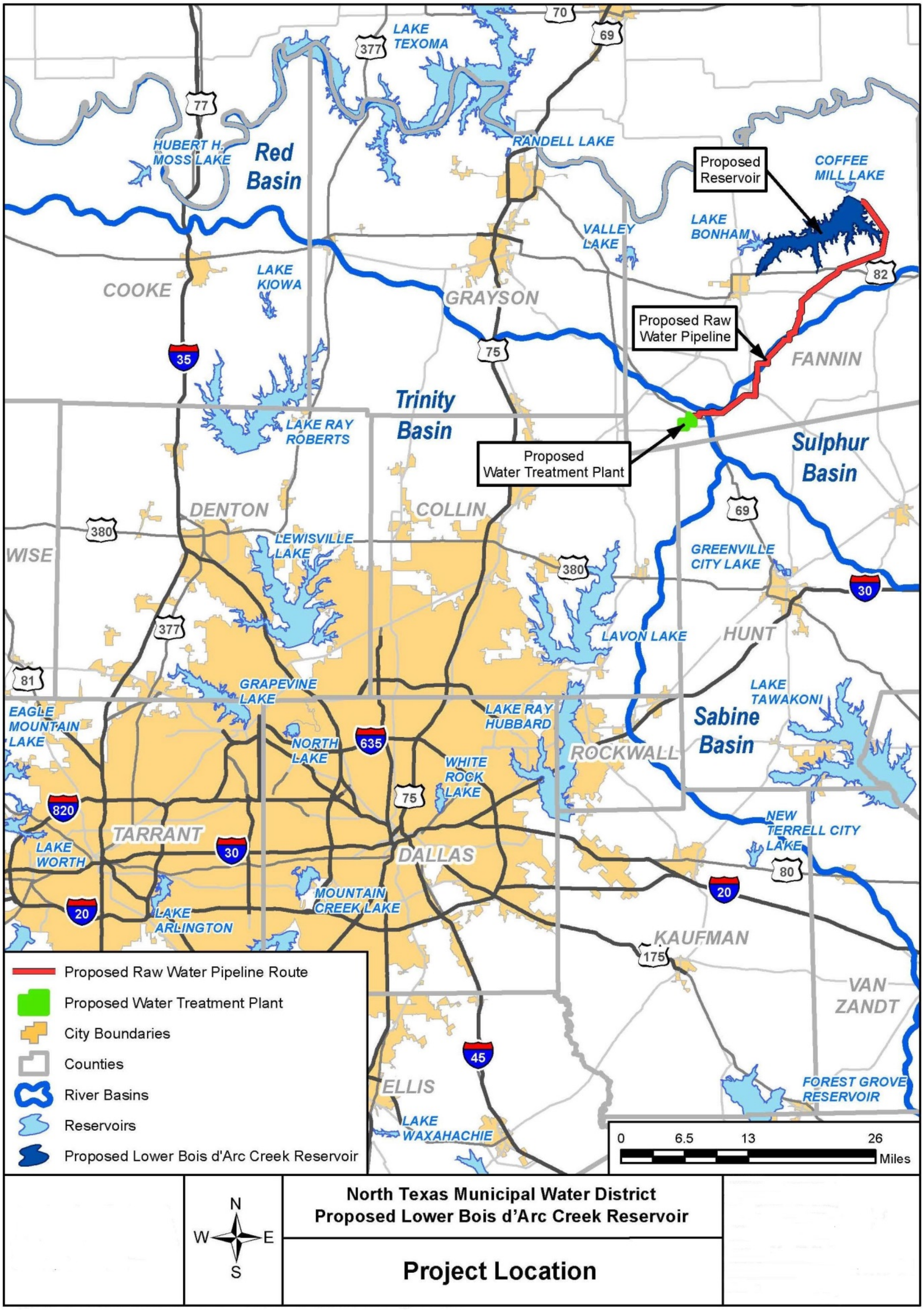


Figure 1.1-2. Project Location (Upper Right) Within North Texas Watersheds (Basins)

As will be explained further in Section 1.5, the purpose of the proposed project is to ensure that NTMWD has an additional, reliable supply of water to meet its near-term needs through 2025. The proposed project would also provide for a portion of the NTMWD long-term water supply needs. NTMWD's long-term water supply planning process, which includes estimated demands and supplies from 2020 through 2060, is described in Appendix N. To accomplish the purpose of meeting their near-term water supply needs through 2025, NTMWD is proposing to impound the waters of Bois d'Arc Creek and its tributaries to create a new 16,641-acre (26-square mile) water supply reservoir. An additional 427 acres would be required for the construction of the dam and spillways, for a total project footprint of 17,068 acres. NTMWD has received a state water right to impound up to 367,609 acre-feet of water and divert up to 175,000 acre-feet per year (AFY), with an estimated firm yield of 120,665 acre-feet of water per year.

NTMWD serves one of the fastest-growing areas of Texas (Kiel and Gooch, 2015), and indeed, the entire country (Potter and Hoque, 2014). Demographic projections show the population of the NTMWD service area more than doubling from about 1.75 million in 2020 to 3.7 million by 2070 (Region C Water Planning Group, 2015). The LBCR would provide a new source of supply to help meet the increasing water demands of this growing population.

The dam for LBCR would be approximately 10,400 feet (about two miles) in length and would have a maximum height of approximately 90 feet. The top of the embankment would be at a design elevation of 553.5 feet above mean sea level (MSL) with a conservation pool elevation of 534.0 feet MSL, controlled by a service spillway at an elevation of 534.0 feet MSL with a crest length of 150 feet. The service spillway would be located at the east abutment of the dam. Required low-flow releases would be made through a 27-inch diameter low-flow outlet. An emergency spillway would also be located in the east dam abutment. The emergency spillway would be a 1,400-foot wide uncontrolled broad crested weir structure with a crest elevation of 541 feet MSL. This elevation was selected to contain a 100-year storm (one which statistically has a one percent chance of occurring in any given year) such that no flows pass through the emergency spillway during this event.

Raw water from the reservoir would be transported by a new pipeline to a proposed new terminal storage reservoir (TSR) and water treatment plant (WTP) – the "North WTP" – west of the City of Leonard in southwest Fannin County (Freese and Nichols, 2013a). The pipeline would be 90 to 96 inches in diameter and 35 miles long.

In order to provide the ability to treat additional water from LBCR at its existing facilities in Wylie, Texas, NTMWD initially proposed to construct 14 miles of 66-inch diameter pipeline that would have extended from the North WTP to an outfall on Pilot Grove Creek. This creek is a tributary of the East Fork of the Trinity River which flows into Lavon Lake. However, upon further evaluation, NTMWD decided not to transfer water from the LBCR to Lavon Lake via this 14-mile section of pipeline and Pilot Grove Creek. In a February 2011 letter to the USACE, NTMWD requested that the transmission pipeline from the proposed North WTP to Pilot Grove Creek and the associated discharge structure be removed from the Section 404 permit application and EIS (NTMWD, 2011).

Construction of the dam and impoundment of water within the normal pool elevation of 534 feet MSL would result in direct fill impact or inundation of waters of the United States, including wetlands. Approximately 120 acres (286,139 linear feet) of existing intermittent streams, 99 acres (365,002 linear feet) of intermittent/ephemeral streams, 78 acres of open water, 4,602 acres of forested wetlands, 1,223 acres of herbaceous wetlands, and 49 acres of shrub wetlands would be impacted.

1.1.2 Applicant

NTMWD is a conservation and reclamation district and political subdivision of the State of Texas (see service area in Figure 1.1-3). It was created by and functions under Article XVI, Section 59, of the Texas Constitution, pursuant to Chapter 62, Acts of 1951, 52nd Legislature of Texas, Regular Session, as amended. A 1975 amendment to the State Legislature Act, which created the NTMWD, authorizes it to acquire, treat, and distribute potable water, and to collect, treat and dispose of wastes, both liquid and solid, in order to reduce pollution, conserve, and develop the natural resources of Texas (TEX REV CIV STAT ANN art. 8280-141).

The primary mission of the NTMWD is to meet the needs of its member cities and customers for drinking water, wastewater treatment, and solid waste disposal. Table 1.1-1 lists NTMWD's member cities and customers, not including prospective future customers. NTMWD acts as a regional wholesale water provider to its member cities and other wholesale customers. Unit costs for services are lower because the services are regional, so the NTMWD can realize economies of scale. Rates for NTMWD services are set at cost, without profits or taxes.

Table 1.1-1. NTMWD Water System

Member Cities (including 10 which originally formed the district and three added later)			
Allen	Garland	Princeton	Wylie
Farmersville	McKinney	Richardson	
Forney	Mesquite	Rockwall	
Frisco	Plano	Royse City	
Direct Customers			
Ables Springs WSC	Fate	Lucas	Rose Hill SUD
Bonham	Forney Lake WSC	Melissa	Rowlett
Caddo Basin SUD	Gastonia-Scurry SUD	Milligan WSC	Sachse
Cash SUD	Greater Texoma Utility Authority	Mt. Zion WSC	Seis Lagos UD
College Mound WSC	Josephine	Murphy	Sunnyvale
Copeville SUD	Kaufman	Nevada WSC	Terrell
Crandall (Kaufman Four-One)	Kaufman Four-one	North Collin WSC	Wylie Northeast SUD
East Fork SUD	Lavon WSC	Parker	
Fairview	Little Elm	Prosper	

SUD = Special Utility District; UD = Utility District; WSC = Water Supply Corporation

Source: NTMWD, no date-a

NTMWD contracts are issued on a "take-or-pay" basis, in which customers agree to pay for the capital costs associated with capacity in NTMWD's water supply system required to provide for the customers' historic maximum use of water. The contracts also include provisions requiring customers to pay for the operation and maintenance costs associated with the water services they receive from NTMWD. The "take-or-pay" rate structure of the current contract (last amended in 1988) with the 13 member cities may discourage conservation by not rewarding cities for using less water, but the structure recognizes that the capital costs assumed by NTMWD in order to satisfy the cities' historic maximum demand for water has to be paid for regardless of a member city's current usage.

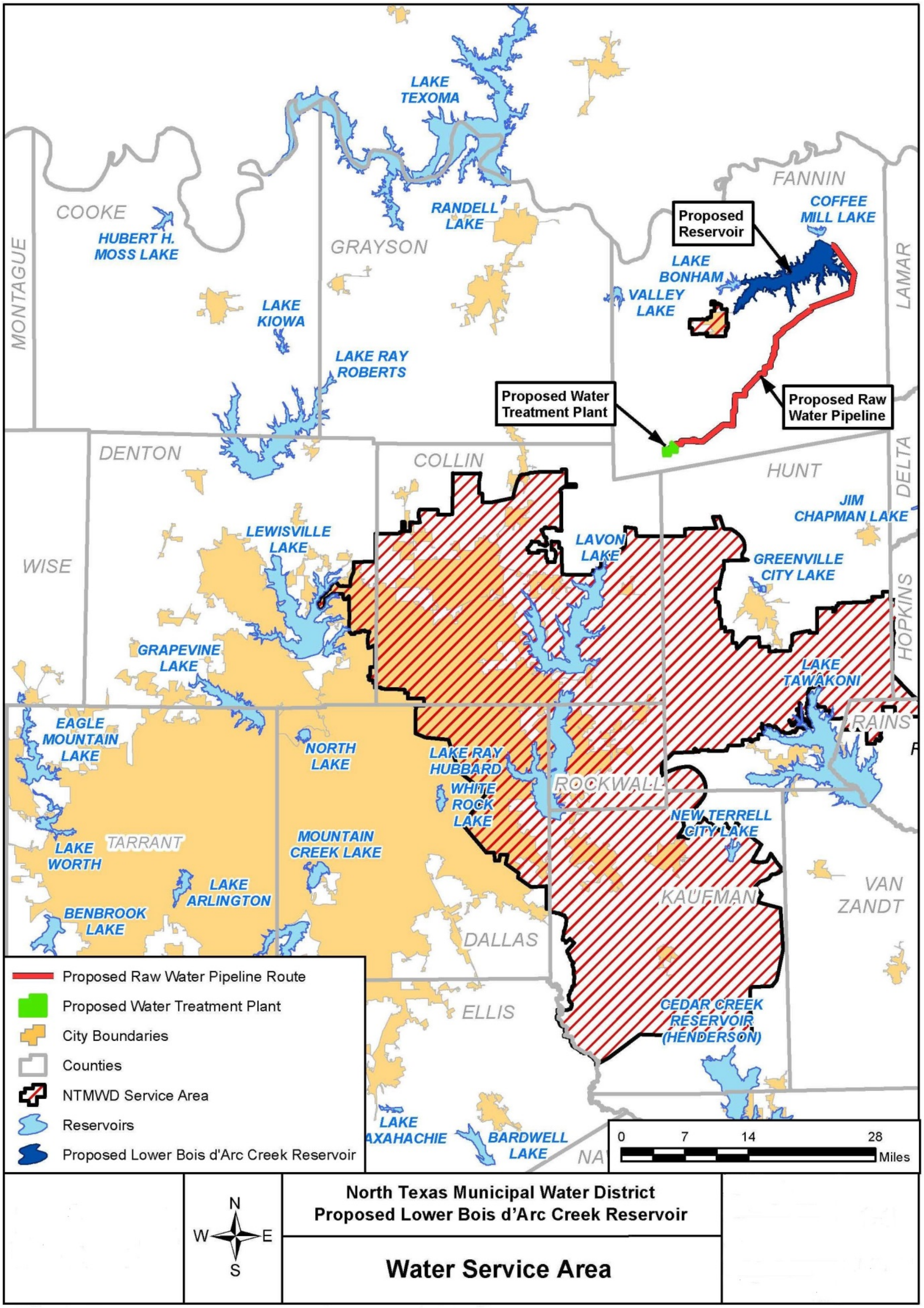


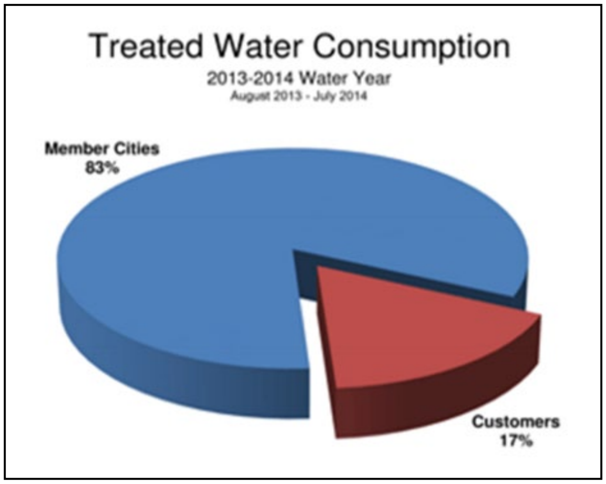
Figure 1.1-3. NTMWD Water Service Area

This rate structure is being reviewed and reconsidered by NTMWD and the member cities, and may be revised if the parties can agree on a different means for allocating costs among member cities while addressing NTMWD's revenue requirements for infrastructure that was built as a result of the cities' historic demands for water (Crimmins, 2016). It is in the interest of NTMWD to incentivize water conservation because this obviates or postpones the need for developing expensive new water supplies and constructing new facilities. With that interest in mind, NTMWD has spent over $11.2 million over the last decade for the development and implementation of the Water IQ campaign. The Water IQ campaign encourages water conservation by NTMWD's customers and the 1.6 million people served by its customers. In addition to Water IQ, NTMWD has also funded several other programs that contribute to public education and outreach. NTMWD has implemented a program to rebate to member cities the portion of NTMWD's operations and maintenance costs (power costs and chemical costs) not incurred when a city reduces its water usage.

NTMWD currently provides treated water to more than 1.6 million citizens in portions of nine counties in northern Texas – Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rains and Rockwall (Figure 1.1-3). Lavon Lake (see Figure 1.1-3) serves as NTMWD's main raw water supply source. Lavon Lake also serves as a terminal reservoir for additional supplies that are transferred from other sources. NTMWD holds water rights for raw water supplies from Lavon Lake, Lake Texoma, Jim Chapman Lake, Lake Bonham, and the Wetland (East Fork Raw Water Supply Project). Additional temporary supplies are available through a contract with the Sabine River Authority (SRA) providing for water transfer to Lavon Lake from Lake Tawakoni. The 20-year contract with SRA was signed in 2005 and has provisions for two, 10- year extensions. NTMWD has begun serving residents of the City of Bonham in Fannin County, near the proposed reservoir site, with water from Lake Bonham that is treated at the newly constructed, state-of-the-art Bonham WTP.

In May 2013, in response to the ongoing drought and the loss of 28 percent of NTMWD's total water supplies from Lake Texoma due to the presence of an invasive species, the zebra mussel, NTMWD entered into a temporary contract with Dallas Water Utilities to purchase up to 60 million gallons per day (mgd) of raw water. This contract expired in April 2016 and Dallas Water Utilities informed NTMWD that it will not be renewing or extending the contract.

During the 2013-2014 Water Year (August 2013 - July 2014), NTMWD treated and delivered 83.6 billion gallons of water for its member cities and direct customers (Figure 1.1-4 and Figure 1.1-5). Member cities of the NTMWD water system received 83 percent of the total supply delivered, and the direct customers listed in Table 1.1-1 received the remaining 17 percent. Water consumption declined in the last two years (2012-2013 and 2013-2014) because of mandatory conservation measures due to the drought.



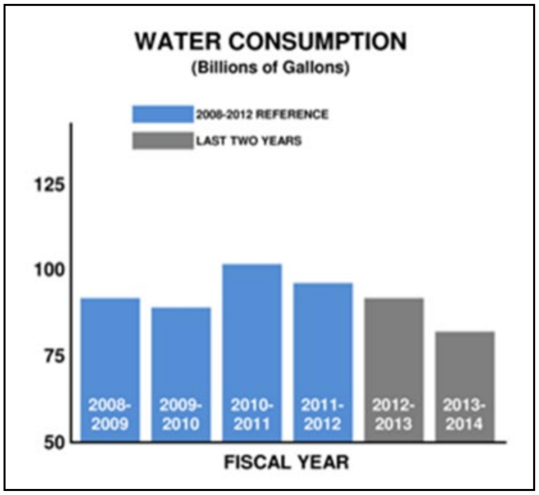


Figure 1.1-4. Treated Water Consumption by Member Cities and Customers of the NTMWD, 2008-2014

Figure 1.1-5. View of Facilities at NTMWD Raw Water Treatment Plant in Wylie, TX

1.2 KEY AGENCY ROLES, RESPONSIBILITIES AND DECISIONS

1.2.1 U.S. Army Corps of Engineers

Section 404 of the CWA established a program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands. Activities affecting waters of the U.S. regulated under this program include discharging fill for development and infrastructure, water resource projects such as dams and reservoirs, and mining. Section 404 requires the USACE Regulatory Program to issue a permit before dredged or fill material may be discharged into waters of the U.S. (USEPA, 2004).

The overall mission of the USACE Regulatory Program is to protect America's aquatic resources, while allowing reasonable development through a system of fair, flexible and balanced permitting decisions. The USACE evaluates permit applications for essentially all construction activities that occur in the nation's waters, including wetlands. USACE permits under Section 404 of the CWA and Section 10 of the Rivers and Harbors Act of 1899 are also necessary for any work in navigable waters, including construction and dredging. In evaluating permit applications, the USACE balances the reasonably foreseeable beneficial and adverse effects of proposed projects, and makes permit decisions that recognize the essential values of the nation's aquatic ecosystems to the general public, as well as the property rights of private citizens who wish to use their land (USACE, 2010a).

The USACE considers the views of stakeholders, including other federal, state and local agencies, interest groups, and the general public in evaluating permit applications. The result of this careful public interest review is fair and equitable decisions that allow for reasonable use of private property, infrastructure development, and growth of the economy, while offsetting the authorized impacts to the waters of the U.S. Adverse impacts to the aquatic environment are offset by mitigation requirements, which may include restoring, enhancing, creating and preserving aquatic functions and values (USACE, 2010a).

The proposed LBCR project is located within the USACE's Tulsa District, headquartered in Tulsa, Oklahoma. The USACE is the lead agency in preparing this revised DEIS. Several federal and state agencies (identified below) are acting as cooperating agencies for the NEPA process: U.S. Environmental Protection Agency (EPA), U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (USFWS), and the Texas Parks and Wildlife Department (TPWD).

1.2.2 U.S. Environmental Protection Agency

The mission of the EPA is to protect human health and the environment. To accomplish this mission, the EPA develops and enforces regulations, provides grants, studies environmental issues, sponsors partnerships, educates people and publishes information about the environment (USEPA, 2010a).

The EPA also has roles and responsibilities specified under Section 404 of the CWA with regard to protection of the nation's waters and wetlands. Under Section 404, the EPA:

- Develops and interprets policy, guidance and environmental criteria used in evaluating permit applications;
- Determines the scope of geographic jurisdiction and applicability of exemptions;
- Approves and oversees State and Tribal assumption of permitting authority;

- Reviews and comments on individual permit applications;
- Has authority to prohibit, deny, or restrict the use of any defined area as a disposal site;
- Can elevate specific cases; and
- Enforces Section 404 provisions (USEPA, 2004).

In addition, with regard to NEPA, the EPA reviews and comments on EISs prepared by other federal agencies, maintains a national filing system for all EISs, and ensures that its own actions comply with NEPA (USEPA, 2010b). The Region 6 Office of the EPA, located in Dallas, Texas, is participating in this EIS for the LBCR project as a cooperating agency. The EPA assisted with Habitat Evaluation Procedures (HEP, see Appendix J) analysis of the proposed reservoir and mitigation sites and also participated in the inter-agency instream flow studies associated with the project. In 2015 and 2016, the EPA Region 6 participated in several workshops and field data collection efforts to evaluate alternatives to the proposed Lower Bois d'Arc Reservoir. The EPA also participated in field data collection on the hydrogeomorphic (HGM) approach to the functional assessment of forested wetlands in East Texas, and fluvial geomorphology and rapid geomorphic assessment (RGA), with expertise provided by Stephen F. Austin State University and Baylor University.

1.2.3 U.S. Forest Service

Established in 1905, the USFS is an agency within the U.S. Department of Agriculture (USDA). Nationally, the USFS manages approximately 193 million acres of public lands in national forests and grasslands, an area equivalent in size to the State of Texas. Its mission is to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations (USFS, 2010). The USFS manages Caddo National Grasslands near the proposed project site.

The USFS is participating in this EIS for the LBCR project as a cooperating agency and also assisted in conducting the HEP analysis and the instream flow study for the proposed reservoir and mitigation sites.

1.2.4 U.S. Fish and Wildlife Service

The USFWS is the primary federal agency responsible for conserving, protecting, and enhancing America's fish and wildlife resources and their habitats. The mission of the USFWS is "working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people" (USFWS, 2009).

While the USFWS shares responsibilities for wildlife conservation with other federal, state, tribal, and local entities, it has specific and primary responsibilities for endangered species, migratory birds, inter-jurisdictional fish, and certain marine mammals, as well as for lands and waters administered by the agency for the management and protection of these resources (e.g., national wildlife refuges). It also operates national fish hatcheries, fishery resource offices, and ecological services field stations. The USFWS enforces federal wildlife laws; administers the Endangered Species Act; manages migratory bird populations; restores nationally significant fisheries; conserves and restores wildlife habitat, such as wetlands; and helps foreign governments with their conservation efforts (USFWS, 2009).

The USFWS is participating in this EIS for the LBCR project as a cooperating agency. Its Ecological Services staff participated actively in applying the USFWS-developed HEP analysis (described in Chapter 3 and Appendix J of this EIS) to both the proposed LBCR site and the proposed Riverby Ranch mitigation site. USFWS staff also participated in other environmental studies at the project site, including the instream flow and HGM studies. As the agency charged with protecting federally threatened and endangered species, USFWS evaluates potential impacts to any federally threatened and endangered species that might occur on the project site.

1.2.5 Natural Resources Conservation Service

Established in 1935 by Congress as the Soil Conservation Service (SCS), the Natural Resources Conservation Service (NRCS) of the USDA has expanded to ensure conservation of all natural resources on the nation's private lands. Seventy percent of U.S. lands are privately owned, making appropriate stewardship by private landowners crucial to environmental conservation efforts. The NRCS works directly with large and small landowners through conservation planning and assistance to benefit soils, water, air quality, plants, and animals.

NRCS also works through partnerships, collaborating closely with individual farmers and ranchers, landowners, local conservation districts, government agencies, Tribes, and many other people and groups concerned about the quality of America's natural resources. NRCS operates at the local level in field offices at USDA Service Centers in nearly every county in the U.S. (NRCS, no date-a). NRCS serves Fannin County, TX with an office in Bonham, TX.

NRCS has published a soil survey for Fannin County (NRCS, 2001) used in this EIS. NRCS also conducts the National Resources Inventory (NRI), a statistical survey of land use and natural resource conditions and trends on U.S. non-federal lands (NRCS, 2010). Through the Wetlands Reserve Program (WRP), which was repealed as of February 7, 2014, NRCS provided technical and financial support to help landowners with their long-term wetlands conservation and restoration efforts (NRCS, no date-c). Although repealed, contracts, agreements, and easements established through the WRP remain valid. The WRP offered permanent easements to private landowners who meet certain conditions. Through this program, NRCS aimed to optimize wetland functions and values as well as wildlife habitat. As of 2013, a cumulative total of 2,723,100 acres had been enrolled nationally in the WRP, of which 96,350 acres were in Texas (NRCS, 2015). There are at least two WRP properties on or near the proposed Riverby Ranch mitigation site.

1.2.6 Texas Commission on Environmental Quality

The Texas Commission on Environmental Quality (TCEQ) is the environmental agency for the state. TCEQ's aim is to protect Texas' human and natural resources in a manner consistent with sustainable economic development. Its goal is clean air and water and the safe management of waste. While receiving its current name only in 2002, TCEQ is actually descended from a number of predecessor state agencies concerned with protecting air and water quality in Texas, dating back to the formation of the Texas Board of Water Engineers in 1913 (TCEQ, 2010a).

The Office of Water is one of six offices within TCEQ. It is responsible for water supply, water planning, and water quality. The TCEQ Office of Water conducts CWA Section 401 water quality certification reviews of projects, such as the proposed LBCR, requiring a Section 404 permit from the USACE for the discharge of dredged or fill material into waters of the U.S., including wetlands (TCEQ, 2009a). The purpose of these certification reviews is to determine whether a proposed discharge will comply with state water quality standards.

Like every other state, Texas sets its own water quality standards with the EPA's approval. These standards ensure that the quality of each water body in the state is maintained at a level sufficient to perpetuate the aquatic life and human uses that have historically existed there. In permitting a broad range of substances, including pollutants or contaminants, to be discharged into state waters, both the federal and the state governments are required to ensure that these discharges will not create conditions that impair the ability of life existing in or depending on the water to survive and reproduce. The 401 certification reviews ensure that Texas is involved in decisions made by the federal government that affect the quality of the water resources of the state (TCEQ, 2004).

There are two types of 401 certifications in Texas – Tier I and Tier II. Tier II projects are those which affect ecologically significant wetlands of any size, are greater than 1,500 linear feet of stream, are greater than three acres of waters of the U.S., or are otherwise not appropriate for Tier I reviews (TCEQ, 2010b). The proposed LBCR is a Tier II project.

After the USACE declares a Section 404 application complete, a joint public notice is issued. Any water quality issues or concerns identified during the 401 review are outlined in a letter from the TCEQ to the USACE following comment deadlines established in the joint public notice. Once the USACE resolves all issues to its satisfaction, the USACE issues a Statement of Findings or a Decision Document. The TCEQ has 10 working days to make a Section 401 certification decision. On December 8, 2009, in Bonham, TX, the TCEQ conducted a public meeting for the 401 certification concurrent with the USACE's Lower Bois d'Arc Creek Reservoir EIS scoping meeting.

In addition to its responsibilities for Section 401 water quality certification, TCEQ administers water rights permitting in Texas. Rivers, streams, underflow, creeks, tides, and/or lakes in Texas are considered state water. The right to use state water may be acquired through appropriation via the permitting process established in Texas Water Code, Chapter 11, and Title 30, Texas Administrative Code. Chapter 11 of the Texas Water Code describes water uses that require a permit and the specific criteria to be used by the TCEQ in its review and action on a permit application (TCEQ, 2009b). NTMWD submitted an application to TCEQ for a Texas Water Right for the proposed LBCR in December 2006 (Freese and Nichols, 2006). TCEQ issued NTMWD a final Water Right ("Water Use Permit") for the LBCR on June 26, 2015, the first uncontested water rights permit issued for a major reservoir in the last half century, and one of the first uncontested interbasin transfers of water (NTMWD, 2015a). The water rights permit for LBCR is included in this EIS as Appendix F.

TCEQ staff also assisted in conducting the HEP analysis, the instream flow study, and HGM studies for the proposed reservoir and mitigation sites.

1.2.7 Texas Water Development Board

Created in 1957, the Texas Water Development Board (TWDB) furnishes leadership, planning, financial assistance, information, and education for the conservation and responsible development of water for Texas and Texans. TWDB provides water planning, data collection and dissemination, and financial and technical assistance services to the citizens of Texas to accomplish its goals of planning for the state's water resources and for providing affordable water and wastewater services (TWDB, no date-a).

In 1997, Governor George W. Bush signed into law Senate Bill 1 (SB 1), comprehensive water legislation enacted by the 75th Texas Legislature. SB 1 was an outgrowth of increased awareness of the vulnerability of Texas to drought and to the limits of existing water supplies to meet increasing demands as the state's population grows. SB 1 specifies that individuals representing 11 interest groups may serve as members of Regional Water Planning Groups (RWPGs) to prepare the regional water plans for their respective areas. These plans specify how to conserve water supplies, meet future water supply needs, and respond to future droughts.

SB 1 designated TWDB as the lead state agency for coordinating the regional water planning process and developing a comprehensive statewide water plan that incorporates each of the regional plans. TWDB developed planning guidance documents to guide preparation of regional water plans, delineated the state's water planning areas, and designated the planning group representatives (TWDB, 2010b). There are 16 regional water planning areas in the state as shown in Figure 1.2-1. The proposed LBCR project is located within Region C

Working within TWDB guidelines, each regional planning group reviews water use projections and water availability volumes in dry or drought-of-record conditions. When a water need is identified, the planning group recommends water management strategies to meet the need. Once the planning group adopts the regional water plan, it is sent to TWDB for approval. The TWDB then compiles the 16 regional water plans and information from other sources to prepare the state water plan (TWDB, 2010a).

The 2016 Region C Water Plan was finalized and submitted to the TWDB in November 2015 (Region C Water Planning Group, 2015). The corresponding, current 5-year state plan – the 2017 State Water Plan – was adopted by the TWDB on May 19, 2016. The previous 2012 State Water Plan, cited extensively in the February 2015 DEIS, had been adopted by the TWDB on December 15, 2011, and sent to the Texas Governor on January 5, 2012 (TWDB, 2012). TWDB personnel assisted with conducting the HEP analysis of the proposed reservoir and mitigation sites and participated with the instream flow study team.

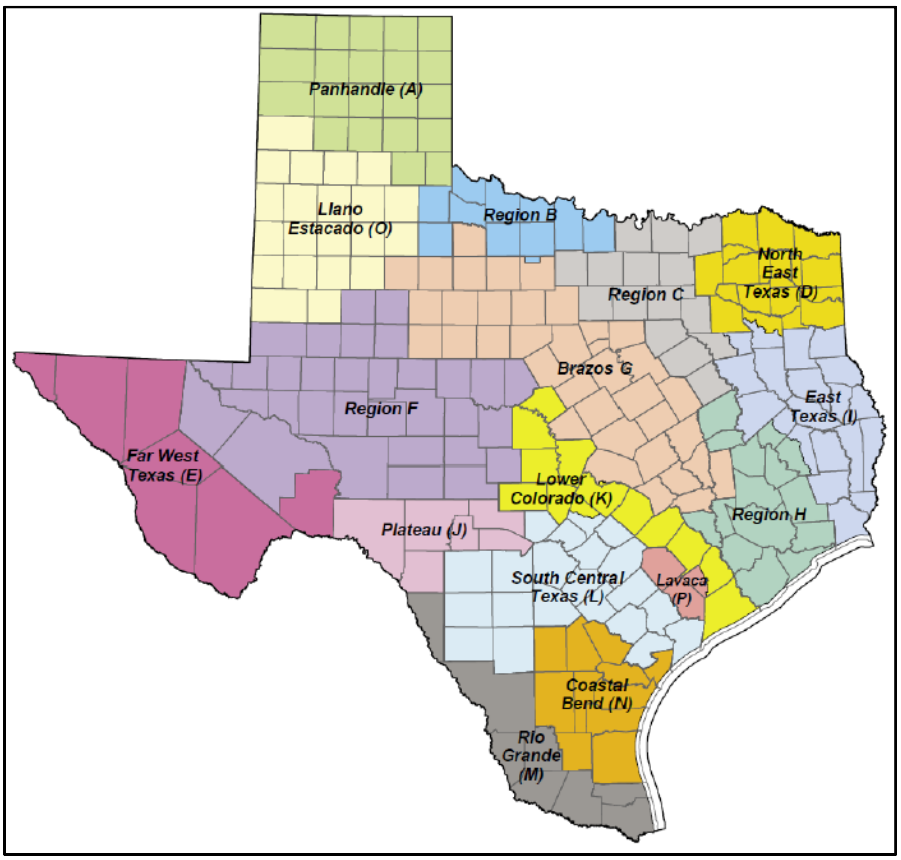


Figure 1.2-1. Regional Water Planning Areas in Texas

1.2.8 Texas Parks and Wildlife Department

The mission of the TPWD is to "manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing and outdoor recreation opportunities for the use and enjoyment of present and future generations" (TPWD, 2010a). TPWD administers the Texas state park system and manages hunting and fishing in the state, among other functions. TPWD was established by the 58th State Legislature in 1963, consolidating operations of the Texas Game and Fish Commission and the State Parks Board. The department is governed by the Texas Parks and Wildlife Commission, appointed by the governor, and headed by an executive director, named by the commissioners (Smyrl, 2010).

TPWD is the state agency with the primary responsibility for protecting the state's fish and wildlife resources as prescribed by Texas Parks and Wildlife Code §12.0011. In accordance with §12.0011, TPWD provides recommendations that will protect fish and wildlife resources to local, state, and federal agencies that approve, permit, license, or construct development projects; TPWD provides recommendations to any local, state, and federal agencies or private organizations that make decisions affecting those resources. TPWD also provides recommendations on scheduling of instream flows and freshwater inflows to Texas estuaries for the management of fish and wildlife resources (TPWD, 2007).

TPWD annually conducts about 2,100 wildlife population surveys, provides recommendations concerning the management of about 1,200 vertebrate wildlife species, and performs about 75 wildlife research studies. TPWD also manages 51 wildlife management areas totaling about 755,000 acres, holds public hunts on more than 200 tracts of land totaling more than 1.4 million acres, informs the public about wildlife, and issues about 1,500 permits of various kinds to take or hold wildlife (Bengston, et al., 2003).

TPWD is acting as a cooperating agency with the USACE for the preparation of this EIS. TPWD assisted with HEP analysis of the proposed reservoir and mitigation sites as well as participating in the inter-agency instream flow and HGM studies associated with the project. In 2015 and 2016, TPWD participated in workshops organized by EPA Region 6 and USACE's Tulsa District on HGM and RGA along with other federal and state agencies, as well as experts and academics from Freese and Nichols, Inc., the Arthur Temple College of Forestry and Agriculture at Stephen F. Austin State University (Dr. Hans M. Williams), and the Department of Geology at Baylor University (Dr. Peter Allen).

1.2.9 Texas Historical Commission

The Texas Historical Commission (THC) is the state's agency for historic preservation. Among other responsibilities, it administers the Antiquities Code of Texas (THC, 2010a; THC, no date-a). THC has 17 commissioners, who are all governor-appointed citizen members with staggered six-year terms. Its staff of 220 employees consults with citizens and organizations to preserve Texas' architectural, archeological and cultural landmarks. THC staff work in various fields, including archeology, architecture, history, economic development, heritage tourism, and urban planning.

THC maintains nearly 12,000 historical markers along the state's roads and other sites. It also manages and promotes 20 state historic sites and conducts a comprehensive program for maintenance, promotion, and restoration of historic county courthouse buildings. THC facilitates federal preservation programs, including the National Register of Historic Places (NRHP) and the Certified Local Government program (THC, 2010a).

In response to growing public concern about increasing threats to the nation's historic sites, the U.S. Congress passed the National Historic Preservation Act (NHPA) in 1966. This law established a national policy for the protection of important historic buildings and archeological sites, and outlined responsibilities for federal and state governments to preserve our country's heritage.

The NHPA created the NRHP, a list of sites, districts, buildings, structures and objects of national, regional or local significance. Section 106 of the NHPA requires federal agencies to consider the effects of their actions on cultural resources eligible for inclusion in the NRHP. Listing in the NRHP is a lengthy process requiring substantial documentation, which is initially reviewed by the State Historic Preservation Officer (SHPO). In Texas, the SHPO is the executive director of the THC. The SHPO's role in the Section 106 process is to determine whether a cultural resource meets the criteria for listing in the NRHP, not to approve the nomination (THC, no date-b).

The NHPA mandates the SHPO to represent the interests of the state when consulting with federal agencies under Section 106 of the NHPA and to maintain a database of historic properties. The NHPA also created the Advisory Council on Historic Preservation (ACHP), an independent federal agency in the executive branch that oversees the Section 106 review process. In addition to the views of the agency, the SHPO and the ACHP, input from the general public and Native American tribes is also required. The NHPA requires any agency issuing a federal permit or license, providing federal funds, or otherwise providing assistance or approval to comply with Section 106 (THC, no date-b).

The USACE must comply with its obligations under Section 106 of the NHPA both in considering the Section 404 permit application from the NTMWD for the proposed LBCR and in preparing this EIS. The USACE and the THC are two of the signatories in a Programmatic Agreement (PA) for conducting a cultural resources survey of the proposed reservoir site (THC, 2010b). The PA is included in this EIS as Appendix G.

1.2.10 Red River Authority of Texas

The Red River Authority of Texas (RRA) was created in 1959 by acts of the 56th Texas Legislature as a political subdivision of the State. The RRA's territorial jurisdiction includes all or part of 43 Texas counties lying within the watershed of the Red River and its tributaries upstream from the northeast corner of Bowie County (RRA, 2009).

The RRA's mission is the conservation, reclamation, protection, and development of water resources in the Red River Basin for the benefit of the public. The Texas Legislature has directed the RRA to:

- Prepare and maintain a basin-wide inventory and assessment of the available water resources to meet present and long-range water use planning, management, and protection needs for the public;
- Provide administrative and technical assistance to public entities in the areas of development, operation, and maintenance to meet the water resource needs to support economic growth of communities within the basin;
- Provide financial assistance to aid in the control of pollution, conservation of water, resource management and development, development of public facilities, navigation, recreation, flood control, and solid waste disposal;

- Provide legal sponsorship of any feasible public works project where the intent is to reclaim, improve or develop water resources of the basin (RRA, 2009).

A large portion of Fannin County, the proposed LBCR, and the proposed Riverby Ranch mitigation site lie within the Red River Basin and are thus within the RRA's territorial jurisdiction.

1.2.11 Native American Tribes

The United States has a unique legal and political relationship with Native American tribes as provided in the U.S. Constitution, various treaties, the federal trust doctrine, and federal statutes. These relationships extend to the federal government's historic preservation activities, mandating that federal consultation with Native American tribes be meaningful, in good faith, and conducted on a government-to-government basis (GSA, 2010).

On September 23, 2004, President George W. Bush issued Executive Memorandum Government-to-Government Relationship with Tribal Governments, recommitting the federal government to work with federally-recognized Native American tribal governments on a government-to-government basis, and strongly supporting and respecting tribal sovereignty and self-determination.

Mandates for the federal government's unique policies and relationship with Native American tribal governments are also codified in various Executive Orders and statutes, the most relevant of which are cited below:

- Executive Order 13175 Consultation and Coordination with Indian Tribal Governments: issued by President Bill Clinton in 2000; recognizes tribal rights of self-government and tribal sovereignty, and affirms and commits the federal government to work with Native American tribal governments on a government-to-government basis.
- Native American Graves Protection and Repatriation Act (NAGPRA): provides a process for museums and federal agencies to return certain Native American cultural items – human remains, funerary objects, sacred objects, and objects of cultural patrimony – to lineal descendants, culturally-affiliated Native American tribes, and Native Hawaiian organizations.
- Archeological Resources Protection Act (ARPA): requires federal agencies to consult with tribal authorities before permitting archeological excavations on tribal lands and mandates the confidentiality of information concerning the nature and location of archeological resources, including tribal archeological resources.
- American Indian Religious Freedom Act (AIRFA): passed in 1978, affirms a national policy to protect and preserve Native Americans' inherent right of freedom to believe, express, and exercise the traditional religions of indigenous America, including protecting and preserving access to sacred sites.
- NEPA: calls for the federal government to invite the participation of any affected Native American tribe in the environmental review process.
- NHPA: enhances Native American tribal roles in historic preservation through the Tribal Historic Preservation Officer (THPO) program. Obligates federal agencies to consult with Native American tribal governments under Section 106 of NHPA (GSA, 2010).

The USACE has a growing Tribal Nations program that has expanded since its inception in 1996 in terms of staffing, improved relations with tribes, accomplishments, and recognition (USACE, 2010b). The program is an outgrowth of the 1994 Presidential Memorandum that called on federal agencies to work more closely with tribes. There is now a Tribal Liaison or point of contact in every District and Division office. The USACE adopted its Tribal Policy Principles in 1998. These Principles direct the USACE to:

- Meet the Trust responsibility;
- Honor the government-to-government relationship;
- Acknowledge the inherent sovereignty of Tribes;
- Engage in pre-decisional consultation;
- Protect natural and cultural resources when possible; and
- Find opportunities to use existing authorities to encourage economic capacity building and growth.

The following 33 Native American Tribes plus the Bureau of Indian Affairs (BIA) in the Department of the Interior were included in public notice mailings for this proposed project:

- Alabama and Coushatta Tribes of Texas
- Apache Tribe of Oklahoma
- Caddo Indian Tribe of Oklahoma
- Cherokee Nation of Oklahoma
- Cheyenne and Arapahoe Tribes of Oklahoma
- Chickasaw Nation of Oklahoma
- Choctaw Nation of Oklahoma
- Comanche Tribal Business Committee
- Delaware Tribe of Indians
- Fort Sill Apache Tribe
- Iowa Tribe of Oklahoma
- Jicarilla Apache Tribe
- Kaw Nation
- Kickapoo Traditional Tribe of Texas
- Kickapoo Tribe of Oklahoma
- Kiowa Indian Tribe of Oklahoma
- Mescalero Apache Tribe
- Modoc Tribe of Oklahoma
- Muscogee (Creek) Nation of Oklahoma
- Osage Tribe
- Otoe-Missouria Tribe of Indians
- Ottawa Tribe of Oklahoma
- Peoria Tribe of Indians of Oklahoma
- Ponca Tribe of Indians of Oklahoma
- Quapaw Tribal Business Committee
- Seminole Nation of Oklahoma
- Seneca-Cayuga Tribe of Oklahoma
- Thlopthlocco Tribal Town
- Tonkawa Indian Tribe
- United Keetowah Band of Cherokee
- White Mountain Apache Tribal Council
- Wichita Affiliated Tribal Executive Committee
- Ysleta del Sur Pueblo

Additional coordination occurred during the development of the PA for Archeological Resources, with four tribal governments, specifically the Caddo Nation of Oklahoma, Comanche Nation of Oklahoma, Kiowa Tribe of Oklahoma, and Wichita and Affiliated Tribes of Oklahoma. Only the Caddo Nation of Oklahoma is a signatory on the PA.

1.3 SECTION 404 PERMIT APPLICATION PROCESS

In 1972, the Federal Water Pollution Control Act was amended and became commonly known as the CWA. Section 404 of the CWA added authority to the Department of the Army's existing regulatory program under Section 10 of the Rivers and Harbors Act of 1899. Under Section 404 of the CWA, the Secretary of the Army, acting through the Chief of Engineers, is authorized to issue permits, after appropriate notice and the opportunity for public hearings, for the discharge of dredged or fill material into waters of the United States at specified disposal sites. The selection of such sites must be in accordance with guidelines developed by the EPA in conjunction with the Secretary of the Army; these guidelines are known as the 404(b)(1) Guidelines (USACE, no date-a).

The basic form of authorization used by USACE districts is the individual permit. Processing such permits involves evaluation of project-specific applications in what can be considered three steps: 1) pre-application consultation (for major projects), 2) formal project review, and 3) decision making.

Pre-application consultation usually involves one or several meetings between an applicant, USACE district (e.g., Tulsa District) staff, interested resource agencies (federal, state, and local), and sometimes the interested public. The main purpose of such meetings is to provide for informal discussions about the pros and cons of a proposal before an applicant makes irreversible commitments of resources (funds, detailed designs, etc.). The process is designed to provide the applicant with an assessment of the viability of alternatives available to accomplish the project purpose, to discuss measures for reducing the impacts of the project, and to inform the applicant of the factors the USACE must consider in its decision-making process.

In its evaluation of Section 404 permit applications, the USACE must analyze alternatives to the proposed project that achieve its purpose. USACE conducts this analysis according to two main requirements: the 404(b)(1) Guidelines (Guidelines) and NEPA. USACE also considers alternatives as part of its public interest review evaluation. USACE must evaluate alternatives that are practicable and reasonable (see Figure 1.3-1). In keeping with the Guidelines at 40 Code of Federal Regulations (CFR) 230.10(a), a permit cannot be issued if a practicable alternative exists that would have a less adverse impact on the aquatic ecosystem – known as the Least Environmentally Damaging Practicable Alternative (LEDPA) – provided that the LEDPA does not have other significant adverse environmental consequences to other natural ecosystem components. Therefore, the alternatives screening process is designed to provide information regarding Purpose and Need and impacts to the natural environment in general and the aquatic ecosystem in particular. With regard to NTMWD's Section 404 permit application to build the LBCR, the USACE decision on the LEDPA will be announced in the Record of Decision (ROD), not in the EIS.

The USACE must consider reasonable alternatives to comply with NEPA. Evaluations to address the Guidelines and NEPA normally satisfy the requirements of the public interest review. The Guidelines include two "rebuttable presumptions" for projects with discharges into waters of the U.S. that are special aquatic sites (including wetlands, riffle pool complexes, and other specific aquatic resources) that do not require access to or siting within the special aquatic site(s) to achieve their basic essence (basic project purpose). The first presumption states that alternatives that do not affect special aquatic sites are presumed to be available. The second states that practicable alternatives located in non-special aquatic sites (e.g., other waters, uplands) have less adverse impact on the aquatic ecosystem. It is up to the applicants to clearly demonstrate to the USACE that both of these presumptions have been rebutted in order to pass the alternatives portion of the Guidelines.

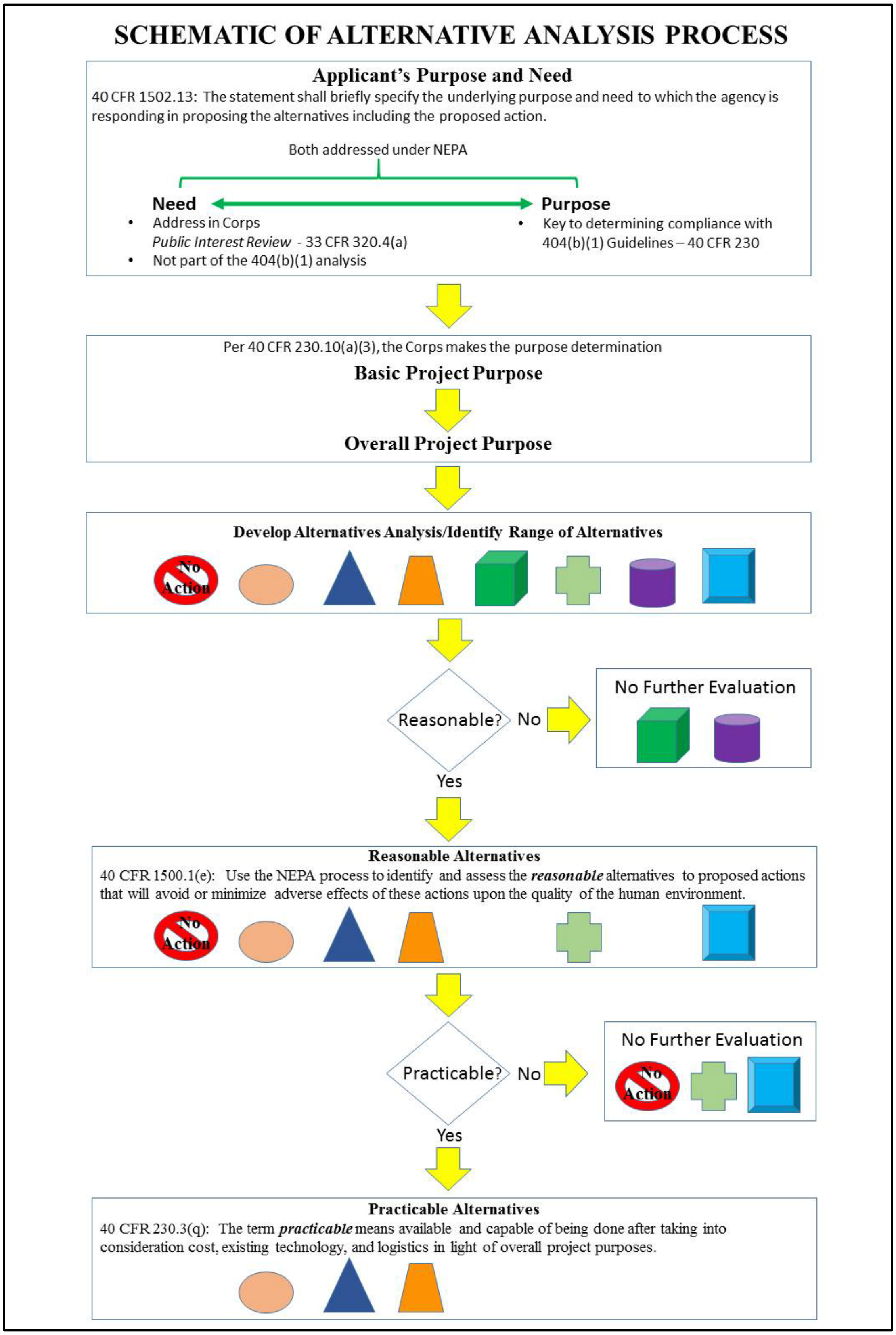


Figure 1.3-1. Alternatives Evaluation in Section 404 Permit Applications

USACE districts operate under a project manager system, where one individual is responsible for handling an application from receipt to final decision. The project manager prepares a public notice, evaluates the impacts of the project and all comments received, negotiates necessary modifications of the project if required, and drafts or oversees drafting of appropriate documentation to support a recommended permit decision. The permit decision is based upon compliance with the Section 404(b)(1) guidelines and a public interest review. The decision document includes a discussion of the environmental impacts of the project, the findings of the public interest review process, and any special evaluation required by the type of activity (USACE, no date-a).

The USACE supports a strong partnership with states in regulating development of water resources. This is achieved with joint permit processing procedures (e.g., joint public notices and hearings), programmatic general permits founded on effective state programs, transfer of the Section 404 program in non-navigable waters, joint EISs, special area management planning, and regional conditioning of nationwide permits.

The USACE's public interest balancing process is of great importance to the project evaluation. The public benefits and detriments of each case are carefully evaluated and balanced. Relevant factors considered may include conservation, economics, aesthetics, wetlands, cultural values, navigation, fish and wildlife values, water supply, water quality, and any other factors judged important to the needs and welfare of the people (33 C.F.R. § 320.4(a)(1)). The following general criteria are considered in evaluating all applications:

- The relevant extent of public and private needs;
- The practicability of using reasonable alternative locations and methods to accomplish project purposes where unresolved conflicts of resource use exist; and
- The extent and permanence of the beneficial and/or detrimental effects the proposed project may have on public and private uses to which the area is suited (33 C.F.R. § 320.4(a)(2)).

The major tools used to interact with the public are the public notice and public hearing. The public notice is the primary method of advising all interested parties of a proposed activity for which a permit is sought and of soliciting comments and information necessary to evaluate the probable beneficial and detrimental impacts according to the public. Public notices on proposed projects always contain a statement that anyone commenting may request a public hearing. Public hearings are held if comments raise substantial issues which cannot be resolved informally and the USACE decision maker determines that information from such a hearing is needed to make a decision. Public notices are used to announce hearings. The public is also informed by monthly notices of permit decisions.

The permit evaluation process contains a number of safeguards designed to ensure objectivity in the evaluation process. Probably the single most important safeguard of the program is the public interest review. This review requires the careful weighing of all public interest factors relevant to each particular case. Thus, one specific factor (e.g., economic benefits) cannot by itself force a decision, but rather the decision represents the net effect of balancing all relevant factors, which frequently may conflict with each other (USACE, no date-a).

There are also external safeguards to maintain objectivity of the Section 404 permitting process. One is the EPA's Section 404(c) or so-called "veto" authority. The EPA may prohibit or withdraw the use of an area as a disposal site for dredged or fill material if the EPA Administrator determines that discharges to the site will have unacceptable adverse effects on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas. This authority also carries with it the requirement for notice and opportunity for public hearing. The EPA may invoke this authority at any time.

Individual state permitting and water quality certification requirements provide another form of objective safeguard for the USACE's regulatory program. As noted above in the discussion of the TCEQ's role and responsibilities, Section 401 of the CWA requires state certification or waiver of certification prior to issuance of a Section 404 permit (USACE, no date-a).

The USACE applies the 404 (b) (1) Guidelines in its evaluation of the Section 404 permit application. Dredged or fill material may not be discharged into the aquatic ecosystem unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern, including bottomland hardwood forests and flowing open water [Part 230, § 230.1 (c)]. Either the public interest review or the 404 (b) (1) Guidelines can be the basis for denial of a permit, while neither can be the sole basis for permit issuance. Subject to compliance with the EPA 404(b) (1) Guidelines and other applicable laws, the USACE Tulsa District Engineer will grant a permit to the NTMWD unless it is determined that granting the permit would be contrary to the public interest [Part 320.4(a)(1)].

If the USACE denies a Section 404 permit, an applicant can apply for another Section 404 permit provided the project is substantially different, that is, a project of different size, location, and potential impacts. However, applying for an altogether new Section 404 permit is a costly and time-consuming endeavor.

1.4 NEPA PROCESS

In evaluating the Section 404 permit application from the NTMWD, USACE must comply with NEPA and its implementing regulations from the Council on Environmental Quality (CEQ) (40 CFR 1500-1508). NEPA requires that the responsible agency:

- Identify the purpose and need to be met;
- Identify the available courses of action to meet that need, including no action;
- Identify, evaluate and compare the impacts on the environment that could arise from each of the reasonable alternatives;
- Publish this information in an EIS for review by the public and other agencies;
- Consider the impacts, ways to lessen or avoid them, and public and agency comments, before making its decision on the proposal.

1.4.1 Draft Environmental Impact Statement

The first stage of EIS development is the scoping process, which is the means by which substantive issues are identified for further study in the EIS. The NEPA scoping process begins with the publication of a Notice of Intent (NOI) to prepare an EIS in the *Federal Register*. The NOI for the LBCR EIS was published in the *Federal Register* on November 13, 2009 (Vol. 74, No. 218, p. 58616-58617). The scoping process often involves face-to-face meetings with the interested public. The USACE then investigates substantive issues raised in scoping, conducts research and analysis, and drafts an EIS.

Availability of the DEIS is announced through public notice, including a Notice of Availability (NOA) in the *Federal Register*, letters to interested parties, and notices in the print and broadcast news media. It is the notice which is intended to solicit comments not only on the NEPA document but substantive comments on the Proposed Action. Again, with complex projects the public may request a public hearing (USACE, no date-a).

Sometimes the USACE decision maker will independently decide to hold a public hearing and the meeting announcement will be incorporated into the NOA of the NEPA document. The public is also informed through NOA of the public release of the final EIS, any EIS supplement, and the decision maker's ROD. Thus, five or more notices to the public may occur during the review of a permit application requiring preparation of an EIS (USACE, no date-a).

The DEIS was completed by the USACE in early 2015. The document was made available for public and agency review and comment for a 60-day period ending on April 21, 2015. The USACE also received oral and written comments on the DEIS at a public meeting held on March 24, 2015 in Bonham, Texas. Comments on the DEIS were submitted by the US EPA Region 6, TCEQ, Texas Conservation Alliance, Natural Resource Defense Council, Audubon Texas, local landowners, and other stakeholders. The USACE has decided to prepare a Revised DEIS after carefully reviewing a broad range of comments considering how best to meet the provisions of NEPA.

About Environmental Impact Statements

An EIS is intended to help federal agencies make environmentally well-informed decisions about major actions. It focuses on providing specific information on the Proposed Action, alternatives, and impacts that is relevant to the agency's decision making.

The EIS answers major questions such as:

- What is the need to be met?
- In what ways could the need be addressed?
- How would these courses of action affect the environment?
- What could be done about those effects?
- What do others think about these alternatives and their impacts?

Preparing an EIS involves several steps, including a "scoping" process at the outset. In scoping, the responsible agency asks other agencies, organizations and the public for input concerning the planned EIS. When the EIS is published as a draft, the agency again invites outside comments, which are reflected in the final EIS; this FEIS is published prior to the agency's final decision, which is documented in a ROD. The public may again comment on the final EIS under NEPA.

1.4.2 Revised Draft Environmental Impact Statement

The Revised DEIS was prepared based on revised project information provided by the applicant (NTMWD) and to address comments raised during the DEIS public and agency review period. The Revised DEIS discloses the environmental effects of constructing and operating a second action alternative and incorporates modifications to the project description, affected environment, and impact analysis to address comments raised during the DEIS public and agency review period. The Revised DEIS also provides a refined mitigation plan developed by the applicant designed to offset impacts on waters of the U.S.

As with the DEIS, the Revised DEIS is being circulated for public and agency review. Comments on the RDEIS will be accepted by the USACE until May 8, 2017.

1.4.3 Final Environmental Impact Statement

Upon completion of the Revised DEIS public and agency comment period, the USACE will prepare a Final Environmental Impact Statement (FEIS). As part of preparing the FEIS, the USACE will respond to the comments received on the DEIS and the Revised DEIS. The FEIS is expected to be completed in the third quarter of 2017. Once the FEIS is completed, the USACE will prepare the ROD for the project.

1.5 Purpose and Need of the Proposed Action

Defining the purpose of a project is crucial to enabling the USACE to evaluate the project's compliance with the Section 404(b)(1) Guidelines. The USACE must define both the basic project purpose and the overall project purpose. Defining the basic project purpose enables the USACE to determine whether the activity is water-dependent and may affect a special aquatic site as described in 40 CFR 230.10(a)(3):

> "Where the activity associated with a discharge which is proposed for a special aquatic site [such as a wetland] does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not 'water dependent'), practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise. In addition, where a discharge is proposed for a special aquatic site, all practicable alternatives to the proposed discharge which do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demonstrated otherwise."

The overall project purpose, which is more specific than the basic project purpose, is used to identify and assess practicable alternatives. According to 40 CFR 230.10(a)(2):

> "An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. If it is otherwise a practicable alternative, an area not presently owned by the applicant which could reasonably be obtained, utilized, expanded or managed in order to fulfill the basic purpose of the proposed activity may be considered."

1.5.1 Basic Purpose of the Applicant's Proposed Action

The USACE Tulsa District is responsible for defining the basic purpose of the proposed project. As described above, under the guidelines governing the USACE's evaluation of a Section 404 permit application, the basic purpose must be identified to determine if the proposed project in question is "water dependent" and requires access or proximity to or siting within a special aquatic site such as wetlands in order to fulfill its basic purpose. The USACE has determined that the basic project purpose in the present case is to develop an additional, reliable water supply for the applicant (NTMWD) and its member cities and customers. Access or proximity to or siting within special aquatic sites is not required to fulfill the basic project purpose in this case; therefore, the basic purpose is not water dependent.

1.5.2 Overall Purpose of the Applicant's Proposed Action

The USACE uses the overall project purpose to assess less environmentally damaging practicable alternatives. The 404(b)(1) Guidelines state that an alternative is practicable if it is available and capable of being accomplished "after taking into consideration cost, existing technology, and logistics in light of overall project purposes" (40 CFR 230.10(a)(2)). This evaluation applies to all waters of the United States, not just special aquatic sites such as wetlands.

The USACE Tulsa District considers the overall purpose of NTMWD's Proposed Action to be developing an additional and reliable water supply of at least 105,804 AFY by 2025, including under drought and other reduced-availability situations. The estimated 105,804-AFY water supply requirement consists of the 58,694 AFY "supply deficient" plus the reserve requirements identified by NTMWD ("recommended reserve supply"). The proposed project would also help meet a portion of the current estimated NTMWD long-term water supply needs through 2060.

Table 1.5-1 provides a summary of the estimated NTMWD water supply and estimated water demands through 2060. This information is used for NTMWD's long-term water supply planning purposes. The gap between NTMWD's existing water supplies and projected demand is expected to widen considerably beginning in about 2020. By 2030, the supply deficit is predicted to be approximately 107,000 AFY, for a net water need of 157,000 AFY with the recommended reserve supply included. By 2060 the water supply demand is estimated to reach approximately 626,000 AFY.

Table 1.5-1. Summary of NTMWD Water Supply and Demand for 2020 to 2060 (AFY)

	2020	2025	2030	2035	2040	2050	2060
Current Supplies	360,831	352,872	344,468	353,782	363,113	381,675	390,738
Main Stem Pump Station[1]	53,135	45,490	37,913	31,660	25,366	13,599	3,235
Total Supplies	**413,966**	**398,362**	**382,381**	**385,442**	**388,479**	**395,274**	**393,973**
Demands (2013 CIP[2])	430,193	471,107	506,904	540,836	574,366	617,393	665,375
Customer Conservation	8,044	10,440	12,805	14,310	15,816	18,955	22,305
NTMWD Water Loss Reduction	2,151	3,611	5,069	6,844	8,615	12,348	16,634
Net Demand	**419,998**	**457,056**	**489,030**	**519,682**	**549,935**	**586,090**	**626,436**
Supply Deficit	6,031	58,694	106,649	134,240	161,456	190,815	232,464
Recommended Reserve Supply	43,020	47,110	50,690	54,080	57,440	61,740	66,540
Total Supply Needed	**49,051**	**105,804**	**157,339**	**188,320**	**218,896**	**252,555**	**299,004**

AFY = acre-feet per year.

[1] See Section 2.2.5.1 for a description of the Main Stem Pump Station.

[2] Capital Improvement Plan (CIP) for NTMWD.

Source: Table 1 in Kiel and Gooch, 2015.

The water supply and demand totals shown in Table 1.5-1 were developed based on information compiled and assessed through NTMWD's long-term water supply planning process. The water supply planning process is described in detail in Appendix N, "NTMWD Water Supply Planning Process."

1.6 PUBLIC PARTICIPATION

The Section 404 permitting process and the NEPA process provide several opportunities for public involvement. At these times, interested and affected parties (stakeholders) may express their concerns and provide their views about: 1) the Proposed Action and its possible impacts on aquatic resources and the environment, 2) what should be addressed in the analysis and evaluation of the Proposed Action, and 3) the adequacy of the NEPA analysis and documentation of potential impacts in the EIS.

1.6.1 Public Notice for Section 404 Permit Application

On October 14, 2008, the USACE-Tulsa District issued Public Notice No. SWT-0-14659, notifying interested parties that the District Engineer had received an application for a Department of the Army Permit under Section 404 of the CWA. The application was to construct a dam on Bois d'Arc Creek in

Fannin County, Texas in order to impound a water supply reservoir. The stated purpose of the work was to expand water supply resources of the NTMWD (USACE, 2008b).

Originally, the expiration date of the 30-day comment period for Public Notice No. SWT-0-14659 was set at November 12, 2008. At the request of the EPA, the comment period was extended by one month to December 12, 2008 (Parrish, 2008).

USACE received comments from approximately 70 individuals and agencies during the extended comment period on Public Notice No. SWT-0-14659. USACE reviewed all comments and conducted an evaluation of the proposed project and its anticipated environmental effects relative to NEPA and Section 404 of the CWA. After careful consideration, in March 2009, USACE determined that the LBCR project constituted a major federal action with the potential to significantly affect the quality of the human environment and that preparation of an EIS would be required. The USACE based its decision on the following factors:

- The impoundment of a large volume of water in the Red River Basin and its diversion to the Trinity River basin could result in significant adverse effects to aquatic ecology.
- The proposed project would result in the direct loss of bottomland hardwood wetlands and altered hydrology downstream of the proposed dam. Bottomland hardwood wetlands are a diminishing habitat in the region, identified by the EPA as an "aquatic resource of National importance".
- The proposed project may result in both adverse and beneficial effects to public lands within the Caddo National Grasslands, Bois d'Arc Unit, located downstream of the proposed dam.
- Two large reservoirs (Lower Bois d'Arc Creek and Lake Ralph Hall) in Fannin County have the potential for combined cumulative impacts on existing development patterns and significant alterations to the rural nature of Fannin County.
- Natural resource agencies such as USFWS, TCEQ, and TPWD, in addition to one environmental organization (Texas Conservation Alliance), are concerned about potential project impacts. The USFWS, EPA, and 45 other commenters requested that USACE prepare an EIS for this project.
- The proposed project would displace residents and result in the loss of livelihoods and substantial reduction to the functional size of adjacent landholdings.
- The need to assure adequate and impartial evaluation of the availability of less environmentally damaging practicable alternatives.
- The absence of a detailed mitigation plan which would offset the extensive impact to wetlands and aquatic resources in the proposed lake basin.
- The need to evaluate potential secondary, indirect, and cumulative impacts related to the construction of related pipeline and water treatment facilities.

In addition, USACE observed that the project appeared to be controversial in nature. In view of these findings, the Tulsa District determined that the LBCR project constitutes a major federal action with the potential to significantly affect the quality of the human environment. As such, in accordance with Regulatory Guidance Letter No. 05-08, "Environmental Impact Statements, Third Party Contracting," Headquarters guidance on EIS preparation, dated December 17, 1997, CEQ Regulations for Implementing the Procedural Provisions of NEPA (CFR 1500-1508), and the USACE Procedures for Implementing NEPA (33 CFR 320), the Tulsa District concluded that USACE is required to prepare an EIS on the proposed permit action through the use of a third party contractor paid by the applicant, but who is selected and supervised by the USACE (Manning, 2009).

1.6.2 Scoping Process for an EIS

NEPA requires lead agencies to invite public involvement prior to decision-making on proposed actions that may affect the environment. "Scoping" is the process of soliciting input (comments) from "stakeholders" – including Tribes, the public (both private citizens and non-governmental organizations or NGOs), and other agencies – at the outset of a NEPA (in this case, EIS) analysis. Not only may the information obtained from interested and knowledgeable parties be of value, but their perspectives and opinions as to which issues matter the most, and how or if the agency should proceed with a given proposed action are equally important. Input from scoping helps shape the development of alternatives to the proposed action and the direction that the NEPA analysis takes, helping analysts decide which issues merit consideration.

Public Scoping

Scoping for the EIS formally began on Friday, November 13, 2009 with the publication of an NOI in the *Federal Register* (Vol. 74, No. 218, pp. 58616-58617). With this public notification, USACE announced its intent to prepare an EIS on whether to issue a Section 404 permit under the CWA for the proposed construction and operation of LBCR in Fannin County, Texas. Comments for scoping were accepted until January 9, 2010.

On the afternoon and evening of December 8, 2009 the USACE conducted a public scoping meeting in the Fannin County Multi-Purpose Complex in Bonham, Texas. This meeting was advertised beforehand in the online and print editions of a local newspaper (*Bonham Journal*), local radio stations, and by means of a public notice issued by the USACE. The format of the meeting was that of an "open house." At their leisure, attendees could pass through the facility looking at exhibits, maps, reports, and information arranged on tables. They could also speak informally and at length with representatives of USACE, TCEQ, NTMWD, and contractors/consultants working for the USACE and the NTMWD. In addition, they could submit written comments on a comment form as well as on a diagram depicting phases and elements of the proposed action. Approximately 100 people participated in this event (Figure 1.6-1).

During the scoping process, members of the public and public agencies broached a wide variety of issues and topics related to the Proposed Action reservoir construction and operation. These comments were furnished in several different modes: 1) on comment forms available at the public scoping meeting; these forms could be filled out and dropped into a box or mailed later; 2) in emails sent to the USACE; and 3) in hard copy letters mailed to the USACE.

Figure 1.6-1. Attendees at the EIS Scoping Open House in Bonham on December 8, 2009

The USACE received a total of 84 comment forms, emails, and letters submitted by more than 100 individual citizens and agencies. Several individuals sent more than one comment form, email or letter. Each form, email or letter contained multiple comments on different issues, sometimes many dozens of issues. Each of these was tallied as a separate "comment" on that given issue or topic. Approximately 630 comments were received in total.

Table 1.6-1 lists the most common issues or topics, as cited in written comments by the members of the public and governmental agencies during the scoping period. These are a gauge of the highest priority concerns that the public and agencies believe need to be addressed in the EIS.

Appendix D to this EIS is a scoping report that documents the public and agency scoping process. It includes the NOI, newspaper display ad, public notice, and a summary of all comments received.

Agency Scoping

On December 9, 2009, the day after the public scoping meeting in Bonham, the USACE held an inter-agency scoping meeting in Wylie, TX. Representatives of a number of federal and state agencies were in attendance. Appendix D to this EIS provides a summary of the agency scoping process.

Table 1.6-1. Top Issues Raised by the Public About the Proposed Lower Bois d'Arc Creek Reservoir

Place	Issue/Topic	Number of Commenters
1	Impacts on native wildlife species and habitats	33
2	Adverse impact to agricultural economy and livelihoods in county	29
3	Reduced tax revenues to county and heavier tax burden for remaining residents	23
3	Water is being wasted and needs to be conserved	23
5	Displacement of multi-generational residents, farmers and ranchers; loss of farming/ranching/rural heritage	20
6	Concerned that reservoir may cause flooding in Bonham, along tributaries, and upstream areas	19
7	Reputed recreational and related economic benefits are questionable because of fluctuating lake level and shoreline, mudflats, etc. – look at other reservoirs in area where claimed benefits have not been realized	17
7	Poor water quality in reservoir from upstream pollutants	17
9	Fluctuating lakeshore and resultant unattractive mudflats	12
10	Impacts to Indian artifacts or burial sites	11
10	Limited viable lifetime of reservoir (storage capacity loss over time from siltation)	11
12	Shallow and fluctuating lake will not be conducive to aquatic recreation opportunities	10
12	Upstream wastewater treatment plant discharges (treated and raw sewage)	10
14	Effects of chemical (arsenic) residues from cotton farming	9
14	Spread of invasive species, e.g. zebra mussel, hydrilla, feral hogs	9
14	Impacts to unmarked slave and pioneer cemeteries	9
14	Losing own home, land, and/or job	9
18	Endangered, threatened, rare species and habitats	8
18	Zoning effects on property rights and lakefront development	8
18	Lost food production and its economic value	8
18	Will benefit Lavon Lake (by maintaining water level) and its residents at expense of Fannin County residents	8
22	Impacts on trees and bottomland/riparian forests	7
22	Increase in disease vectors, e.g. mosquitoes	7
22	Damage to historic/cultural/archeological properties	7
22	Project will encourage beneficial local economic development	7
22	New reservoir will not be able to compete with established lakes that already offer high-quality recreational experience and real estate properties	7
22	Shallow depth of reservoir/reservoir only partially full much of year	7
22	Benefit of adding more water supply/additional water will be needed	7

1.6.3 Other Related Opportunities for Public Participation

Four meetings on the proposed LBCR took place several years ago and provided other opportunities for public comment and input. NTMWD voluntarily held an open meeting on January 30, 2007 in the City of Bonham to inform the public of the upcoming project. NTMWD and TCEQ jointly conducted three Inter-Basin Transfer (IBT) meetings: in Bonham on September 17, 2007; in Greenville on September 17, 2007; and in McKinney on September 18, 2007.

The January 30, 2007 public meeting was held at the Bonham Civic Center. Several hundred Fannin County residents attended this event to learn more about the LBCR project. Engineering experts, along with NTMWD representatives and Dr. Terry L. Clower, assistant professor with the Institute of Applied Economics at the University of North Texas, informed attendees how the reservoir would provide water supplies and recreational opportunities as well as spur economic growth for Fannin County. Six fact sheets were distributed and 90 comments were received at the meeting.

The IBT public meeting held on September 17, 2007 at the Fletcher Warren Civic Center in Greenville attracted about 18 attendees. The September 17, 2007 IBT public meeting in Bonham was at the Fannin County Multi-Purpose Complex. About 150 people were in attendance, not including TCEQ staff and the applicant. About 10 people attended the public IBT meeting the following day, September 18, 2007, at McKinney High School in McKinney.

All of these meetings gave local residents of Fannin County and neighboring areas the opportunity to provide comments and ask questions regarding a wide variety of issues and topics related to the Proposed Action – reservoir construction/operation, locations, acquiring mitigation lands, the impact to the county tax base, and others.

NTMWD has been working for years with local entities and interested parties to address their concerns on the LBCR project. NTMWD has a local office in Bonham that provides information to the public on the project. NTMWD also puts information about the proposed project on its website.

1.6.4 Draft Environmental Impact Statement

The original DEIS was released to the public in February 2015. The USACE and cooperating agencies conducted a public open house on the DEIS on March 24, 2015 at the Fannin County Multi-Purpose Complex (Figures 1.6-2 and 1.6-3). The comment period on the DEIS was from February 20 to April 21, 2015. A number of stakeholders (agencies and private citizens) commented on the DEIS and their comments, as well as the USACE's responses, are included in the Administrative Record for this NEPA process.

Figure 1.6-2. Fannin County Multi-Purpose Complex in Bonham

Figure 1.6-3. Attendees at the March 24, 2015 Public Open House on the DEIS at the Multi-Purpose Complex in Bonham

1.6.5 Forthcoming Opportunities for Public Participation under NEPA

Interested parties will be able to comment on the Revised DEIS for the proposed LBCR when it is released in early 2017. Concerned citizens will also be able to comment on the Final EIS later in 2017, although NEPA does not require the USACE to respond to these comments.

1.7 ISSUES DEVELOPMENT

The USACE considered all comments received from the public and agencies during the Section 404 public notification and during the scoping period for this EIS. Based on this review, and its own internal assessment of relevant topics, USACE developed a list of key issues raised by the proposed LBCR project.

1.7.1 Key Issues

<u>Inter-Basin Water Transfer Issues</u>

If approved, the Proposed Action would eventually result in the transfer of approximately 120,665 acre-feet of water annually from the Red River basin to the Trinity and Sulphur River basins. The appropriation request to TCEQ is for a maximum projected use of 175,000 AFY, but the firm yield would be approximately 120,665 AFY. Inter-basin water transfers may potentially affect both the "source" and "receiving" water basins. Socioeconomic impacts to source basin communities, in-stream impacts to fish and wildlife, water and air quality degradation, and induced or indirect impacts from enabled population growth (e.g., from suburban sprawl that would not have occurred were water not made available) in the receiving water basin are all potential impacts of transfers (Baggett, 2009).

Wetlands and Other Waters of the U.S.

As noted earlier in Section 1.2.1, under Section 404 of the CWA, the USACE has the legal authority to regulate discharge of dredged and fill materials into waters of the United States, including wetlands. Under national policy, wetlands are recognized as a productive and valuable resource, and their destruction is discouraged as contrary to the public interest. In developing plans for any project that may affect wetlands, consideration must be given to alternatives that can avoid or minimize impacts to wetlands where practicable. The USACE is restricted from authorizing activities in wetlands where there is a practicable alternative with less adverse impact on the aquatic environment. Once the presumption of the availability of a less environmentally damaging practicable alternative has been refuted, those remaining wetland impacts which can neither be avoided nor minimized will require compensatory wetland mitigation. Such compensatory wetland mitigation may take the form of wetland restoration, enhancement, construction, or preservation (USACE, 2010a).

Impacts on wetlands and their values and functions were a concern expressed during scoping for this EIS. The proposed project would impact over 6,000 acres of wetlands and/or other waters of the U.S.

Alternatives to the Proposed Action

During the public participation process, many commenters argued that the proposed water supply dam and reservoir may not be necessary to meet the stated purpose and need (meeting NTMWD's projected near term water needs by 2025 and a substantial portion of its long-term water needs through 2060), and that less environmentally damaging alternatives were available and needed to be thoroughly investigated. Among the many possible alternatives cited were water conservation and reuse, pipelines from existing water sources (mostly existing reservoirs), a desalination plant and pipeline to take advantage of virtually unlimited saltwater in the Gulf of Mexico, groundwater (the Carrizo-Wilcox formation), and various combinations of these actions. Chapter 2 of this EIS describes and analyzes the Proposed Action and alternatives to the Proposed Action.

Biological Resources

More commenters cited potential impacts of the proposed reservoir on native wildlife species and habitats as a concern than any other single issue in scoping (Table 1.6-1). The scale of the project – over 17,000 acres for the reservoir "footprint", plus additional acreage impacted by the proposed pipeline(s), the WTP, and TSR – as well as the fact the proposed reservoir would impact wetlands and waters of the U.S., diminish bottomland hardwood forest in northern Texas, and convert the flowing waters of a stream into the slack waters of a lake, are the bases for these concerns.

The topic of biological resources is multi-faceted, and the EIS addresses a number of issues. A number of topics cited as concerns during scoping are covered in the EIS, including potential impacts to trees and bottomland/riparian forests, threatened and endangered species, Caddo Grasslands and its wildlife, timber rattlesnakes, bald eagles, cougars, wild turkeys, freshwater mussels, and migratory birds. Another concern expressed by agency staff was the potential for the spread of invasive plant and animal species.

Cultural Resources

Cultural resources broadly include archeological sites, artifacts, historic structures, as well as landscapes with cultural, spiritual, or historic properties. During scoping, concern was expressed about potential impacts to American Indian artifacts or burial sites and unmarked slave and pioneer cemeteries. Other commenters mentioned Camp Benjamin for Confederate Soldiers near former Onstott Lake, the need for surveys given the cultural resource potential of the area, and the potential for historic structures within the reservoir site.

Geology and Soils

During scoping, several commenters expressed concern about the permanent loss of fertile, productive soils in the Lower Bois d'Arc Creek valley. Construction of the reservoir would permanently inundate thousands of acres of soils that are or could be used for sustainable agricultural production, including crop cultivation, hay production, and grazing. In addition, the geology of the reservoir site affects its suitability for dam construction and water impoundment behind the dam to form a reservoir.

Human Health and Safety

During scoping, commenters raised the prospect of a risk to human health and safety from an increase in disease vectors such as mosquitoes. Others commented on traffic, emergency access, health risks from chemicals used to control mosquitoes and aquatic weeds, and emotional stresses on the local population from the disruptions posed by the project.

Land Use

The public listed a number of concerns related to land use during scoping, among them zoning effects on property rights and lakefront development, the fate of the proposed mitigation land (Riverby Ranch), adverse impact to the Legacy Ridge golf course and Country Club, and loss of farmland and beef production acreage within the reservoir footprint.

Recreation

At present, Lower Bois d'Arc Creek, within the footprint of the proposed reservoir, supports a certain amount of outdoor recreation, primarily hunting and fishing. These activities would be permanently adversely affected by the Proposed Action. A substantial amount of recreation also occurs on Caddo National Grasslands that might be affected temporarily during reservoir construction and perhaps over the long term during operation. In contrast, the proposed reservoir could potentially provide lake-based recreation such as boating, fishing, and swimming, all of which are supported by other reservoirs in the region. During scoping, a number of commenters expressed concern that the lake would be shallow with a fluctuating lakeshore, which would not be conducive to aquatic recreation opportunities.

Socioeconomics

Socioeconomic issues are very important to the public as expressed during scoping for the EIS. A variety of interrelated concerns were raised. Many commenters feared adverse impacts to Fannin County's agricultural economy and livelihoods. A number worried that the Proposed Action would result in less tax revenue to the county government and a heavier tax burden on remaining residents. Others objected to the displacement of multi-generational residents, farmers and ranchers, and the loss of Fannin County's proud farming, ranching, and rural heritage. Various commenters called into question the reputed recreational and related economic benefits of the Proposed Action because of what they claimed would be a fluctuating lake level and shoreline and the presence of aesthetically displeasing mudflats. Still others pointed out that they and their families would be losing their homes and property because of the project. A number of other concerns were cited as well; they are listed in the Scoping Report (Appendix D).

A number of commenters noted the potential economic benefits of the Proposed Action to Fannin County, including the development of additional water supplies and generation of jobs.

Transportation and Utilities

The project has the potential for short-term and long-term adverse effects on existing roads and bridges, traffic, and infrastructure. The project also has the potential for long-term improvements to transportation infrastructure and utilities as a result of the need to rebuild, replace, or move affected infrastructure and facilities.

Air Quality

During construction, the Proposed Action could impact local air quality both from fugitive dust and from tailpipe emissions from workers' vehicles and heavy equipment. Long-term direct effects on surrounding air quality over the decades that the reservoir would be in operation would be relatively small, although a potential indirect, cumulative effect of the project would be degraded air quality within the NTMWD service area from a substantial increase in the number of residents and vehicles.

Climate Change

Impacts of the project on climate change from emissions of the greenhouse gases carbon dioxide (CO_2) and nitrous oxide (N_2O) during project construction would be negligible. However, there could be potential cumulative impacts from climate change on the yield of the proposed reservoir over the medium-term to long-term future, due to potential changes in regional precipitation patterns. Additionally, changes in air temperature can impact evaporation rates and water availability. Any such changes would also equally affect all existing and future water supply projects in the region.

Water Resources

The public provided many comments related to water during the scoping process for this EIS. A number of commenters believed that water is being wasted and needs to be conserved before considering the construction of a large, costly new reservoir that would permanently affect water resources. Many were concerned that the proposed reservoir may cause flooding in Bonham, along its tributaries, and in upstream areas. A fluctuating lakeshore and resultant unattractive mudflats and the proposed reservoir's limited viable lifetime (i.e., gradual storage capacity loss over time from siltation) were cited as other concerns with the Proposed Action.

Concerns about water quality were also cited by many during scoping. In particular, various commenters feared poor water quality in the reservoir from upstream pollutants, the ill effects from upstream wastewater treatment plant discharges of treated sewage, and the effects of chemical (arsenic) residues from cotton farming on drinking water derived from the reservoir.

Two commenters during scoping cited the possibility of reduced discharge from Bois d'Arc Creek, a tributary of the Red River, having a negative impact on the prospects for navigation in the Red River downstream of its confluence with Bois d'Arc Creek.

As mentioned earlier, several commenters also discussed the importance of developing Texas water resources to meet the growing demands of the greater North Texas area. Other issues related to water resources and water quality were mentioned during the scoping process, as listed in the Scoping Report (Appendix D).

Environmental Justice/Protection of Children

Two Executive Orders (12898 and 13045) require all federal agencies to examine possible disproportionate impacts of the Proposed Action on minority and low-income populations and on children.

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, directs Federal agencies to identify and address any disproportionately high adverse human health or environmental effects of its projects on minority or low-income populations.

Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, directs federal agencies to "identify and address environmental health risks and safety risks that may disproportionately affect children."

In 2010, four parties – NTMWD, USACE Tulsa District, THC (i.e., the SHPO in Texas), and the Caddo Nation of Oklahoma – signed a PA regarding compliance with Section 106 of the NHPA of 1966 (as amended) concerning construction of the proposed LBCR dam and reservoir on lands that were traditionally inhabited by the Caddo people. This PA is still in effect and has governed all cultural resources investigations and analysis associated with this undertaking (i.e., the Proposed Action).

1.7.2 Issues Considered But Dismissed from Detailed Consideration

Incidental Wildlife Mortality in Mudflats

Concern was raised during scoping over the possibility of wildlife getting stuck and dying in mudflats around the perimeter of the prospective LBCR once water has been impounded. Throughout the state and the nation, millions of acres of mudflats occur at the margins of rivers, lakes, bays, estuaries, and saltwater marshes. The presence of these extensive areas of soft surfaces into which animals could hypothetically sink or become entrapped is not known to be a widespread or significant source of stress or mortality for any of the vertebrates (mammals, birds, reptiles, amphibians and fish).

Oil and Gas Resources Beneath the Reservoir

During scoping, several commenters remarked on the possibility of oil and gas resources occurring beneath the reservoir footprint being rendered inaccessible by the project. However, modern horizontal or directional drilling technology now used widely within the industry would hypothetically allow for exploration and production wells located at some distance from the edge of any future reservoir on the site. These wells would be able to drill into hydrocarbon-bearing formations located hundreds or thousands of feet below the bottom of the reservoir, and extract these liquid and gaseous fossil fuels without contaminating the overlying water. Therefore, the presence of a water reservoir alone would not preclude access to subsurface hydrocarbon reservoirs.

Increasing Humidity

Evaporation from the surfaces of inland bodies of water such as lakes and reservoirs is a source of moisture and moist static energy to the surrounding atmosphere, resulting in a general increase in water vapor loading over an area (Tomassetti et al., 2003). As such, large bodies of water can be expected to increase humidity and affect precipitation over surrounding areas. By increasing the surface area of water from which evaporation can occur, reservoirs are known to change local micro-climates by increasing relative humidity and reducing temperature extremes. These effects would be expected to occur as well from any future LBCR. However, while this effect of the lake on surrounding humidity levels can be predicted with confidence, the magnitude of this effect is not easy to determine (Nielsen-Gammon, 2011).

The phenomenon of increased humidity would likely occur to a greater extent in the summer months, when air and water temperatures are higher, and the potential for evaporation is greater. A small cumulative effect from the increasing area dedicated to water surfaces of reservoirs throughout north-central Texas may be observable; however, this has never been documented or quantified. The Texas State Climatologist has documented an increase of precipitation overall in the state over the past century, and has suggested that the increased area of surface water, from reservoirs to stock tanks to irrigation, may have contributed to some extent (Nielsen-Gammon, 2011).

While there would be more evaporation and thus more humidity from the proposed reservoir in the summertime, conversely, any evaporation would remove energy away from heating the air, so summertime temperatures would be cooler. Furthermore, the increased humidity would increase precipitation. Therefore, two out of three of the potential effects would be considered beneficial (Nielsen-Gammon, 2011).

This much is known, and since it is not possible to amplify or modify these conclusions through further research and investigation for this EIS, this issue will not be considered further in the EIS.

1.8 MITIGATION SUMMARY

1.8.1 Project Footprint

The mitigation plan was developed to compensate for impacts to aquatic and terrestrial resources associated with the proposed LBCR project. This section provides a high-level summary of the mitigation plan; the reader is referred to the original plan for additional details (Appendix C). As proposed, the LBCR project encompasses approximately 20,732 acres of land (excluding proposed mitigation acres) of which 19,872 acres lie within the Bois d'Arc Creek watershed.
For purposes of this mitigation plan, the scope of the LBCR project consists of:

- 19,768 acres, which includes 16,641 acres for the reservoir (conservation pool elevation 534 feet MSL), 2,700 acres of storage lands (between 534 and 541 feet MSL) and 427 acres for the dam and spillways;
- 860 acres associated with the proposed raw water pipeline, WTP, TSR, and rail spur; and
- 104 acres associated with the relocation of FM 1396 outside of the reservoir footprint

1.8.2 Impacts and Mitigation

The HEP methodology (see Appendix J) was used to evaluate emergent wetland, scrub shrub wetland, and terrestrial (upland) resources that could be impacted following construction of the proposed reservoir and its related components. Impacts for emergent and scrub shrub wetlands were measured using Habitat Units (HUs), a metric specific to the HEP methodology. Mitigation was developed using HUs to fully compensate for both cover types. In addition, NTMWD identified 98 acres of shrub wetlands at the Riverby Ranch mitigation site (Figure 1.8-1) that would be preserved as shrub wetlands, but a HEP evaluation of this area was not performed. Therefore, no HUs were calculated for the 98 acres of preserved shrub wetland area.

The Modified East Texas HGM Method was used to assess the functions of forested wetlands (see Appendix K). The proposed impacts and mitigation credits for forested wetlands are measured using Functional Capacity Units (FCUs). The RGA tool was used to assess stream quality (see Appendix L). Stream impacts and mitigation credits are measured using RGA Stream Quality Units (SQUs). A detailed summary of potential net impacts to resources and proposed compensatory mitigation to offset those impacts is shown in Tables 4.6-6, 4.6-7 and 4.6-8 and Appendix C.

1.8.3 Mitigation Objectives

Specific plan objectives are to mitigate for unavoidable adverse impacts to waters of the United States in the project area, which include forested wetlands, emergent wetlands, scrub shrub wetlands, open water, and streams, that would occur as a result of constructing the proposed LBCR. This mitigation would be achieved through wetland restoration and enhancement and stream restoration and enhancement at the nearby mitigation sites, Riverby Ranch and the Upper Bois d'Arc Creek (BDC) Mitigation Site. On the reservoir site, the creation of the lake would offset impacts to open waters and some of the stream impacts, and it would allow for creating emergent wetlands in shallow areas around the lake (littoral wetlands). The development of the reservoir also would enhance Bois d'Arc Creek downstream of the proposed reservoir site through reductions in the frequency of destructive high flow events and the passage of sustainable environmental flows to maintain and enhance existing downstream habitats.

Figure 1.8-1. Project Mitigation Site Riverby Ranch is a 15,000-acre Working Ranch in Fannin County

Specific plan objectives are to mitigate for impacts to:

- 4,035 FCUs of forested wetlands
- 514 HUs of emergent wetlands
- 23 HUs of scrub shrub wetlands
- 78 acres of open water
- 192,377 SQUs of streams

The impacts to 49 acres (23 HUs) of scrub shrub wetland at the reservoir site would be mitigated by restoring 150 acres (103.5 HUs) of scrub shrub wetlands habitat at the Riverby Ranch mitigation site, resulting in a mitigation surplus of 80.5 HU for this habitat type. In addition to restoring 150 acres of scrub shrub wetlands, NTMWD proposes to preserve 98 acres of existing scrub shrub wetlands at Riverby Ranch for a total scrub shrub mitigation area of 248 acres.

Mitigation would occur in three areas: 1) on-site mitigation at the proposed reservoir site; 2) near-site mitigation on the nearly 15,000-acre Riverby Ranch; and 3) near-site mitigation on the 1,900-acre Upper BDC Mitigation Site. Important points to note are:

- Mitigation provided for forested wetlands would be 4,675 FCUs, as well as 957 HUs for emergent wetlands, 103.5 HUs for scrub shrub, 16,036 acres for open water, and 181,153 linear feet for streams.
- Most of the proposed aquatic and terrestrial mitigation would occur on the Riverby Ranch, a contiguous, nearly 15,000-acre tract of land located downstream of the proposed reservoir site and partially within the Bois d'Arc Creek watershed (the remainder located directly within the Red River Basin).
- The remaining terrestrial mitigation area is located adjacent to the project site.
- These mitigation sites are proximal to each other and to lands enrolled in the Pintail Farms WRP area and the nearby Caddo Grasslands.

1.8.4 Site Protection, Management, and Financial Assurances

The compensatory mitigation resulting from construction of the LBCR would provide long-term protection through USACE- approved deed restrictions for the time NTMWD owns and controls the properties. Should the properties be transferred to a third-party land manager other than a governmental entity, a conservation easement or some other similar USACE-approved agreement shall be placed on the properties for perpetual protection.

All sites proposed as part of this mitigation plan would be managed long-term as compensatory mitigation areas associated with impacts to wetlands and waters of the United States. The long-term management of the mitigation site would be provided by the NTMWD until the USACE has determined that the mitigation project is meeting its performance standards or is on an acceptable trajectory to meeting those standards. An adaptive management approach would be used to assess mitigation conditions to facilitate project success with the final goal of native habitats that are stable and self-sustaining over time. If monitoring reports indicate that mitigation progress is falling short of success standards, consultation with the USACE and TCEQ would be initiated regarding the need for additional adaptive management measures to meet performance standards and overall mitigation goals and objectives. Once the USACE determines the mitigation project is fulfilling the compensatory mitigation requirements and the mitigation site is self-sustaining, NTMWD may seek to convey the mitigation site and long-term management to a public agency (i.e., state or federal resource agency).

NTMWD has made a commitment to mitigating for impacts to natural resources by already purchasing the approximately 15,000-acre Riverby Ranch Mitigation Site and portions of the 1,900-acre Upper BDC Mitigation Site that would be used for compensatory mitigation.

2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter of the Revised Draft Environmental Impact Statement (RDEIS) is divided into five main topics:

- Decision options available to the USACE
- Action alternatives
- No Action alternative
- Alternatives considered but dismissed from detailed consideration
- Summary comparison of impacts

Chapter 2 draws upon data, information, and analyses developed and compiled by water resources planners and civil engineers in Texas, including the Texas Water Development Board (TWDB), the Region C Water Planning Group, the North Texas Municipal Water District (NTMWD), and NTMWD's agent Freese and Nichols, Inc. Information sources are listed in Chapter 6.0, References Cited and include Freese and Nichols, 2003, 2006, 2008a, 2008b, 2009, 2010a, 2011c, 2013, 2015 a through i, 2016a and 2016b. These reports and data sources include information on reservoir design and operations, instream flow characteristics, geomorphic conditions, pipeline routing considerations, and jurisdictional wetlands. These data and analyses have been subjected to independent review and scrutiny by the Tulsa District of the U.S. Army Corps of Engineers (USACE), its third-party contractor (Solv), and Solv's subcontractors. These data and analyses were also used in subsequent chapters of this Revised DEIS.

The basic premise of Section 404 of the Clean Water Act (CWA) is that no discharge of dredged or fill material to waters of the U.S. should be permitted if there is a practicable alternative that would be less damaging, or if significant degradation would occur to the nation's waters. The USACE's permit review process is sequential regarding evaluation of impacts to waters of the U.S. It first requires demonstration of avoidance of impacts, followed by minimization of impacts and finally mitigation to compensate for unavoidable impacts to the aquatic environment (33 Code of Federal Regulations (CFR) 332.1c).

The alternative analysis presented in this document is intended to be thorough enough to be used in the USACE Tulsa District's public interest review and Section 404(b)(1) guidelines evaluation. The USACE Tulsa District intends to identify the Least Environmentally Damaging Practicable Alternative (LEDPA) in the Record of Decision (ROD) for this EIS.

2.1 DECISION OPTIONS AVAILABLE TO THE USACE

In evaluating the application for a Section 404 permit received from NTMWD, the USACE has three decision options: 1) to issue the Section 404 permit; 2) to issue the Section 404 permit with conditions; or 3) to deny the Section 404 permit. Each option is discussed further in the following subsections.

2.1.1 Issue the Section 404 Permit

One potential decision option available to the USACE is to issue the Section 404 permit for the project as described in the application submitted by NTMWD. In this option, the permit to allow for discharge of dredged or fill material into waters of the United States would be issued to NTMWD so that construction of the proposed project at the identified site on Bois d'Arc Creek could proceed.

2.1.2 Issue the Section 404 Permit With Conditions

Another potential decision option available to the USACE is to issue the Section 404 permit to NTMWD with conditions so that the water supply project at the identified site on Bois d'Arc Creek may be constructed. The permit conditions would be measurable and quantifiable performance standards relating to the required mitigation for unavoidable permanent impacts associated with waters of the U.S., cultural sites, and/or endangered species with which NTMWD would have to comply. Compliance with such conditions may avoid and/or reduce the project's adverse impacts on physical, chemical, biological, hydrological, and cultural resources, but would also potential benefit to these resources as they relate to the human environment.

2.1.3 Deny the Section 404 Permit

Another decision option available to the USACE is to exercise its prerogative to deny the Section 404 permit for construction of the Lower Bois d'Arc Creek Dam and Reservoir. Denial of the permit would mean NTMWD could not proceed with the proposed Lower Bois d'Arc Creek Reservoir (LBCR) project.

If the USACE were to deny the Section 404 permit, the denial could be based on its public interest review of NTMWD's current application or its evaluation of the Section 404(b)(1) guidelines. If the Section 404 permit was denied based on evaluation of the Section 404(b)(1) guidelines, it would be because the USACE determined that: 1) one or more practicable alternatives are available that would cause less damage to aquatic resources, or 2) significant degradation would occur to waters of the U.S. The alternative analysis presented in this document is intended to be thorough enough to be used in the public interest review and the Section 404(b) (1) guidelines evaluation.

2.2 ALTERNATIVE 1 – APPLICANT'S PROPOSED ACTION (APPLICANT'S PREFERRED ALTERNATIVE)

Under Alternative 1, the Proposed Action, a dam would be constructed on Bois d'Arc Creek to form the proposed LBCR. The proposed project site is in Fannin County, Texas, within the Red River Basin watershed, approximately 15 miles northeast of the City of Bonham. Lake Bonham is immediately to the west of the upstream edge of the proposed reservoir, while the small towns of Honey Grove, Windom, and Dodd City are located along Route 56 several miles to the south of the project site. Figures 2.2-1 and 2.2-2 are location and vicinity maps of the proposed reservoir. The proposed reservoir site is upstream of the Bois d'Arc Unit of the Caddo National Grasslands.

The drainage area of the proposed reservoir would be approximately 327 square miles, of which 29.6 square miles are upstream of Lake Bonham. At its full conservation elevation of 534 feet, the reservoir is expected to cover 16,641 acres, store 367,609 acre-feet of water and be approximately 70 feet deep at its deepest point. Figures 2.2-3 and 2.2-4 are photos taken within the proposed reservoir site.

2.2.1 Dam and Reservoir

Under Alternative 1, the LBCR dam would be constructed as a zoned earthen embankment. The dam would be approximately 10,400 feet long (approximately two miles long) and would have a maximum height of approximately 90 feet. The design top elevation of the embankment would be 553.5 feet above mean sea level (MSL). The embankment would be 19.5 feet higher than the conservation pool of the reservoir, which would be at elevation 534.0 feet MSL, and the embankment would provide approximately three feet of freeboard above the Probable Maximum Flood (PMF) elevation of 550.5 feet MSL. The upstream slope of the embankment would be three horizontal to one vertical (3:1), and the downstream side slightly less inclined at a slope of 3.5:1. All fill for the embankment is expected to come from required excavations of the spillways and from the reservoir pool area. Soil cement would be placed on the upstream slope and a grass cover would be placed on the downstream slope. Preliminary drawings of the proposed dam and spillways are presented in Figures 2.2-5 and 2.2-6. The areas within the reservoir footprint that would be cleared of trees are illustrated in Figure 2.2-7.

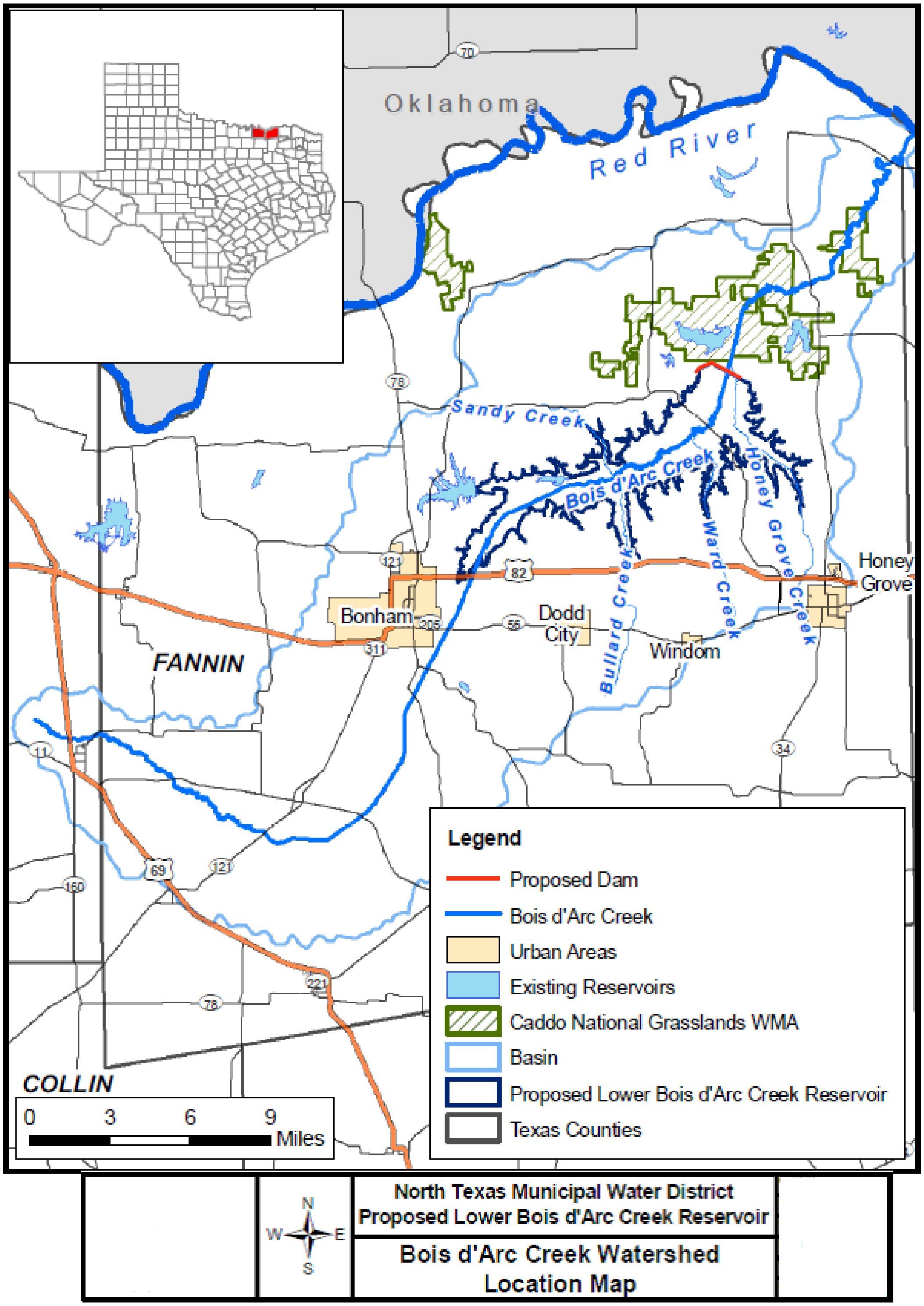


Figure 2.2-1. Lower Bois d'Arc Creek Reservoir Location Map

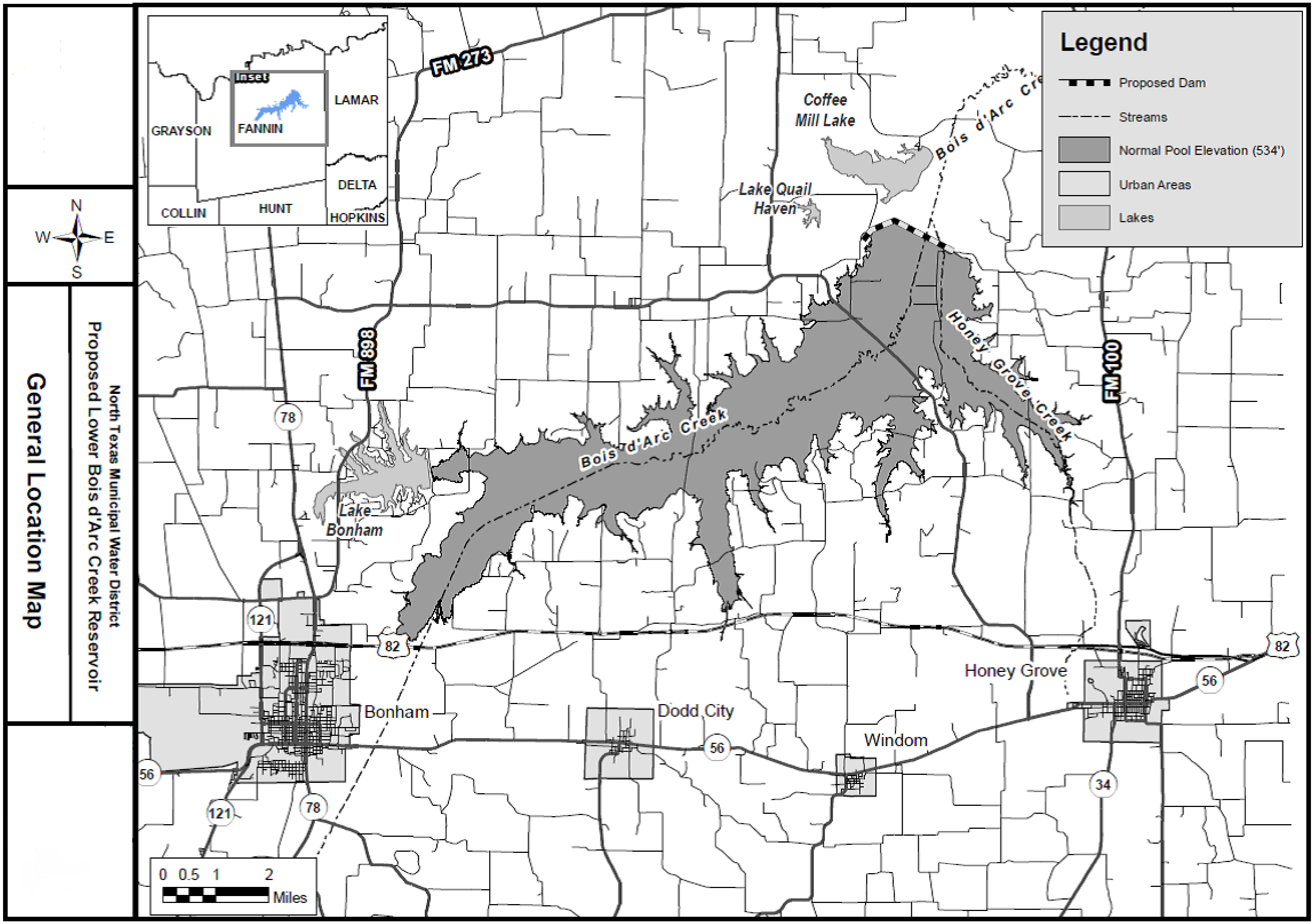


Figure 2.2-2. General Vicinity Map of the Lower Bois d'Arc Creek Reservoir

Figure 2.2-3. FM 1396 and Grazing Land Within the Proposed Reservoir Footprint

Figure 2.2-4. Bois d'Arc Creek and Riparian Corridor

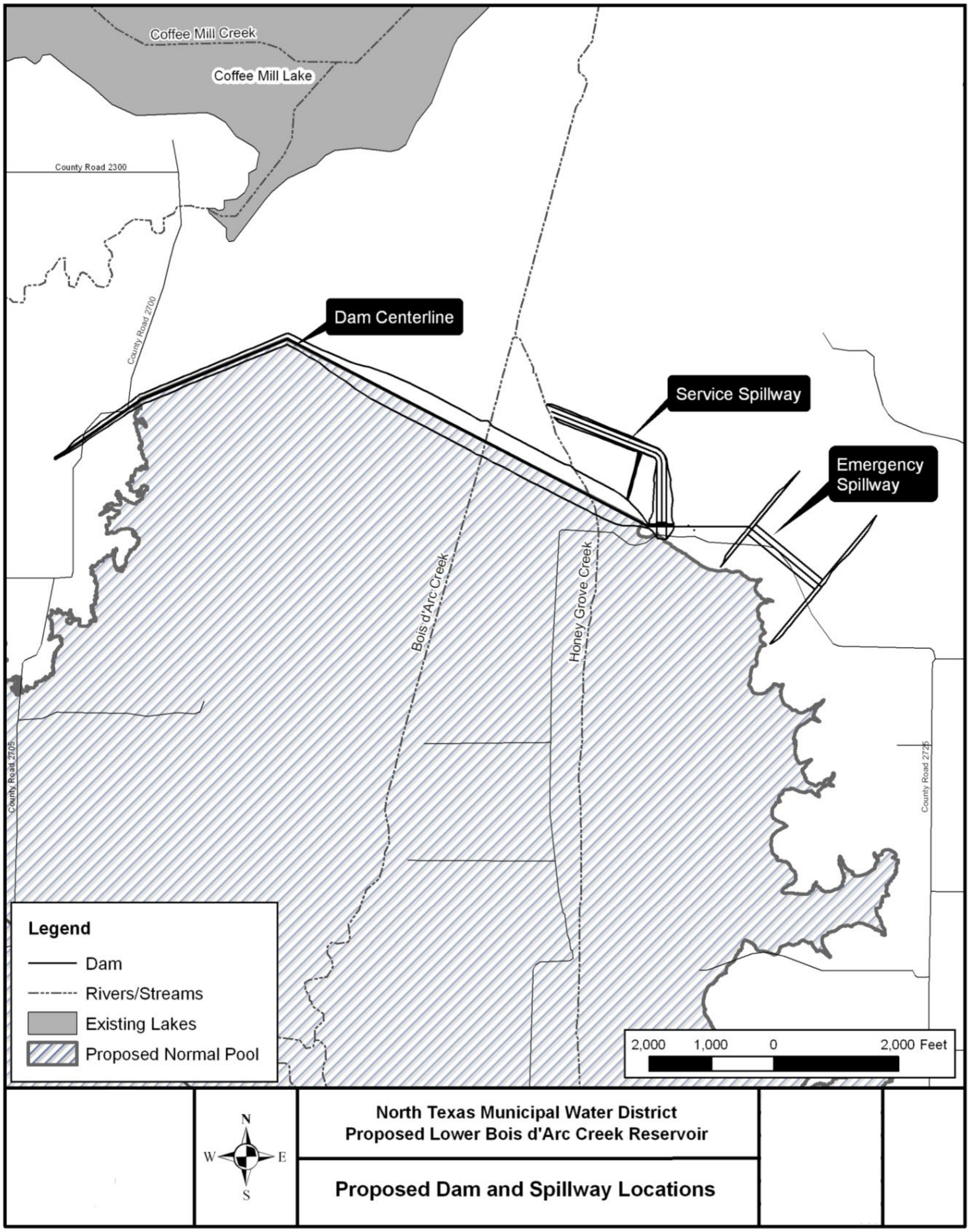


Figure 2.2-5. Proposed Lower Bois d'Arc Creek Reservoir – Dam and Spillway Locations

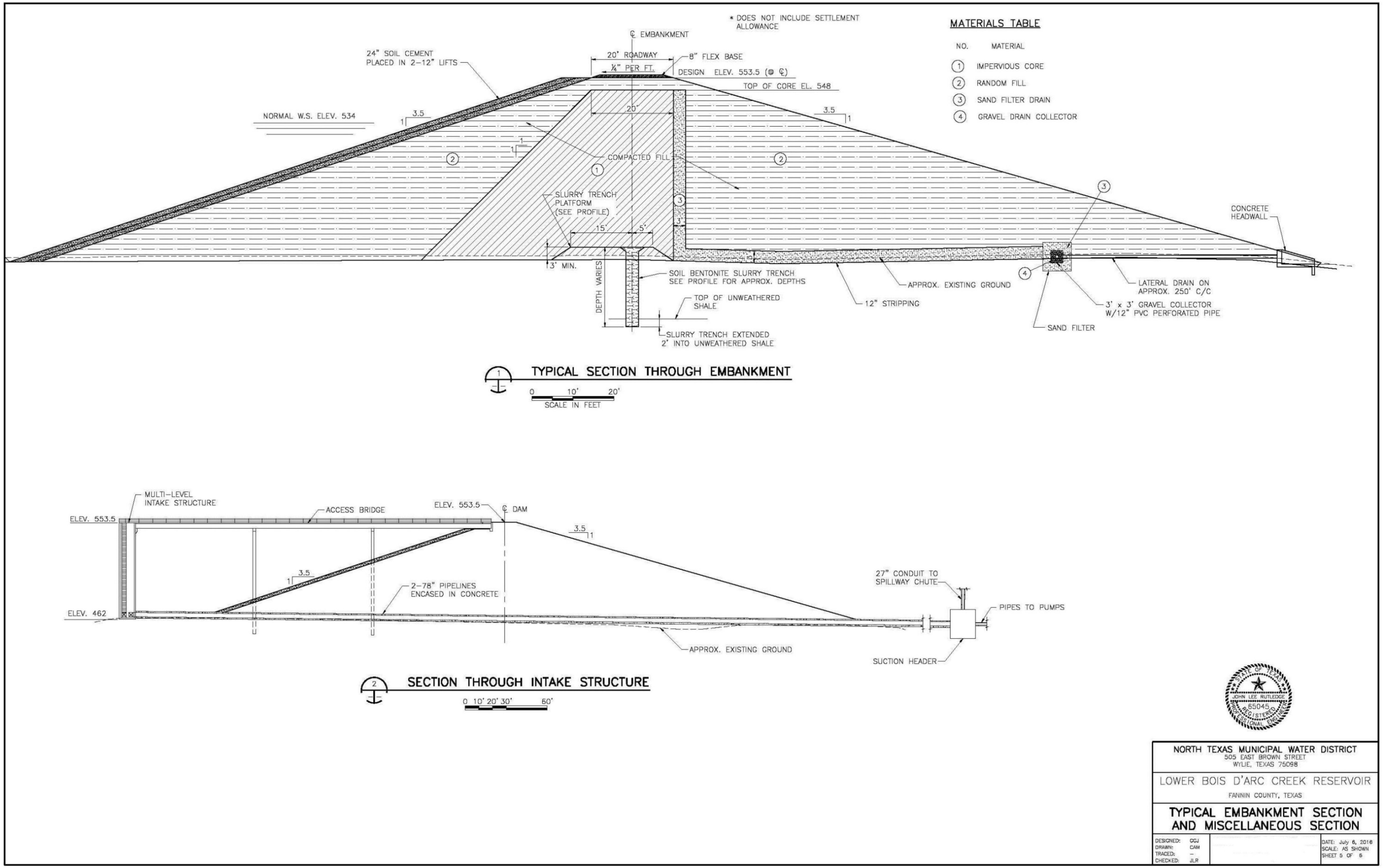


Figure 2.2-6. Preliminary Drawings of Lower Bois d'Arc Reservoir Dam Cross-section

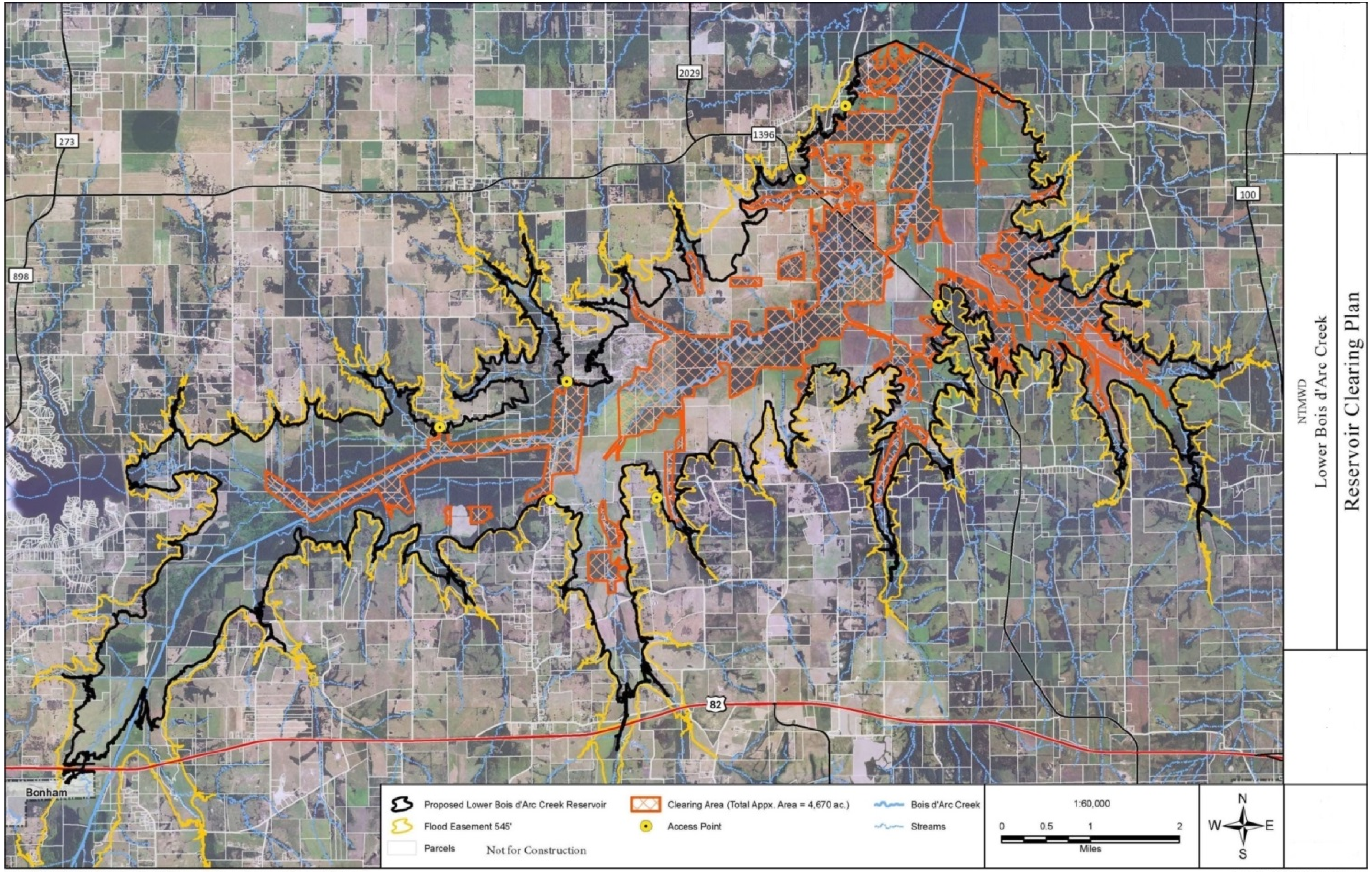


Figure 2.2-7. Conceptual Reservoir Clearing Plan

Source: NTMWD, 2015b

Table 2.2-1 summarizes the quantities and types of fill material to be deposited into Bois d'Arc Creek, Honey Grove Creek, and the wetlands abutting Bois d'Arc Creek.

Table 2.2-1. Types and Amounts of Fill Discharged into Bois d'Arc Creek and Tributaries for LBCR Dam Construction (Cubic Yards)

Location	Slurry Material[1]	Earthen Material[1]	Soil Cement[1]
Bois d'Arc Creek	67	2,230	27
Wetlands abutting Bois d'Arc Creek	11,494	130,503	1,891
Honey Grove Creek	61	411	5
Total	**11,622**	**133,144**	**1,923**

[1] Estimated amounts up to ordinary high water mark

2.2.2 Service Spillway and Outlet Works

Under Alternative 1, the service spillway would be located at the right abutment of the dam (Figure 2.2-5). The spillway would consist of an approach channel, a concrete weir, a chute, a hydraulic jump stilling basin and an outlet channel. The crest of the weir would control the conservation pool level at elevation 534.0 feet MSL, and the weir would have a discharge capacity of approximately 37,300 cubic feet per second (cfs) at the maximum design water surface, the PMF elevation of 550.5 feet MSL.

The spillway structure would extend 958 feet downstream from the dam centerline. A hydraulic jump stilling basin would be constructed with baffle blocks and an end sill. The stilling basin would be at elevation 456.0 feet MSL and it would be 128 feet long. Service spillway discharges would be conveyed to Honey Grove Creek by a discharge channel approximately 2,300 feet long and then flow approximately 1,500 feet in Honey Grove Creek to its confluence with Bois d'Arc Creek.

Water would be diverted by NTMWD through a multi-level intake tower located near the dam that would transport the water to a pumping station located immediately downstream of the dam. The intake structure would be a rectangular tower with two cells, each of which would have the capacity to withdraw water for the needed water supply demands as well as for the releases to meet Bois d'Arc Creek flow requirements. Under normal operating conditions, both cells would be used concurrently and would feed a pair of 78-inch concrete pipes that would carry water through the dam embankment to the pumping station. Diversions could occur through a single cell when the other is closed for maintenance, but this operation is not planned to occur during times of high demand. In the pumping station, the two 78-inch pipes would feed a 90-inch suction header line that would distribute the flow to the pumps being utilized.

Required low-flow releases would be conveyed from the reservoir through the multi-level intake tower and low-level outlet works (a closed conduit or tube through the dam with a slide gate to control the rate of flow) to be discharged to the service spillway chute. An approximately 27-inch pipeline would extend from this to the spillway channel and would be used to convey required low-flow releases. Higher velocity pulse flows would be released from the reservoir through multiple levels of sluice gates located in the service spillway.

An emergency spillway would also be located in the eastern abutment of the dam (Figure 2.2-5). The spillway would be a 1,400-foot wide uncontrolled broad crested weir structure with a crest elevation of 541 feet MSL. This elevation was selected to contain a 100-year storm such that no flow would pass through the emergency spillway.

During preliminary project design, NTMWD's engineers opted for a labyrinth spillway, shown in Figure 2.2-8, because of its ability to decrease the overall spillway width and footprint while still maintaining adequate discharge over the weir during frequent flood events (Rutledge, 2016). A labyrinth spillway offers greater overflow weir length at lower water surface elevations (depths) than a traditional ogee spillway. Among other advantages, this spillway design permits storm events to pass through the reservoir faster when the lake is above the conservation pool (534 feet MSL). Furthermore, the labyrinth configuration allows large sluice gates to be incorporated into the spillway structure, which can be used for the higher environmental flow releases required by the Texas Commission on Environmental Quality (TCEQ) Water Use Permit, and reduces the size, cost, and complexity of the intake structure for the pumping station (Rutledge, 2016).

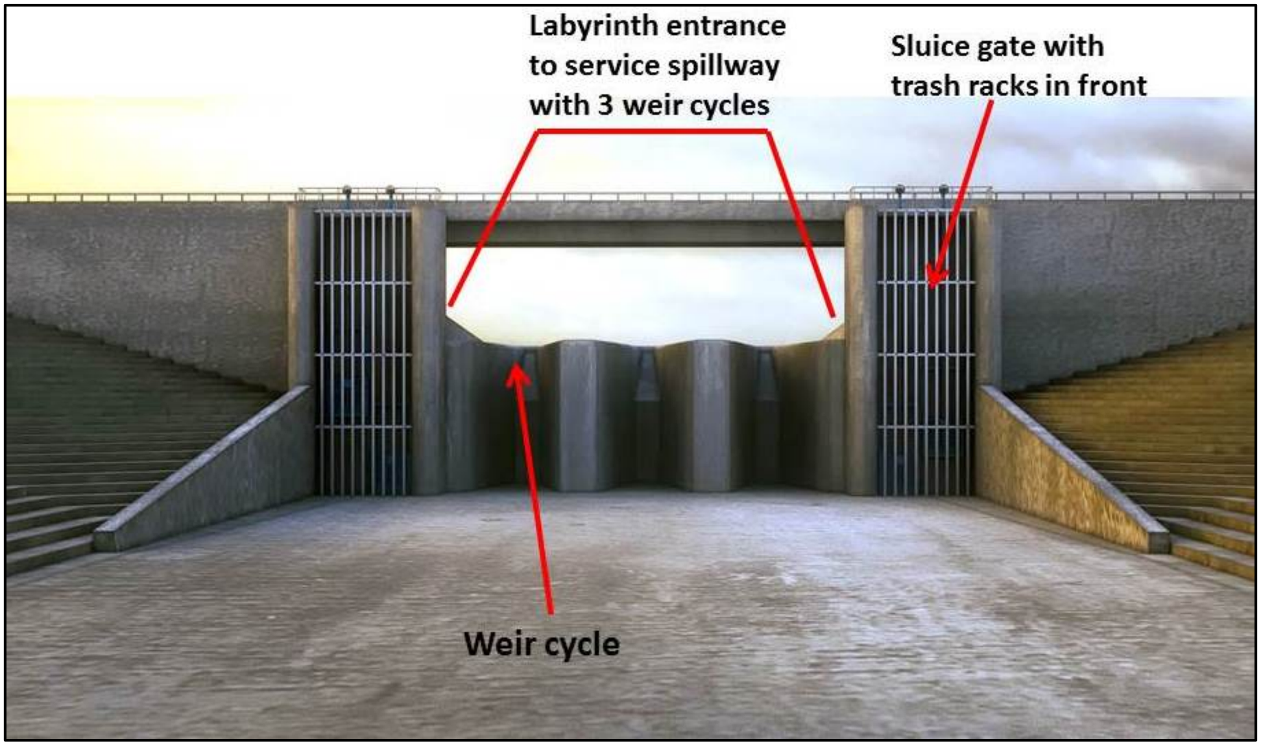


Figure 2.2-8. Rendering of Labyrinth Weir for LBCR Service Spillway, Viewed From Upstream

Source: Rutledge, 2016

The labyrinth configuration for the service spillway would be 60 feet wide with three weir cycles ("V" structure); each weir cycle would be 20 feet wide with a crest elevation of 534 feet MSL. The length of the weir parallel to water flow would be 46.55 feet, providing an effective weir length of 292 feet (the entire length along the rim of the three "V's"), the same as the preliminary design which was part of the design storm determination reviewed and approved by the TCEQ (Rutledge, 2016).

2.2.3 Reservoir Clearing

Under Alternative 1, subject to the provisions of the Section 404 permit, Texas water right permit and Section 401 water quality certification, selected trees and shrubs would be cleared from the LBCR footprint prior to impoundment of water behind the dam. Standing woody material, including dead and living trees and shrubs five feet or more in height, as well as fallen trees five feet or more in length with a diameter of six inches or greater, would be cleared and removed in the areas shown on Figure 2.2-7.

NTMWD prepared first a preliminary Reservoir Clearing Plan and then a Conceptual Clearing Plan to guide the clearing process. The objectives of these plans are to enhance creation of fish habitat by minimizing the clearing of standing trees and shrubs in selected areas within the reservoir; to improve human access to shore locations by creating shore access locations for boat ramps, bank fishing, etc. through selective clearing of trees and shrubs; to reduce hazards to boating safety and fishing resulting from large floating debris by minimizing the source of such debris; and to create aesthetic views of the reservoir along selected segments of the shoreline (NTMWD, no date-b; NTMWD, 2015b).

Both hand and machine clearing are proposed. The preferred method is mechanical clearing by shear-blading during the dry season. In this method, the cleared material would be deposited in windrows or piles and left to dry and eventually burned as fire danger conditions allow. Machine clearing has the advantage of shearing stumps off at ground level, along with all other vegetation. It also accumulates most of the loose and dead woody debris that is on the forest floor. Machine clearing would minimize the amount of woody and organic debris remaining on site and entering the water after reservoir impoundment.

The designated areas on Figure 2.2-7 would be cleared using mechanical methods, except for the following:

- Cultural sites, known or discovered to exist, within the areas identified for mechanical clearing would receive different treatment, as appropriate, determined on a case by case basis (see Cultural Resources, Section 3.14).
- Selected locations as may be designated by the NTMWD for tree salvage (for use as firewood, saw-logs, cabins, etc.), which would be hand cleared using chain saws or other appropriate timber harvesting machinery.

It may also be necessary to utilize hand clearing where it is not possible to operate mechanical clearing equipment due to site location or conditions.

Access and safe landing sites would be established along the reservoir shoreline to facilitate eventual lake-based recreational development. Consideration would be given to both wood salvage and environmentally sensitive areas that may require specific treatment during clearing operations. Flagging or marking of clearing boundaries and on-site supervision would be carried out for the successful implementation of all aspects of reservoir clearing.

After reservoir impoundment, large woody debris would continue to be removed as necessary for the safe operation of boats, boat ramps, swimming areas, water intake structures, and spillways (NTMWD, 2015b). NTMWD and Texas Parks and Wildlife Department (TPWD) are participating in ongoing discussions about the specific details of reservoir clearing that would best facilitate and enhance recreational fisheries at the proposed lake (McCarthy and Hein, 2016).

2.2.4 Road Realignment and Bridge Construction

Construction of the LBCR would inundate the existing paved rural road labeled Farm to Market (FM) 1396 and the existing bridge over which it crosses Bois d'Arc Creek (Figure 2.2-3). NTMWD would be responsible for replacing the road and bridge. The existing alignment of FM 1396 spans Bois d'Arc Creek at what would become one of the widest portions of the proposed reservoir (Figure 2.2-9). If the existing alignment was maintained and a new, longer bridge was constructed to span the reservoir at this location, it would likely interfere with possible recreational uses on the proposed reservoir. Thus, NTMWD investigated several options to relocate FM 1396 and build a new bridge crossing the proposed LBCR. NTMWD's preferred option would be to extend the existing rural road FM 897 two to three miles to the west of FM 1396 and build a new bridge over the reservoir along that alignment; the blue line in Figure 2.2-9 depicts the proposed alignment of the FM 897 extension.

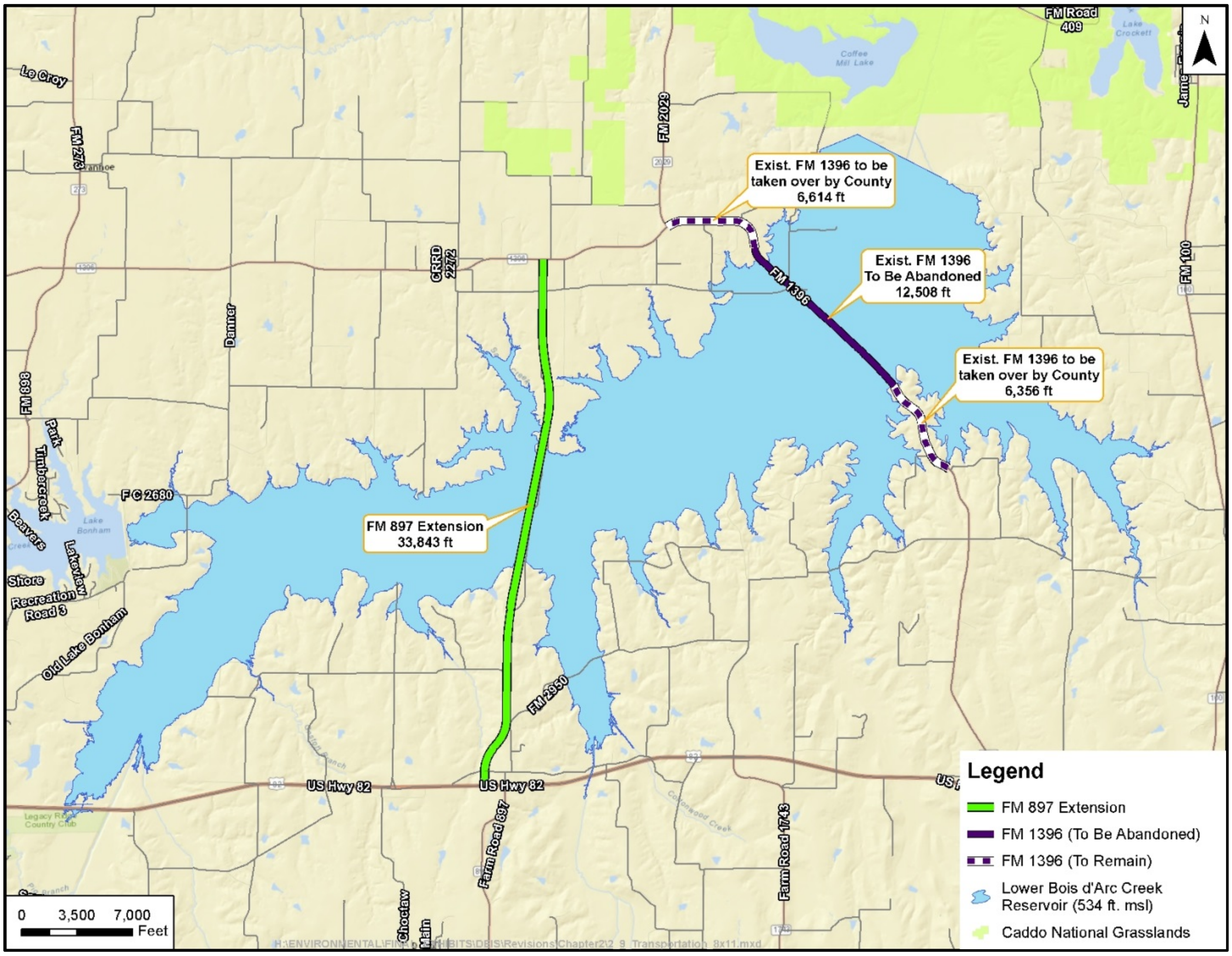


Figure 2.2-9. Proposed FM 897 Extension and New Bridge to Replace FM 1396

2.2.5 Raw Water Transmission, Storage, and Treatment Facilities

As part of Alternative 1, NTMWD would construct water transmission facilities. These facilities would be part of an overall system of raw water storage, raw water transmission, water treatment, and treated water transmission facilities that would ultimately provide water to the growing northern section of NTMWD's service area. These proposed facilities include a raw water intake pumping station and electrical substation at the reservoir site and approximately 35 miles of 90-96 inch diameter raw water pipeline. Figures 2.2-10 and 2.2-11 show the location of the proposed raw water transmission pipeline as well as ancillary and associated facilities, including the proposed pumping station, electric substation, terminal storage reservoir (TSR), TSR outfall, water treatment plant (WTP), and rail spur on the WTP site.

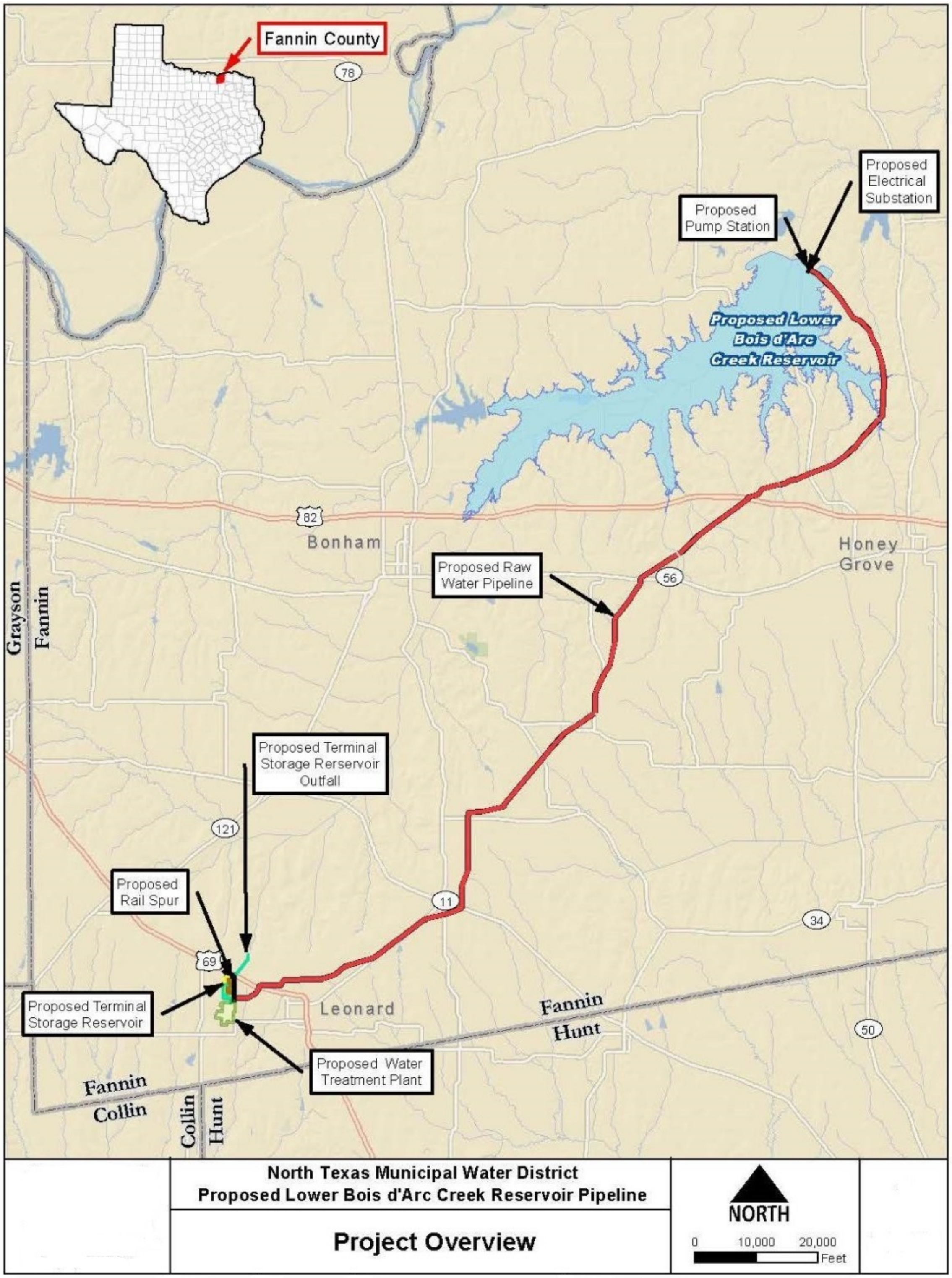


Figure 2.2-10. Proposed Alignment of Raw Water Pipeline and Location of Associated Facilities

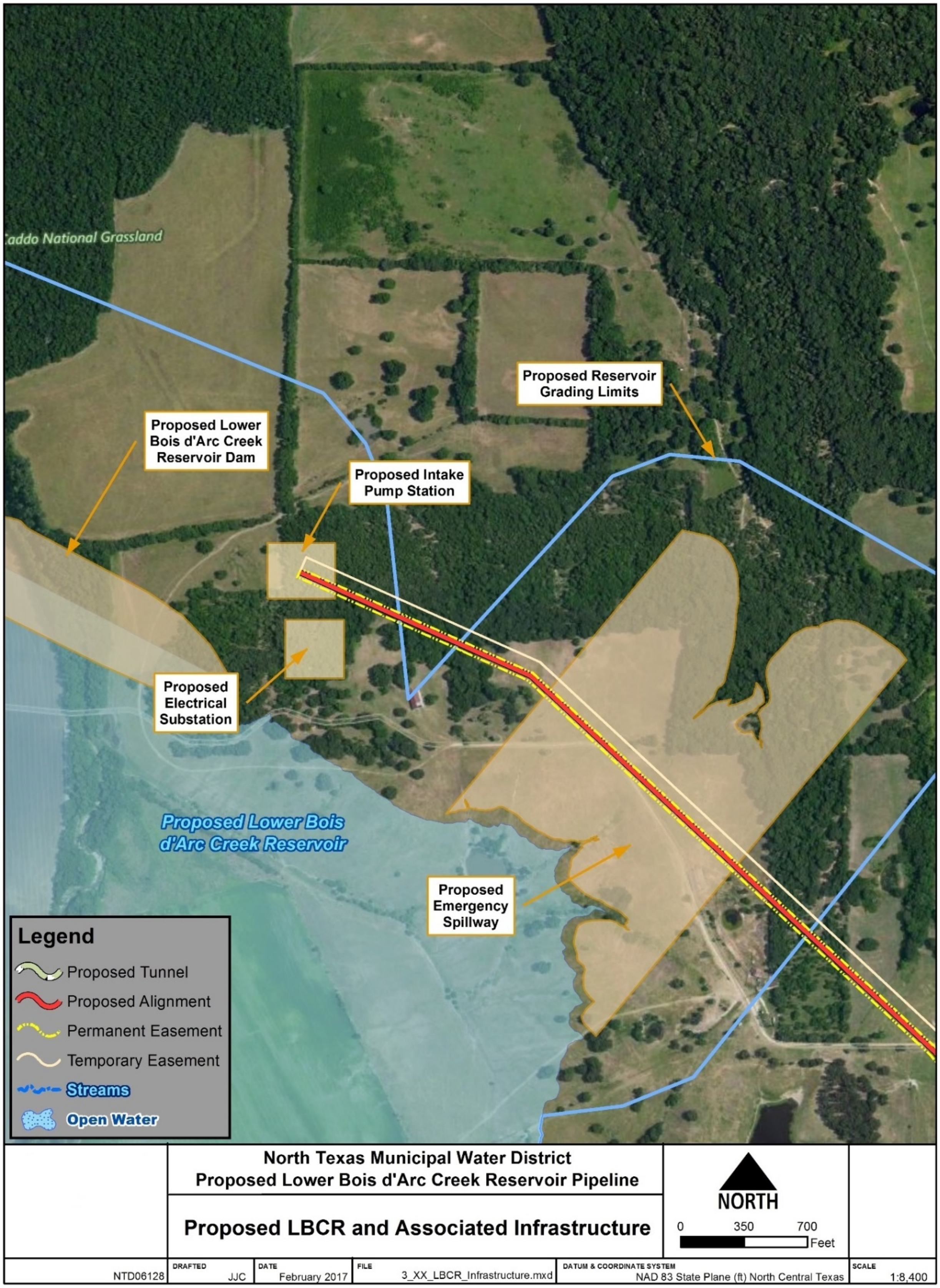


Figure 2.2-11. Location of Proposed Intake Pumping Station and Electrical Substation

The transmission facilities for the proposed LBCR would be constructed for an initial capacity of at least 170 million gallons per day (mgd), which represents a 1.5 peaking factor over the firm yield from the reservoir (120,665 acre-feet per year [AFY] or 108 mgd). However, the transmission system would be sized to allow for an ultimate peak flow capacity of at least 236 mgd, which is about 2.2 times the firm yield from the reservoir. The firm yield of a water supply reservoir is the maximum amount of water that can be diverted on an annual basis during a repeat of the historical drought of record without shortage, assuming that all of the water in the reservoir is available for use.

Intake Pumping Station

Because raw water flowing through the 35 miles of 90-96 inch diameter pipeline must move uphill for part of the distance, it will not flow on its own due to the force of gravity and must be pumped. Thus, a pumping station with several pumps would be built close to the southeastern end of the proposed dam site at the point of water withdrawal through the intake facilities (Figure 2.2-11). Each pump would require an approximately 6,000-horsepower (hp) motor.

The dimensions of the raw water intake pumping station site would be approximately 310 feet by 375 feet, or approximately 2.7 acres. This facility is proposed to be built at a different location than originally indicated in the Individual Section 404 Permit application submitted to the USACE Tulsa District in June 2008. However, it would still be within the original proposed footprint of the proposed dam and spillways associated with the reservoir and would not require additional acreage.

Electrical Substation

In order to provide power to the proposed intake pumping station, a new, dedicated, 138 kilovolt (kV) – 6.9 kV, low-resistance grounded substation housing two transformers would be built next to the proposed pumping station, near the southern end of the proposed LBCR dam site (Figure 2.2-11). The 138kV distribution line would potentially parallel the pipeline easement between the substation and the pumping station.

The electrical substation site would be approximately 325 feet by 325 feet, or approximately 2.4 acres. This facility would also be constructed within the footprint of the proposed dam and spillways associated with the reservoir. As with the intake pumping station, this site would be in a somewhat different location than in the Individual Section 404 Permit application submitted in June 2008. However, because it would still be within the grading limits initially proposed, it would not require additional acreage.

Raw Water Pipeline

NTMWD is proposing to build a pipeline that would convey raw water from the proposed reservoir site to the proposed WTP site near the City of Leonard in southwest Fannin County (Figure 2.2-10). The proposed 90 to 96-inch diameter pipeline would run from just downstream of the proposed LBCR dam site in a southwesterly direction for approximately 35 miles to just west of Leonard. The proposed pipeline would have a permanent easement width of 50 feet and a temporary construction easement width of 70 feet. Construction of the proposed pipeline would be achieved primarily with open-trench construction methods. However, three stream crossings – Ward, Honey Grove, and Bullard Creeks – would be tunneled. Once the pipeline is in place, all pre-construction contours would be restored, exposed slopes and stream banks would be stabilized, and disturbed areas would be revegetated. The total area of grading for pipeline construction would be approximately 512 acres.

The proposed pipeline route would cross several state, county, and minor roads as well as gas/petroleum pipelines, overhead power lines, train tracks, and minor utilities. It is anticipated that highway and railroad crossings would be designed as lined tunnel crossings across the entire Right-of-Way as per Texas Department of Transportation (TxDOT) specifications. County road, gas/petroleum pipeline, overhead electric transmission line, train track, and minor utility crossings would be designed according to the requirements of each facility's owner and permitted as required by the relevant permitting authority.

The construction of the pipeline is proposed to be concurrent with the construction of the dam. The permanent easement would be cleared and seeded with native vegetation where possible. Most previous activities on the easement would be able to continue with the exceptions of the construction of structures and planting of trees.

This pipeline route was one of several pipeline routes examined and is being proposed because of its minimal impacts to waters of the U.S. (see Appendix I for Preliminary Jurisdictional Determination).

North Water Treatment Plant

Raw water transported from the proposed LBCR would be treated at a proposed WTP site (the "North WTP") that would be constructed just west of the town of Leonard, TX, (Figures 2.2-10, 2.2-12, 2.2-13, 2.2-16, 2.2-17). NTMWD currently owns an approximately 662-acre site that is located between State Highway 69 and FM 78 (Figures 2.2-12 and 2.2-13). The 662-acre site is bisected by County Road 4965, dividing the site into an eastern section (339 acres) and a western section (323 acres). The proposed WTP would be constructed within the western section and the grading limits would encompass approximately 186.2 acres.

The North WTP at Leonard is a facility that will be needed by NTMWD in the 2020 – 2021 timeframe, and it is being designed to treat water from several potential sources. NTMWD's intent is to treat LBCR water at the North WTP; should this reservoir project not proceed as planned, a WTP will still be constructed.

While the final treatment plant layout and processes would not be determined until the design phase of the LBCR project, because the raw water quality in Lower Bois d'Arc Creek is generally similar to that found at the District's Wylie and Bonham facilities and NTMWD's staff is accustomed to operating the treatment processes used at those facilities, the new North WTP would likely be a conventional, modular arrangement treatment facility, similar to the existing WTP IV in Wylie, but with the addition of ozonation equipment.[1]

A TSR is proposed to be constructed west of the City of Leonard (Figures 2.2-10, 2.2-14, 2.2-15, and 2.2-16). The TSR site would consist of a north cell and a south cell, with grading limits of approximately 153.5 acres. Both cells would hold approximately 210 million gallons of water, thus providing a total of approximately two days of storage during peak water demand periods. The TSR site would be designed in such a way that it could be drained and the flow directed into the Red River Basin. This would be accomplished by building an overflow structure within the north cell which would lead to a proposed drainage pipeline. The drainage pipeline would only be used during overflow events and as needed for maintenance of the TSR. The grading limits for construction of the pipeline would be approximately 11.44 acres. It would have an outfall structure with a footprint of approximately 0.36 acres located slightly south of the headwaters of Valley Creek (Figure 2.2-15).

[1] Ozonation is the process of bubbling ozone gas through water during the water treatment process. The ozone reacts with metals present in the water to form insoluble metal oxides (solid particles) that can be filtered out.

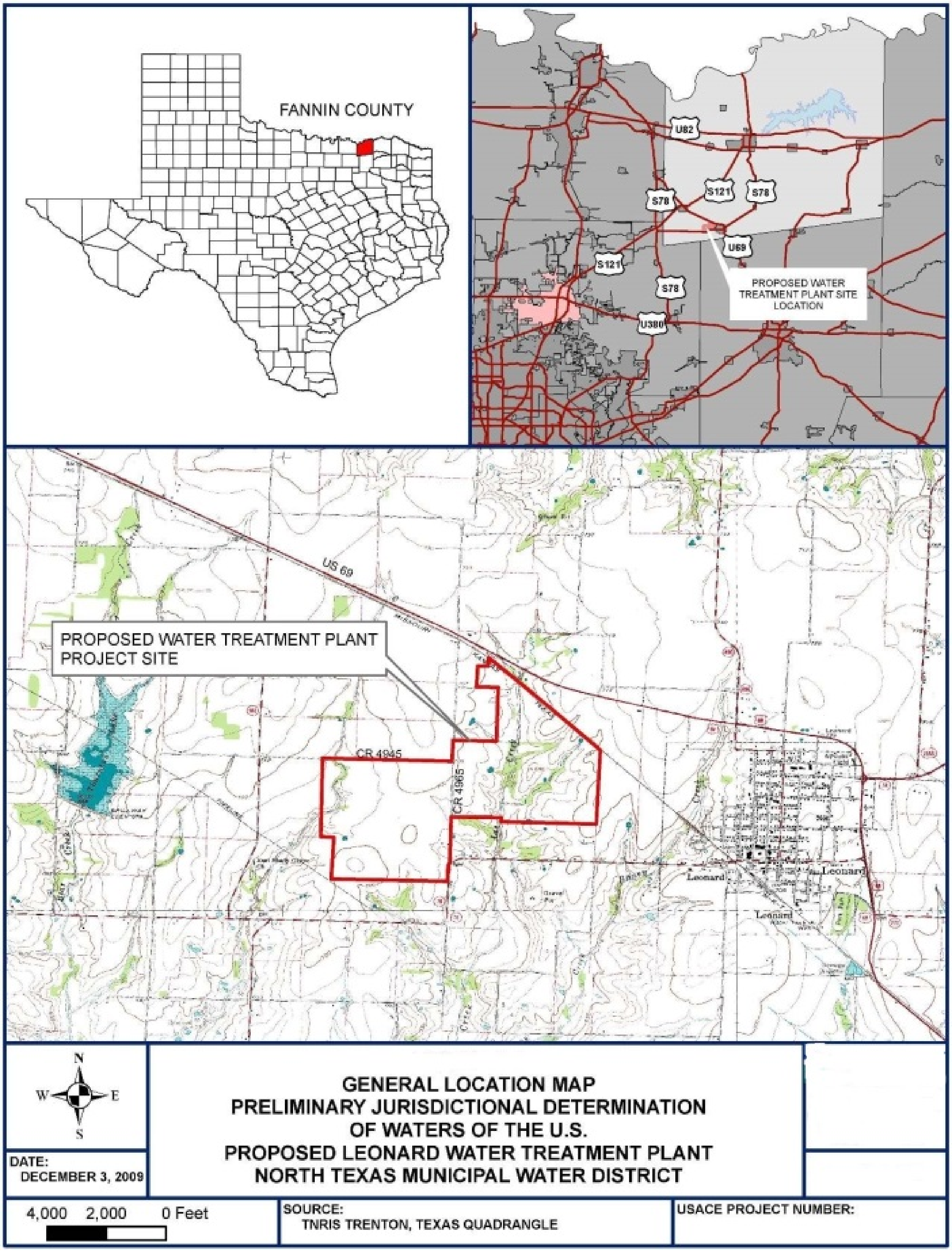


Figure 2.2-12. Location of NTMWD-Owned Property for Construction of North Water Treatment Plant

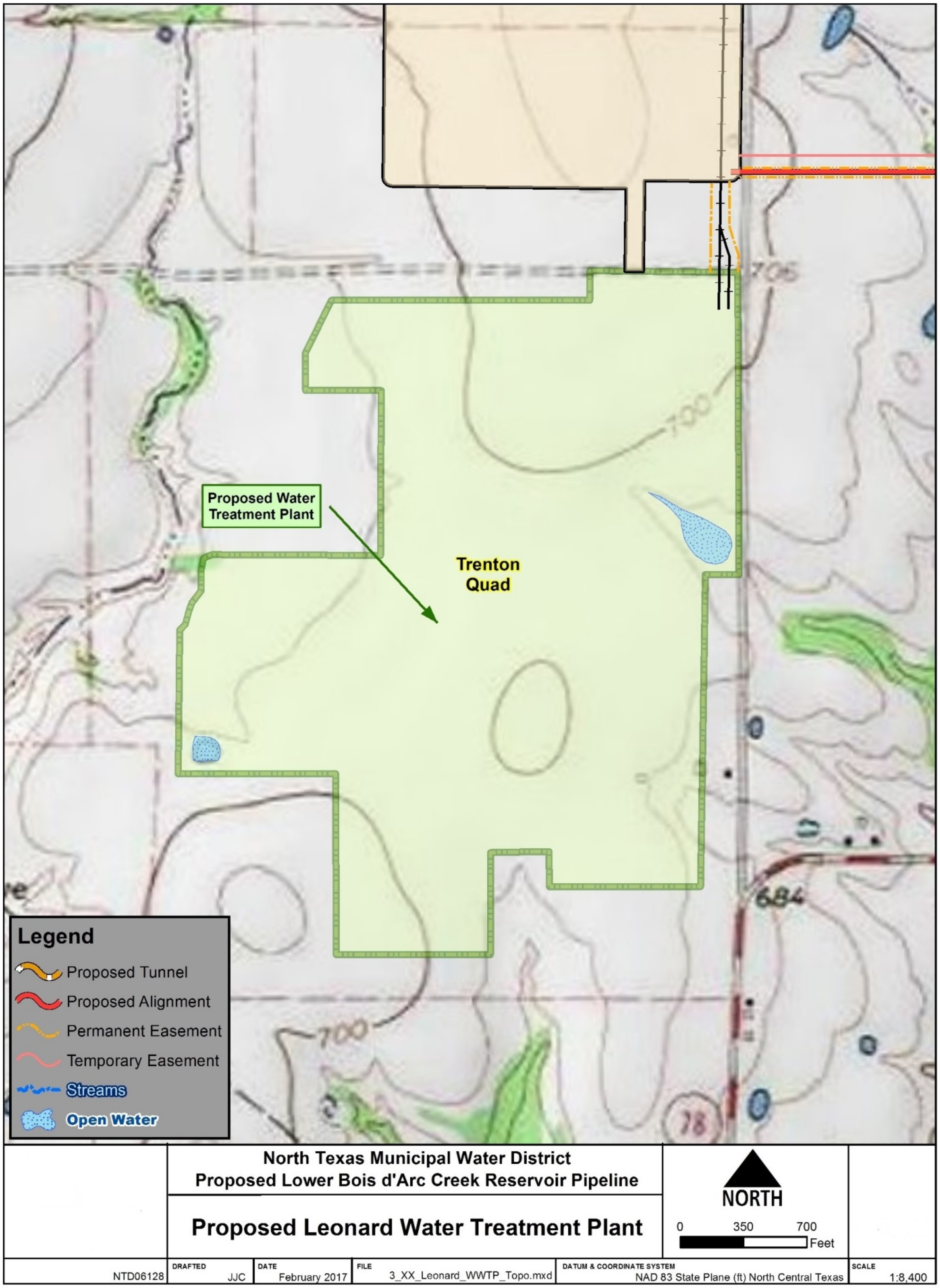


Figure 2.2-13. Location of Proposed North WTP

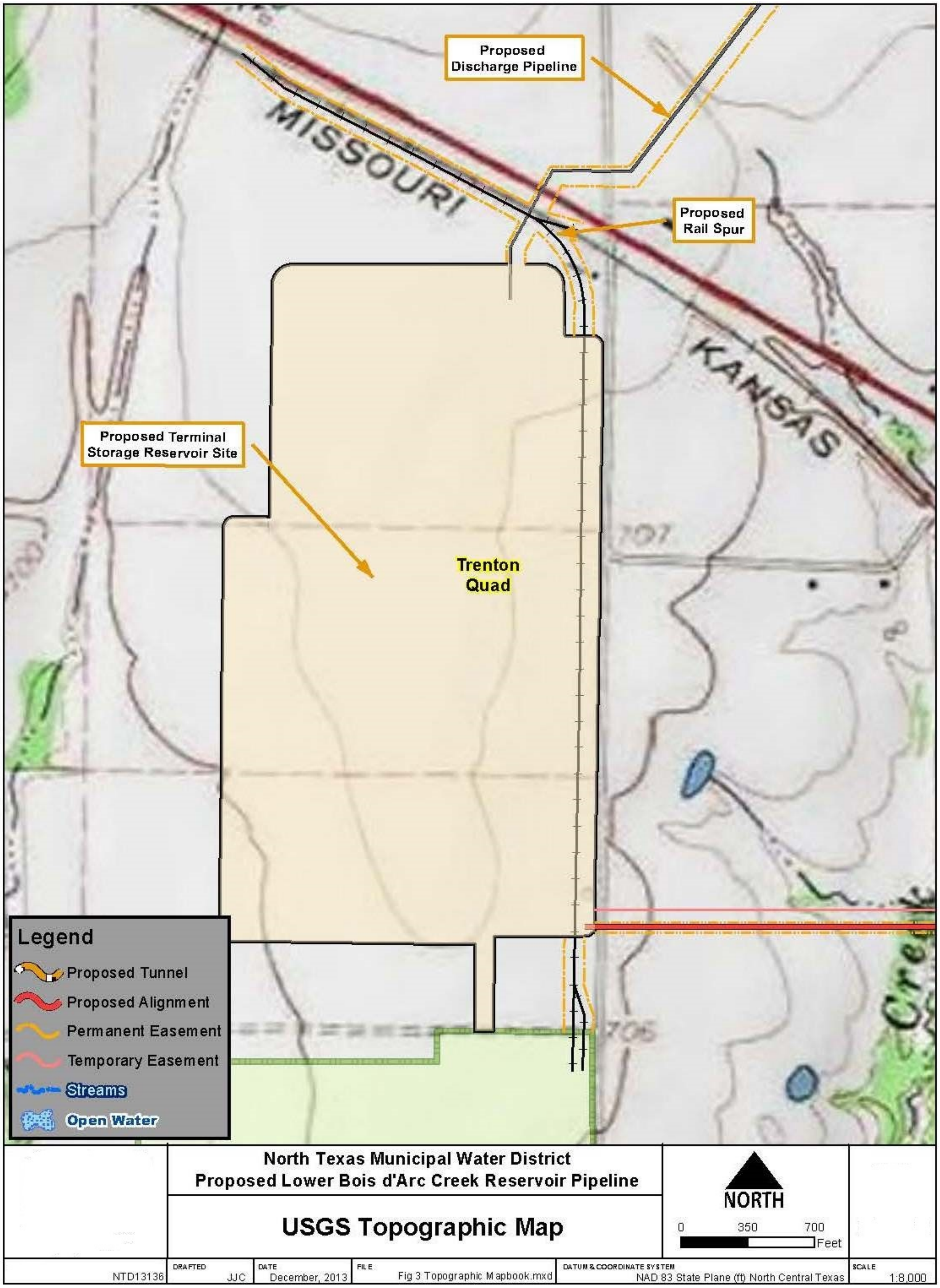


Figure 2.2-14. Location of Proposed Terminal Storage Reservoir

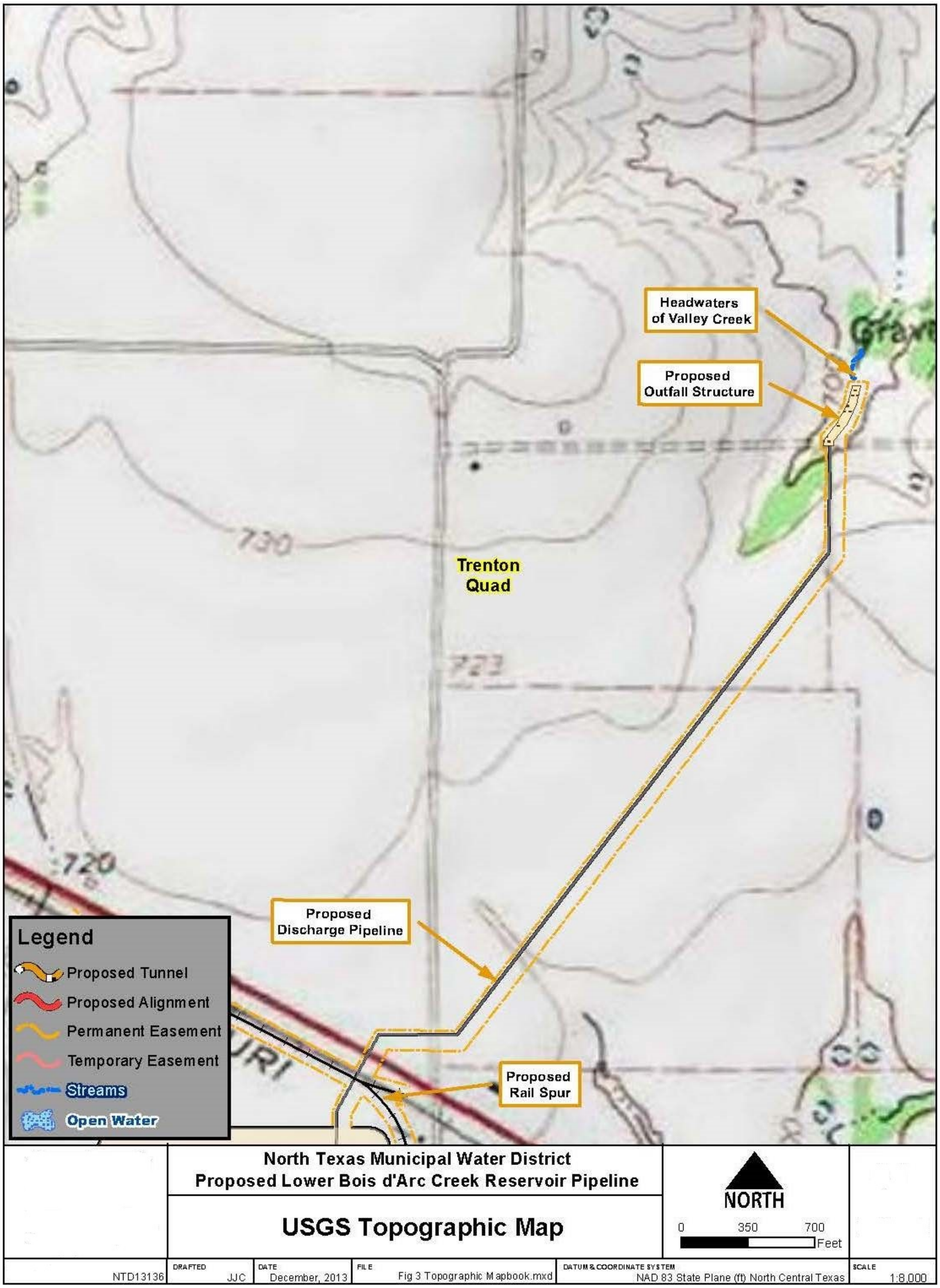


Figure 2.2-15. Location of Proposed TSR Discharge Pipeline and Outfall

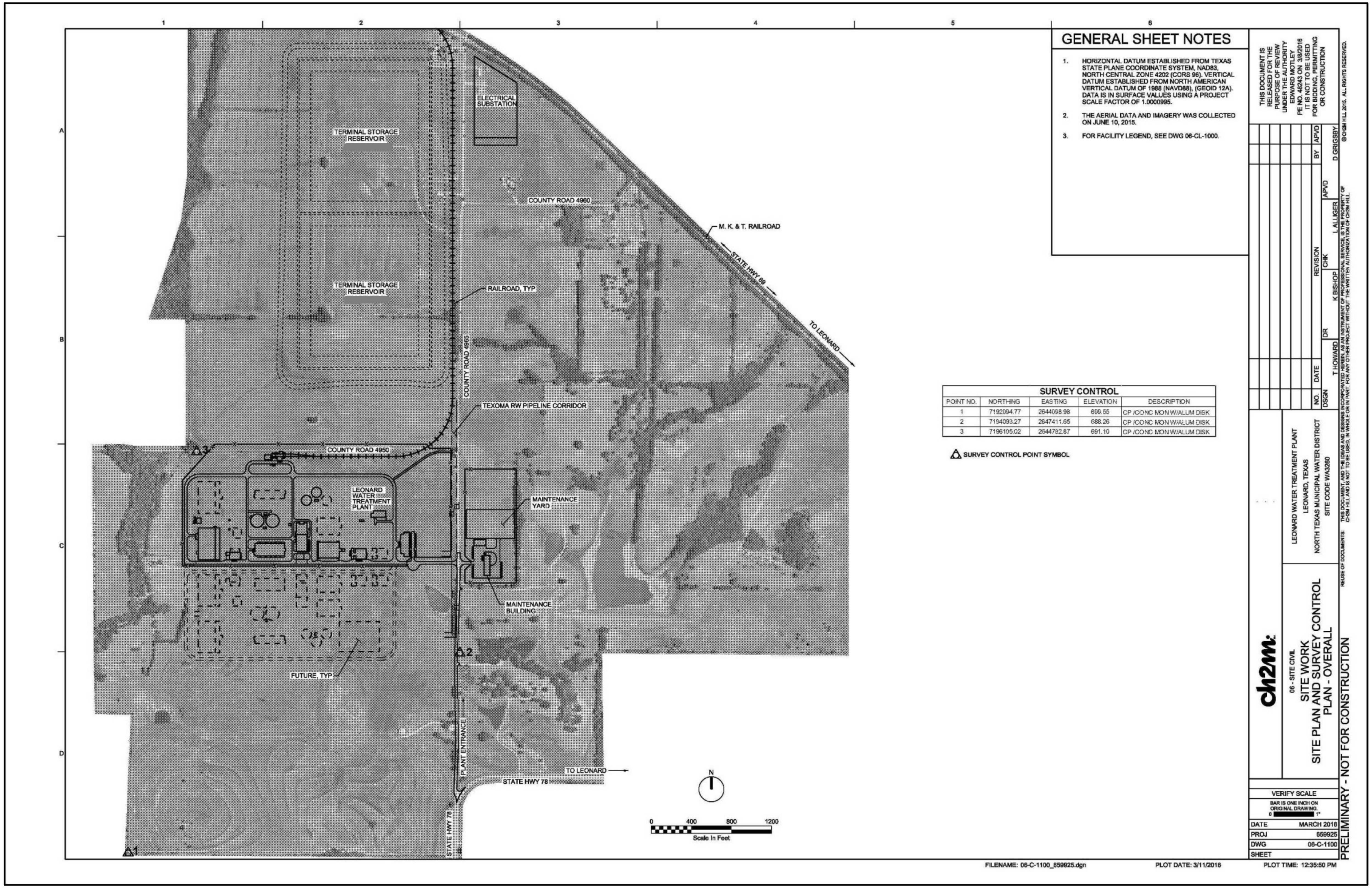


Figure 2.2-16. Site Plan Showing Proposed North WTP and TSR

Source: CH2M, 2015a

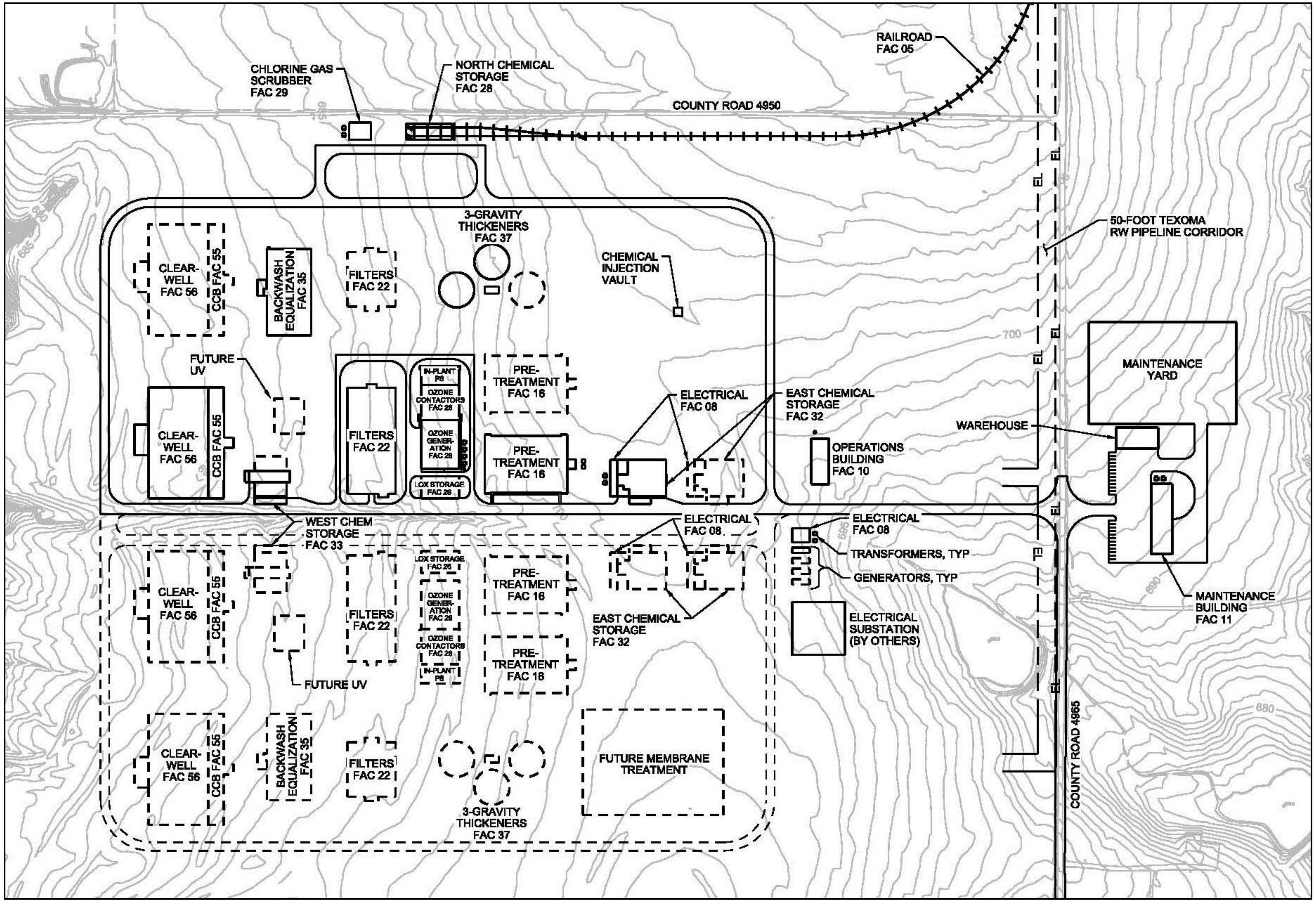


Figure 2.2-17. North Water Treatment Plant Site Plan

Source: CH2M, 2015b

The North WTP is anticipated to use conventional treatment with intermediate ozonation for primary disinfection and taste and odor (T & O) control. Major treatment processes would include flow metering and distribution, rapid mix chambers, flocculation basins, sedimentation basins, ozone contact basins, biologically-active filters, and a clearwell. Major treatment plant structures would include a control and chemical feed building, blower building, reclaimed water basin, sludge lagoons, and maintenance building. Liquid ammonium sulfate and sodium hypochlorite would likely be utilized for residual disinfection to avoid the risk management issues from gaseous chlorine and ammonia. The initial plant capacity is expected to be 70 mgd with future plant expansions as needed to meet growth in treated water system demands.

Rail Spur

A rail spur is proposed for construction off of the Missouri-Kansas-Texas Railroad located north of the TSR site; its terminus would be the proposed WTP site (Figures 2.2-10, 2.2-14, 2.2-15, 2.2-17). It would be routed through uplands along existing roads entirely on property already owned by NTMWD (Kiel, 2016a). The proposed rail spur would be used to transport materials and supplies to the WTP. The rail spur would be approximately 6,600 feet in length (1.25 miles) and the grading limits would be approximately 7.2 acres.

At a capacity of 70 mgd, it is estimated that the WTP would use slightly more than two tons of chlorine per day for the purpose of water disinfection. It is estimated that this would require a delivery of one train approximately every six weeks once the WTP is in operation; actual chlorine demand would be determined upon start-up testing. Chlorine is considered a hazardous material but the rail spur will be designed to comply with all safety requirements for transporting chlorine (Kiel, 2016a; Kiel, 2017).

Project Construction Schedule

The construction phase of Alternative 1 (including all components) would last approximately three to four years (Figure 2.2-18). Construction would begin first on the dam, mitigation, and FM 897 (replacement of the FM 1396 road and bridge). Construction of the pumping station, TSR, WTP, and raw water pipeline would start about a year later.

2.2.6 Reservoir Operation

It is important to note that the Section 404 permit, if issued by the USACE, does not address, authorize, or regulate reservoir operations once the reservoir is constructed. That is the purpose of TCEQ's Water Use Permit, issued on June 26, 2015. The Section 404 permit only addresses placement of dredge and fill material into waters of the U.S. to construct the LBCR dam. Under Alternative 1, year-to-year and seasonal operation of the reservoir would be governed by an Operation Plan (NTMWD, 2017). In general, the LBCR would impound up to 367,609 acre-feet of water and produce an estimated firm yield of 120,665 acre-feet of water per year (about 15,000 AFY more than the amount identified in the purpose and need identified in Chapter 1), an average of 108 mgd. The conservation pool, or normal water surface, of the reservoir would be maintained at an elevation of 534.0 feet MSL; however, the actual water surface and shoreline would fluctuate above and below this level.

In a typical year, the reservoir would be fullest in May and June. Reservoir elevations would typically drop during the drier months of late summer due to less precipitation and in-flow and more surface evaporation, with the lowest elevations typically occurring in September and October. However, water levels are related to extended periods of dry conditions versus wet conditions, as well as seasonal variations. Based on the historical hydrologic record, the water surface would exceed 534.0 feet MSL less than 10 percent of the 612-month (51-year) hydrologic period, and would drop below 516.4 feet MSL (40 percent full) approximately 10 percent of the time during this period (Figure 2.2-19). This means that

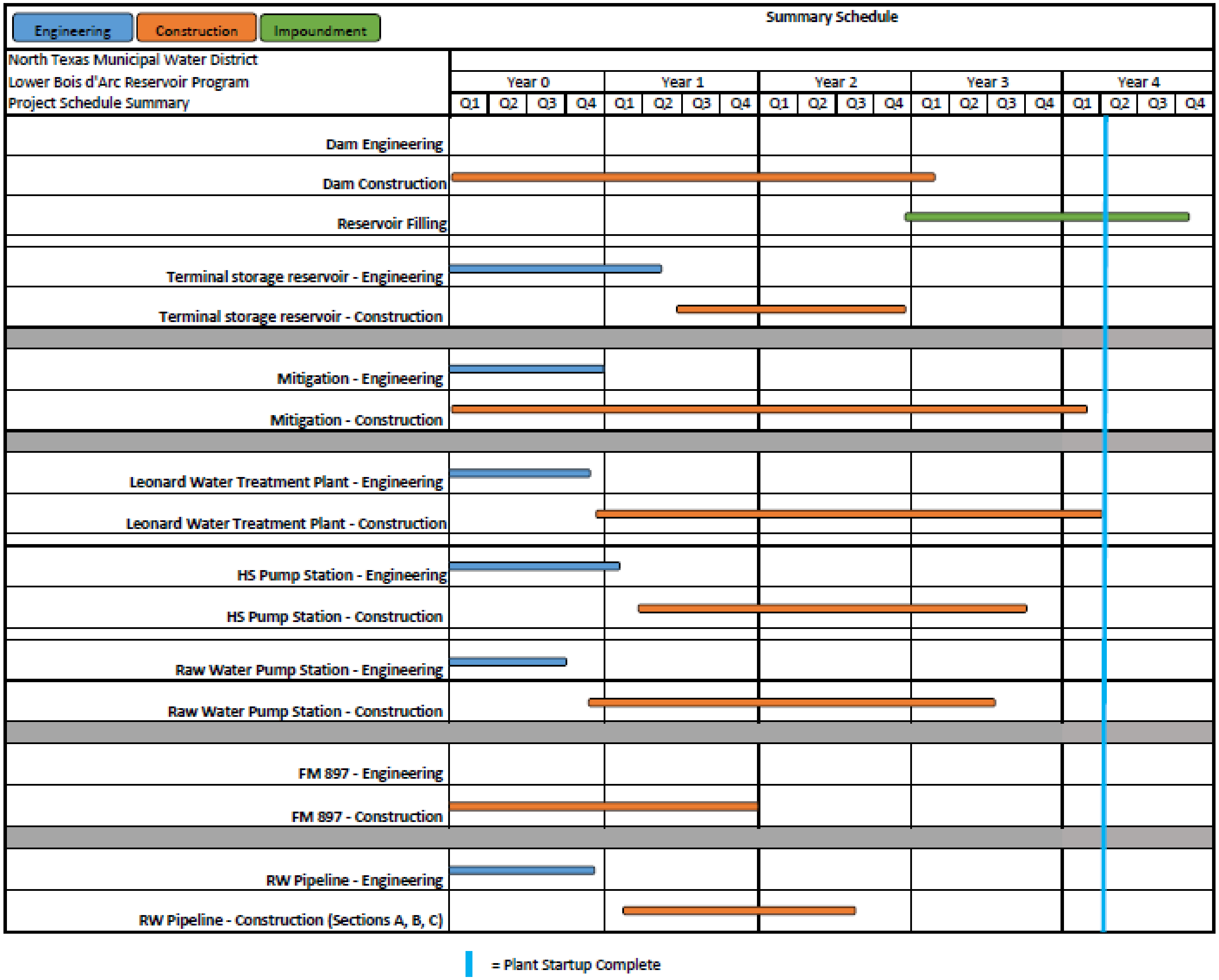


Figure 2.2-18. Alternative 1 Project Construction Schedule

Source: Kiel, 2016

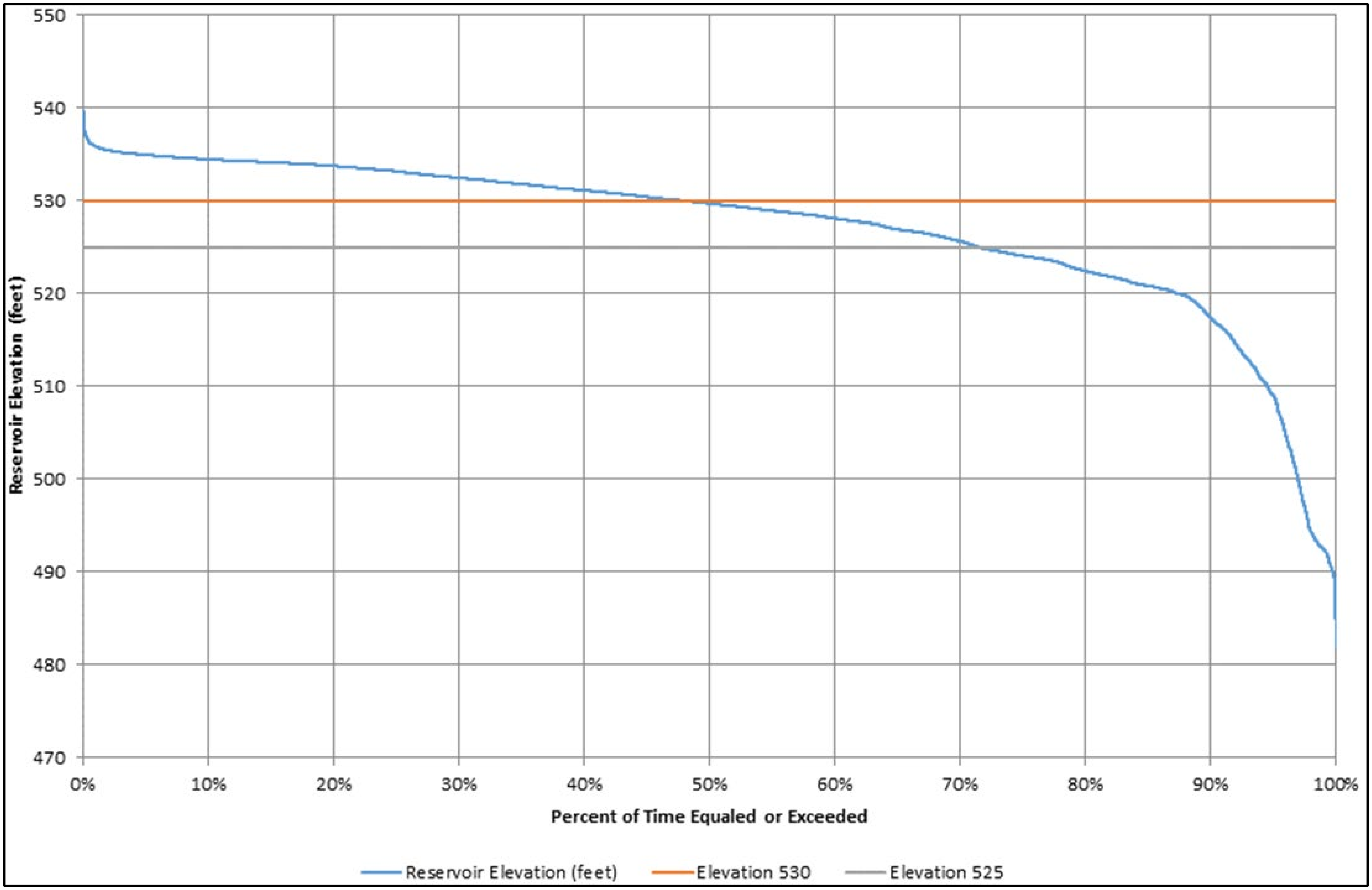


Figure 2.2-19. Alternative 1 Reservoir Elevation Frequencies, Including Permitted Environmental Flows and Bonham Wastewater Treatment Plant Discharges

the water level would be at 516.4 feet MSL or less for about 60 months of the 612-month hydrologic period. Low water levels could occur during several months of one year and not at all during most other years.

The reservoir would be operated in compliance with the state water right (i.e., the Water Use Permit issued by TCEQ in June 2015), and as part of the overall NTMWD water supply system. If conditions allow, and if the system need is there, NTMWD is authorized to divert water at a rate of 175,000 AFY, at a maximum diversion rate of 365.15 cfs from any point on the perimeter of the reservoir. As previously mentioned, a reservoir intake and pumping station is proposed to be built near the dam. In addition to diversions for water supply, inflows to the lake would be passed through the LBCR dam to Bois d'Arc Creek for downstream senior water rights and environmental flows (TCEQ, 2015).

The environmental flow releases incorporated into the Water Use Permit for the LBCR are based on the instream flow needs analysis and subsequent discussions with the TCEQ, and are summarized in Table 2.2-2. Under the Water Use Permit, the reservoir is considered to be in subsistence conditions when the lake storage reaches 40 percent capacity. According to the TCEQ technical memorandum accompanying the June 2015 Water Permit, subsistence flows are those that are "extremely low." They should occur only during temporary or infrequent conditions, and they are intended to maintain survival of aquatic organisms. While they will not always provide suitable water quality, they will furnish limited instream habitat (TCEQ, 2013).

Table 2.2-2. Environmental Flow Criteria for Bypassing Inflows Through the Reservoir

Season	Months	Subsistence Flow	Base Flow	Pulse Flow
Fall-Winter	November - February	1 cfs[a]	3 cfs	2 per season Trigger: 150 cfs Volume: 1,000 AF Duration: 7 days
Spring	March - June	1 cfs[a]	10 cfs	2 per season Trigger: 500 cfs Volume: 3,540 AF Duration: 10 days
Summer	July – October	1 cfs[a]	3 cfs	1 per season Trigger: 100 cfs Volume: 500 AF Duration: 5 days

AF = acre-feet; cfs = cubic feet per second

[a] A subsistence period freshet requirement with a trigger level of 20 cfs, a volume of 69 AF, and a duration of 3 days, to occur no more than every 60 days, also applies.

Source: NTMWD, 2017

Under normal operations, it is expected that the full yield of the reservoir would be 85 percent utilized within ten years of operation (i.e., by 2030). Figure 2.2-20 shows the projected annual diversions from LBCR based on current normal year projected demands. Under drought year conditions, demands on the reservoir would likely be higher. Depending upon the conditions of NTMWD's other water sources, LBCR water levels, and locations of demands on NTMWD's system, the diversions from LBCR could increase to the maximum allowable amount of 175,000 AFY.

Leading up to the current (February 2017) Draft Operation Plan for LBCR, potential reservoir operation was discussed in general terms in two memoranda written by FNI for NTMWD (Albright, 2014a; Albright and Gooch, 2008). The ability to maximize supply from LBCR is a key element in the operation of NTMWD's water supply system, which utilizes multiple sources of water. Long-term utilization of water from LBCR would be influenced by demands in the system, local demands from Fannin County, and the possible development of other water sources for NTMWD. A 2008 FNI memorandum examined one potential operation scenario, considering the aim to maximize supply while balancing long-term needs. This memorandum is included with the Operation Plan in Appendix D.

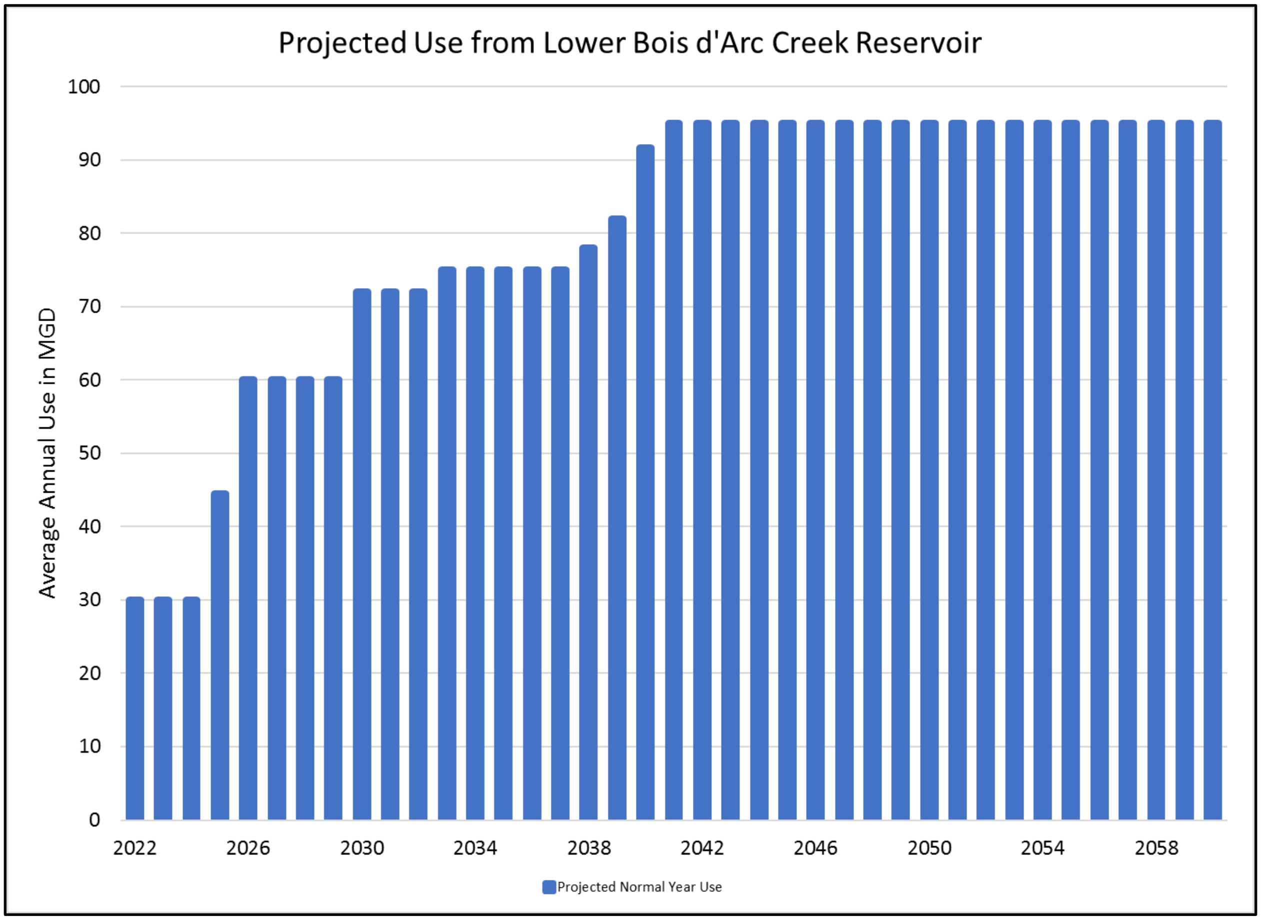


Figure 2.2-20. Projected Normal Year Diversions of Water from LBCR into NTMWD's System

Note: In 2028, water diversions from the LBCR would reach an average of 70 mgd or 78,400 AFY. If maintained for 365 days (1 year), an average of 1 mgd would equal 1,120 AFY, 10 mgd would equal 11,200 AFY, and 100 mgd would equal 112,000 AFY.

The potential operation scenario assumes that diversions would be made at the maximum diversion rate if the reservoir water level was above elevation 532 feet MSL (2 feet below the conservation pool elevation). When the water level was below 532 feet MSL, diversions would be reduced to less than the maximum diversion rate. Under this operation scenario, the maximum diversion of 175,000 AFY would be made in 14 years of the 51-year hydrologic period. About 50 percent of the time, the LBCR could support diversions above the firm yield, provided diversions were made at slightly less than the firm yield the other 50 percent of time.

Figure 2.2-21 compares the flow rate frequency at the FM 409 crossing stream gage with the LBCR operating at its firm yield and with the overdraft operation (a temporarily higher rate of water diversion or withdrawal than the firm yield) described in the potential operation scenario. The daily RiverWare model was developed to examine environmental flows for this project. Flows in Figure 2.2-21 are displayed on both a normal (top) and a log scale (bottom). The log scale graph accentuates the differences in flow between the two operations. The greatest difference is in the frequency of flows between 20 and 110 cfs. This difference occurs during periods when the LBCR dam would be spilling (releasing water) under firm yield operation. During overdraft operation, water releases are slightly smaller and may occur over a shorter duration because of the larger diversion during wet periods. During drier periods, when the reservoir content is lower, the flows are essentially the same. There is very little difference in flows less than 10 cfs. The critical period is during dry times when there are little to no differences in downstream flows with overdraft operation.

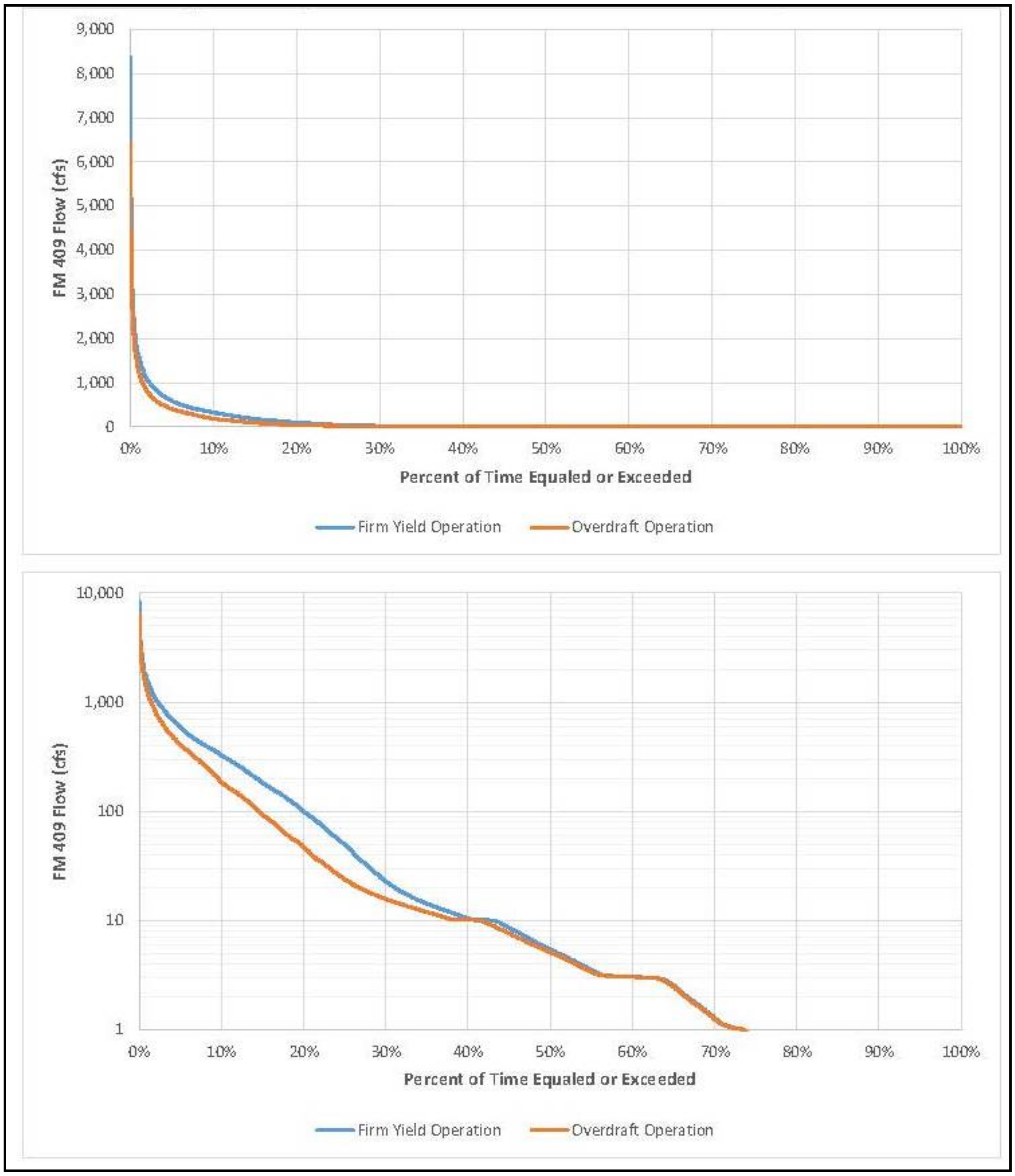


Figure 2.2-21. Comparison of Flows at FM 409, Firm Yield and Overdraft Operation, on Normal (Top) and Logarithmic Scales (Bottom)

As specified in the Draft Operation Plan (NTMWD, 2017), some of the factors that could affect the operation of the LBCR as part of NTMWD's water supply system would include:

- Climatic conditions. During relatively wet times, NTMWD could decide to use less imported water if Lake Lavon was full, to reduce its expenditures on electricity consumption.
- Available infrastructure. Initially, complete use of the LBCR could be limited by treatment and distribution capacity. At times, use of the LBCR could increase if another reservoir or other water transfer facilities were out of service which would limit the use from other supply sources.
- Other future water sources. As NTMWD adds more sources of supply to its system, the operation of the LBCR could change to accommodate the use of those other supplies, particularly if those sources are treated at the North WTP.

The operation policy outlined in the Draft Operation Plan is only one of many different potential operational options for the LBCR. Actual operation of the reservoir would depend on the extent of development of the NTMWD system, overall customer demands within the system, and local demands in Fannin County. As an example of other policies that might be used, the full permitted diversion from LBCR might be used even when the reservoir is drawn down two feet below the conservation pool level if NTMWD system demands are located close to available supplies and if new sources are being developed that would allow reduced diversions from LBCR in later years. NTMWD currently has six major sources of water (Lakes Lavon, Texoma, Chapman, and Tawakoni and reuse at Wilson Creek and the East Fork), and anticipates adding several more over the next few decades.

Some of these other potential new sources are quite far away from the NTMWD service area and it would be costly to pump their water to members and customers. Also, as described in Chapter 1, water from Lake Texoma has a relatively high salt content and must be blended with water from other sources to make it drinkable. LBCR would be relatively close to the NTMWD service area and the water is expected to be of high quality. The ability to use up to 175,000 AFY of water from the LBCR would give NTMWD flexibility, allowing it to make efficient use of LBCR during relatively wet times. During drier periods, other sources of water would be used to a greater extent. In all cases, NTMWD would need to balance the needs for reliable water supply, costs, water quality, water rights, and agreements when operating its system.

LBCR would provide lake-based recreational opportunities, such as boating, fishing, water-skiing, swimming, and other water sports. NTMWD would collaborate with county and state authorities to facilitate development of recreation infrastructure (e.g., docks, marinas, beaches, campgrounds, access roads, utilities) at the LBCR. At this stage, no specific facilities, activities, designs or locations have been chosen.

2.3 ALTERNATIVE 2 – DOWNSIZED LBCR WITH BLENDING

In response to comments, and in the interest of investigating alternatives that might result in reduced impacts to waters of the U.S. and to the environment in general, USACE analyzed the potential yield and impacts of a reduced size reservoir as a water supply supplemented with blended water from Lake Texoma. This alternative is referred to as Alternative 2 in this document. The dam would be located at the same site as Alternative 1, the proposed full-scale LBCR project (Kiel, 2015a; Kiel, 2016b).

The estimated 86,100-AFY firm yield from a downsized LBCR would provide insufficient water to meet the identified purpose and need of the Proposed Action (105,804 AFY by 2025). However, if water from this smaller version of LBCR were to be blended with water from Lake Texoma, the yield would be sufficient to meet the purpose and need. Water from the proposed LBCR is expected to have an acceptable Total Dissolved Solids (TDS) concentration. The firm yield of 86,100 AFY of water from the smaller LBCR could be blended with 28,700 AFY of Lake Texoma water with elevated TDS concentrations at a ratio of three parts LBCR water to one part Lake Texoma water (3:1). This would result in a combined reliable supply of 114,800 AFY, greater than the 105,804 AFY need established in Chapter 1. Alternative 2 would therefore consist of three main elements: 1) a smaller dam and reservoir at the same LBCR site as Alternative 1, 2) a new raw water pipeline from LBCR to a new WTP at the same site as Alternative 1 (Figure 2.3-1), and 3) a new raw water pipeline from Lake Texoma to the new WTP.

NTMWD originally estimated that 2025 would be the earliest year that water could be available from a smaller LBCR. This time frame would allow for project design modifications; for amendments to the NTMWD water right application to TCEQ; for TCEQ's technical review of the smaller project; and for changes to the proposed project mitigation.

However, a more recent, more in-depth analysis suggests that December 2026 is a more realistic date for project completion than 2025 (Thornton and Rochelle, 2016). This is mostly due to the time required to amend the existing LBCR Water Right Permit No. 12151 with TCEQ to authorize the smaller footprint version of LBCR. Permit 12151 contains very specific conditions linked not only to the full-sized LBCR conservation storage level, 534 feet MSL, compared to 515 feet MSL for the smaller LBCR, but also to the quantity of diversions from LBCR, particularly when diversions reach 100,000 AFY. Permit 12151 Special Condition 6.O. provides that "[s]ubsistence flow requirements apply when storage is less than 40% of the authorized conservation storage." This condition was included based on the conservation storage level of 534 feet MSL. TCEQ would need to determine whether the percentage of authorized conservation storage needs to be adjusted for the environmental flow requirements based on the new conservation storage level of 515 feet MSL for the smaller LBCR, and may issue a permit amendment (Thornton and Rochelle, 2016).

Under another Special Condition (6.U.), NTMWD must conduct instream monitoring of Bois d'Arc Creek downstream at various intervals after reservoir impoundment. These monitoring requirement intervals continue until diversions reach 100,000 AFY. Reducing the size of the LBCR renders Special Condition 6.U. obsolete, because the firm yield would only be 86,100 AFY; thus, 6.U. would need to be modified and amended commensurate with the smaller reservoir size and diversions. Similarly, the mitigation requirements for LBCR in Permit 12151 are specific to the full-sized reservoir and would have to be revisited. Additional studies, surveys, and analyses would be needed to support the application for an amended permit, and the application may be protested by various stakeholders, a process which could considerably delay the issuance of the amended Water Use Permit.

A completion date of late 2026 is close enough to the 2025 criterion in the purpose and need statement that it is reasonable to consider this alternative more thoroughly in this EIS. However, in the subsequent Section 404 permit decision-making process, in determining the LEDPA in accordance with the 404(b)(1) Guidelines, the completion date is one of the factors that will be considered in determining the practicability of Alternative 2. See Figure 1.3-1 for a diagram of the factors taken into account in evaluating practicability during Section 404 permitting.

2.3.1 Dam and Reservoir

Alternative 2's smaller reservoir would have a conservation pool elevation at elevation 515 feet MSL, and would have a storage capacity of 135,200 AF and a surface area of approximately 8,600 acres, approximately half the acreage of Alternative 1. Figure 2.3-1 shows the configurations of the downsized and full-sized LBCR alternatives at their respective conservation pool elevations of 515 and 534 feet MSL.

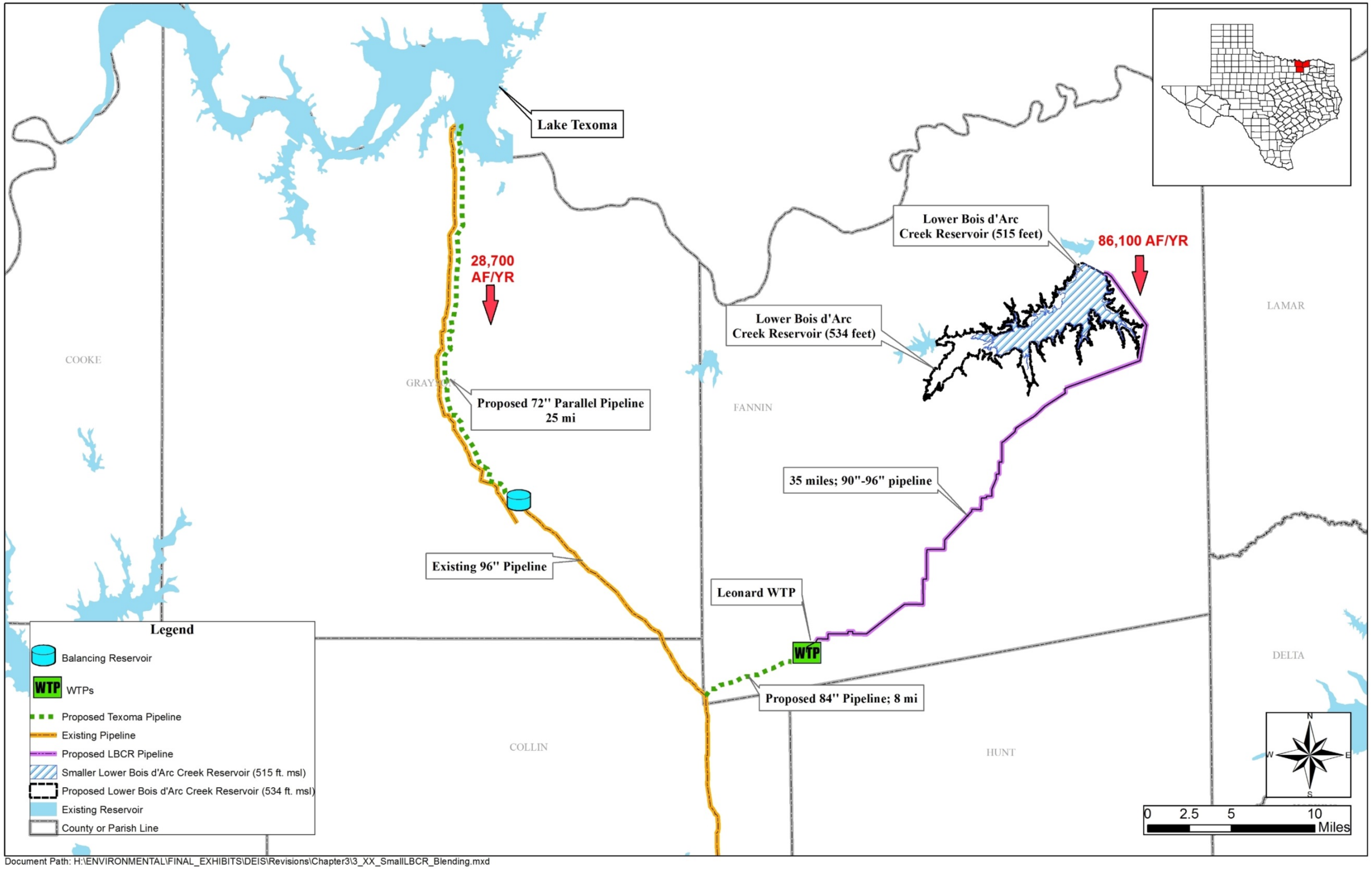


Figure 2.3-1. Alternative 2, Major Components of Downsized Lower Bois d'Arc Creek Reservoir with Lake Texoma Blending

Source: Kiel, 2016b

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The footprint of the dam is assumed to be similar in size and at the same location as Alternative 1. There would be a small reduction in dam height and corresponding footprint, but the dam would still need to be able to contain the PMF. Based on engineering judgment, it is estimated that the dam footprint would be about 90-100 percent of the size of the dam footprint for Alternative 1, although the reservoir footprint would be significantly smaller for Alternative 2 than for Alternative 1. The limit of construction for Alternative 2 is estimated at 9,390 acres (Kiel, 2016b), slightly more than half that of the full-sized LBCR (Alternative 1). Instream flow requirements for Bois d'Arc Creek downstream of the reservoir, specified in the Texas water right permit for the full-sized LBCR, would also apply to the smaller LBCR. The firm yield of this downsized version of the LBCR would be approximately 86,100 AFY of water, or approximately 68 percent of the 120,665 AFY yield of Alternative 1 (Kiel, 2015a).

2.3.2 Service Spillway and Outlet Works

The service spillway and outlet works for Alternative 2 would be slightly smaller versions of those proposed for Alternative 1. The service spillway for Alternative 2 would be located at the right abutment of the dam, as shown in Figure 2.2-5 for the full-sized dam. The spillway depicted in Figure 2.2-8 would include an approach channel, an uncontrolled concrete labyrinth weir, a chute, a hydraulic jump stilling basin and an outlet channel. Required low-flow releases would be made through a low-flow outlet. The weir would consist of a concrete gravity, labyrinth-type section. The crest of the weir would control the conservation pool level at elevation 515.0 feet MSL.

The spillway structure would extend downstream from the dam and discharge into Honey Grove Creek. A hydraulic jump stilling basin would be constructed with baffle blocks and an end sill. Service spillway discharges would be conveyed to Honey Grove Creek by a discharge channel and then flow approximately 1,500 feet in Honey Grove Creek to its confluence with Bois d'Arc Creek.

Water would be diverted by NTMWD through a multi-level intake tower located near the dam that would transport the water to a pumping station located immediately downstream of the dam. The intake structure would be a rectangular tower with two cells, each of which would have the capacity to withdraw water for the needed water supply demands as well as for the releases of water required for base and subsistence flows for Bois d'Arc Creek. Under normal operating conditions, both cells would be used concurrently and would feed a pair of concrete pipes that would carry water through the dam embankment to the pumping station. Diversions could occur through a single cell when the other is closed for maintenance, but this operation is not planned to occur during times of high demand.

Required low-flow releases would pass from the reservoir through the multi-level intake tower and low-level outlet works to be discharged to the service spillway chute. Higher velocity pulse flows would be released from the reservoir through multiple levels of sluice gates located in the service spillway.

An emergency spillway would also be located in the right abutment of the dam (see Figure 2.2-5). The service spillway would be sized to contain a 100-year storm such that no flow would pass through the emergency spillway.

2.3.3 Reservoir Clearing

Reservoir clearing for Alternative 2 would be similar to Alternative 1, though on a somewhat smaller scale due to the downsized dimensions of the reservoir footprint. Subject to the provisions of the Section 404 permit, revised Texas water right permit and Section 401 water quality certification, selected trees and shrubs would be cleared from the reservoir footprint prior to impoundment of water behind the dam. Standing woody material, including dead and living trees and shrubs five feet or more in height, as well as fallen trees five feet or more in length with a diameter of six inches or greater, would be cleared and removed. Figure 2.3-2 shows vegetation cover types within the footprint of the Alternative 2 smaller reservoir.

NTMWD prepared first a preliminary Reservoir Clearing Plan and then a Conceptual Clearing Plan to guide the reservoir footprint clearing process. Under Alternative 2, both plans would be revised to account for the downsized reservoir footprint. The objectives of these plans would remain the same: to enhance creation of fish habitat by minimizing the clearing of standing trees and shrubs in selected areas within the reservoir; to improve human access to shore locations by creating shore access locations for boat ramps and bank fishing through selective clearing of trees and shrubs; to reduce hazards to boating safety and fishing resulting from large floating debris by minimizing the source of such debris; and to create aesthetic views of the reservoir along selected segments of the shoreline.

Both hand and machine clearing would be used under Alternative 2. The preferred method is mechanical clearing by shear-blading during the dry season. Under this method, the cleared material would be deposited in windrows or piles and left to dry and eventually burned as fire danger conditions allow. Machine clearing has the advantage of shearing stumps off at ground level, along with all other vegetation. It also accumulates most of the loose and dead woody debris that is on the forest floor. Machine clearing would minimize the amount of woody and organic debris remaining on site and entering the water after reservoir flooding.

Mechanical methods would be used in clearing except for the following sites:

- Cultural sites within the areas identified for mechanical clearing would receive different treatment, as appropriate, determined on a case by case basis (see Cultural Resources, Section 3.14).
- Selected locations that may be designated by the NTMWD for tree salvage (for use as firewood, saw-logs, cabins, etc.), would be hand cleared using chain saws or other appropriate timber harvesting machinery.

It may also be necessary to utilize hand clearing where it is not possible to operate mechanical clearing equipment due to site location or conditions.

Access and safe landing sites would be established along the reservoir shoreline to facilitate eventual lake-based recreational development. Consideration would be given to both wood salvage and environmentally sensitive areas that may require specific treatment during clearing operations. Flagging or marking of clearing boundaries and on-site supervision would be carried out for the successful implementation of all aspects of reservoir clearing.

After impoundment, large woody debris would continue to be removed as necessary for the safe operation of boats, boat ramps, swimming areas, water intake structures, and spillways (NTMWD, 2015b).

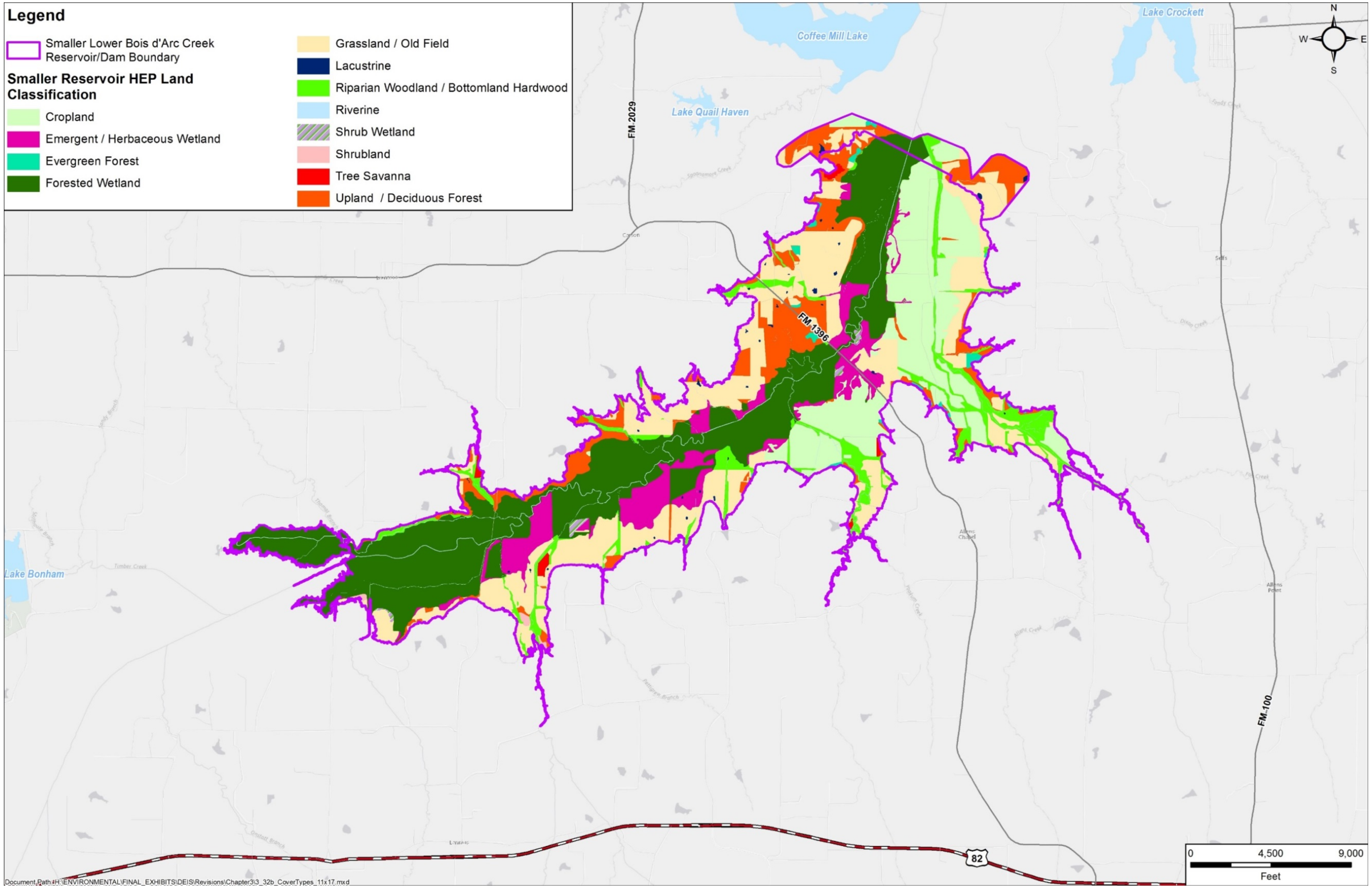

Figure 2.3-2. Existing Vegetation Cover Types within the Alternative 2 Reservoir Footprint

Source: Kiel, 2016b

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2.3.4 Road Realignment and Bridge Construction

Construction of the downsized LBCR under Alternative 2 would also impact FM 1396 and the bridge over which it crosses Bois d'Arc Creek. NTMWD would be responsible for replacing the road and bridge. As noted for Alternative 1, the existing alignment of FM 1396 spans Bois d'Arc Creek at what would become one of the widest portions of the smaller reservoir. If the existing alignment was maintained and a new, longer bridge was constructed to span the reservoir at this location it would likely interfere with possible recreational uses on the proposed reservoir. As discussed in Section 2.3.4, NTMWD examined several options to relocate FM 1396 and build a new bridge crossing the proposed LBCR. NTMWD's preferred option would be to extend the existing rural road FM 897 two to three miles to the west of FM 1396 and build an entirely new bridge over the reservoir along that alignment. The existing FM 1396 and bridge crossing over Bois d'Arc Creek would be abandoned and inundated by LBCR.

The principal difference between Alternative 2 and Alternative 1 is that the new bridge on FM 897 spanning the reservoir would be slightly shorter (because the smaller reservoir would not be quite as wide) and the portion of the new paved road on FM 897 would be relatively longer. However, the total length of the FM 897 extension and new bridge as a replacement for FM 1396 and the existing bridge would be essentially the same under Alternatives1and 2.

2.3.5 Raw Water Transmission, Storage, and Treatment Facilities

Under Alternative 2, NTMWD would construct raw water transmission facilities that would be essentially the same as those for Alternative 1, though in some instances on a slightly smaller scale. The 35-mile long raw water transmission line, for example, would be a 90-inch diameter pipeline under Alternative 2 compared to a 90 to 96-inch diameter pipeline for Alternative 1. Locations and alignments would be virtually identical between the two alternatives.

As with Alternative 1, under Alternative 2 these facilities would be part of an overall system of raw water storage, transmission, treatment, and treated water transmission facilities that would ultimately provide water to the growing northern section of NTMWD's service area. These proposed facilities include a raw water intake pumping station and electrical substation at the reservoir site and approximately 35 miles of 90-inch diameter raw water pipeline. Figures 2.2-10 through 2.2-17 and 2.3-1 show the location of the proposed raw water transmission pipeline as well as ancillary and associated facilities, including the proposed pumping station, electrical substation, TSR, TSR outfall, WTP, and rail spur on the WTP site.

Intake Pumping Station

Since raw water flowing through the 35 miles of 90-inch diameter pipeline must move uphill for part of the distance, it will not flow on its own due to the force of gravity, and must be pumped. Thus, a pumping station with several pumps would be built close to the proposed dam site at the point of water withdrawal through the intake facilities (Figures 2.2-10 and 2.2-11). Each pump would require an approximately 6,000-hp motor. The dimensions of the raw water intake pumping station site would be up to 310 feet x 375 feet in size, or approximately 2.7 acres. The pumping station would be located within the original proposed footprint of the proposed dam and spillways associated with the reservoir.

Electrical Substation

In Alternative 2, as in Alternative 1, a new dedicated, 138kV – 6.9kV, low-resistance grounded substation housing two transformers would be required to power the 6,000-hp motors in the pumping station. The new electrical substation would be built near the southern end of the proposed LBCR dam site, next to the proposed pumping station (Figure 2.2-11). The 138kV distribution line would potentially parallel the pipeline easement between the substation and the pumping station. The electrical substation site would be up to 325 feet x 325 feet, or approximately 2.4 acres. It would be constructed within the footprint of the proposed dam and spillways associated with the reservoir.

Raw Water Pipelines

Under Alternative 2, as in Alternative 1, NTMWD would build a pipeline to convey raw water from the proposed reservoir site to the proposed North WTP site west of Leonard (Figures 2.2-10 and 2.3-1). The proposed route and construction process under Alternative 2 would be identical to Alternative 1, but the pipeline would be slightly smaller in diameter (90 inches compared to 90 to 96 inches in diameter for Alternative 1). See Section 2.2.5.3 for a more detailed description of the construction process and procedures, including stream and road crossings. Pipeline construction would occur concurrently with dam construction.

Under Alternative 2, a second raw water pipeline would be constructed to carry water from Lake Texoma to blend with LBCR water at the North WTP (Figure 2.3-3). This alternative would entail constructing a new 72-inch, 25-mile pipeline carrying raw water from Lake Texoma to the Texoma Balancing Reservoir (uppermost green dots in Figure 2.3-3), parallel to the existing NTMWD Lake Texoma raw water pipeline. From there, raw Texoma water would utilize the existing 96-inch pipeline toward the proposed North WTP pipeline spur (yellow solid line). The proposed pipeline spur (green dots) connecting the existing Texoma to Wylie raw water pipeline with the proposed North WTP would be 84 inches in diameter and eight miles long, with a capacity of 70 mgd. These features are also shown in Figure 2.3-4.

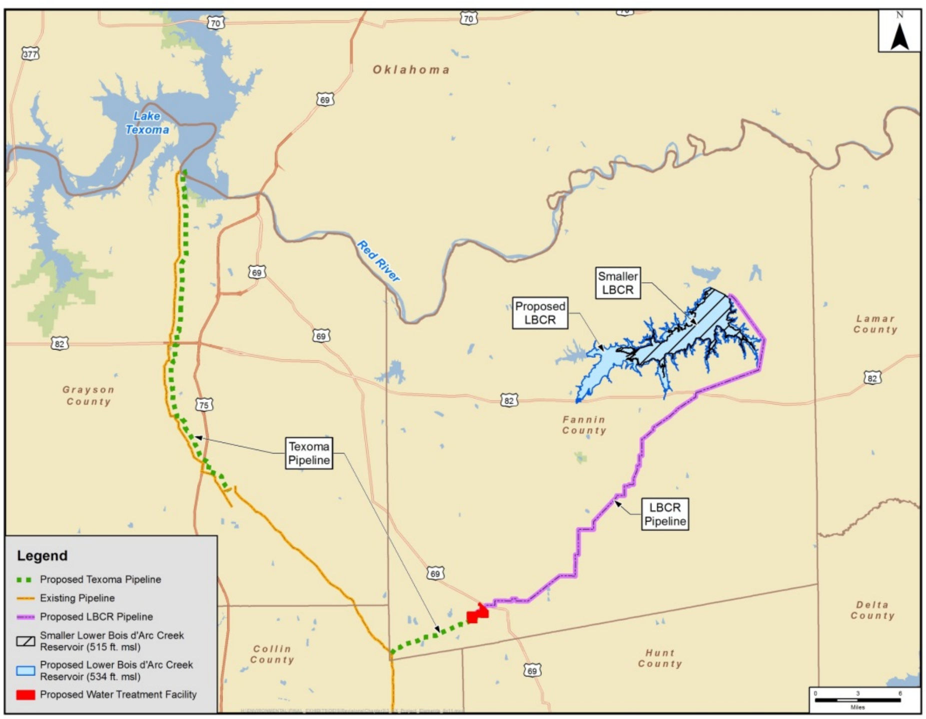

Figure 2.3-3. Proposed Raw Water Pipelines Carrying Lake Texoma Water for Blending with Water from the Downsized LBCR (Alternative 2) at the North WTP

Note: Alternative 2 would entail constructing a new 72-inch, 25-mile pipeline carrying raw water from Lake Texoma to the Texoma Balancing Reservoir (upper segment with green dots). From there, raw Texoma water would utilize the existing 96-inch pipeline to the proposed North WTP pipeline spur (green dots). The proposed pipeline spur would be 84 inches in diameter and 8 miles long, with a capacity of 70 mgd.

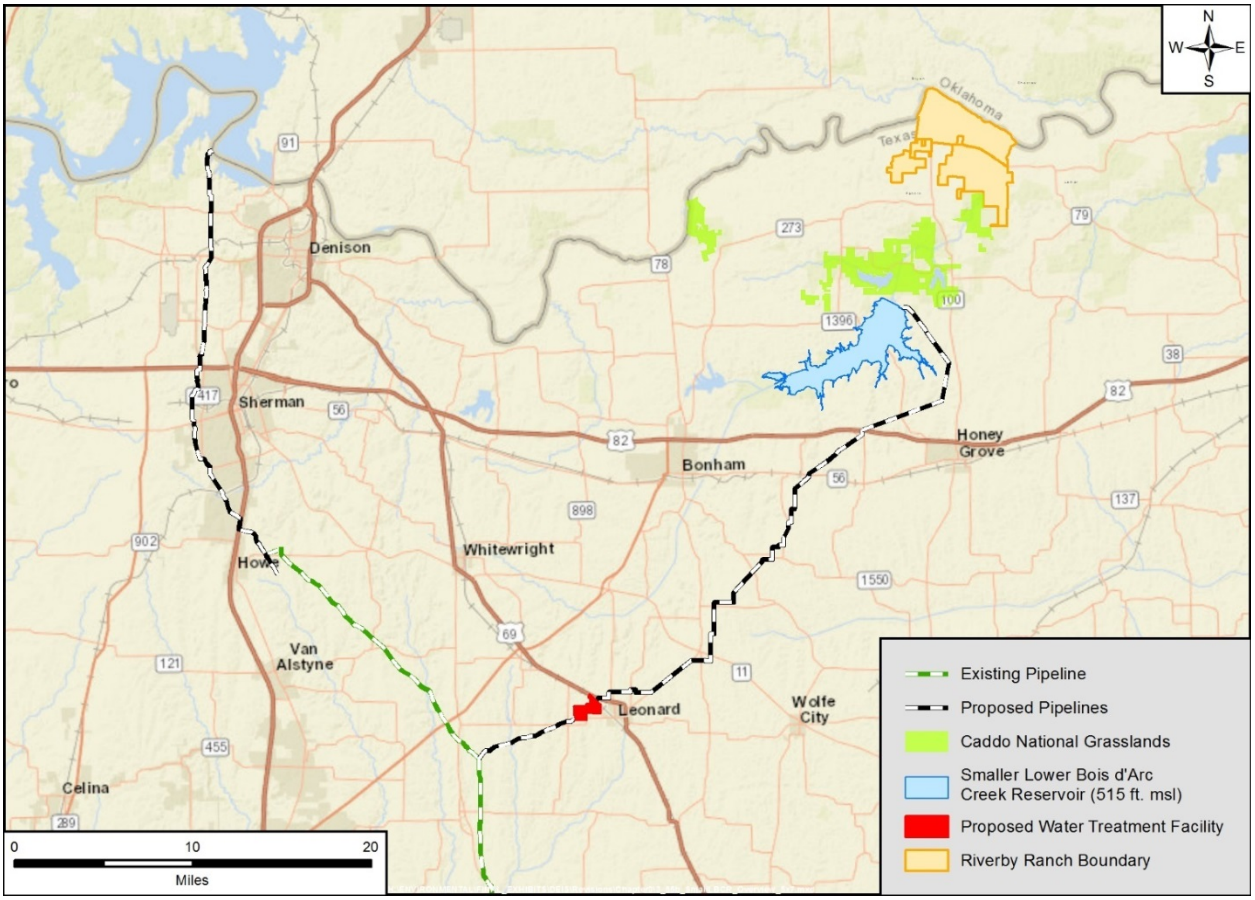

Figure 2.3-4. Proposed Pipelines for Alternative 2

Source: Kiel, 2016b

North Water Treatment Plant

Under Alternative 2, raw water from the downsized reservoir would be treated at the same proposed WTP site as in Alternative 1, which would be constructed just west of the town of Leonard, TX, (Figures 2.2-10, 2.2-12, and 2.3-3). See Section 2.2.5.4 for a more detailed description and diagrams of this site and its proposed facilities, the North WTP and accompanying TSR and overflow structure.

Rail Spur

In Alternative 2 as in Alternative 1, a rail spur would be constructed from the Missouri-Kansas-Texas Railroad located north of the TSR site; its terminus would be the proposed WTP site (Figures 2-16 and 2.2-17). The rail spur would be entirely located on property already owned by NTMWD. The proposed rail spur would be used to transport materials and supplies to the WTP. As in Alternative 1, under Alternative 2, the rail spur would be approximately 6,600 feet in length (1.25 miles) and the grading limits would be approximately 7.2 acres.

At a capacity of 70 mgd, it is estimated that the WTP would use slightly more than two tons of chlorine per day for the purpose of water disinfection. It is estimated that this would require a delivery of one train approximately every six weeks once the WTP is in operation; actual chlorine demand would be determined upon start-up testing. As noted above, chlorine is a hazardous material and but the rail spur will be designed to comply with all safety requirements for transporting chlorine (Kiel, 2016a; Kiel, 2017).

Project Construction Schedule

The construction phase of Alternative 2 (including all components) would likely last almost as long as Alternative 1, which was estimated to last three to four years (Figure 2.2-18). Construction would begin first on the dam and FM 897 (replacement of the FM 1396 road and bridge). Construction of the pumping station, TSR, WTP, and raw water pipeline would start about one year later. With anticipated delays from having to modify specific conditions in the Water Use Permit with TCEQ, it is estimated that Alternative 2 could not provide water for NTMWD before 2026 (Kiel, 2016b; Thornton and Rochelle, 2016).

2.3.6 Reservoir Operation

Under Alternative 2, as in Alternative 1, year-to-year and seasonal operation of the reservoir would be governed by an operation plan. The Alternative 2 operation plan would be similar to that already drafted for the Proposed Action, Alternative 1 (NTMWD, 2017). In general, Alternative 2 would impound up to 135,200 AF of water and produce an estimated firm yield of 86,100 AFY, an average of 108 mgd. The conservation pool, or normal water surface, of the reservoir would be maintained at an elevation of 515.0 feet MSL, though actual water surface and shoreline would fluctuate above and below this level.

In a typical year, the reservoir would be fullest in May and June. Reservoir elevations would typically drop during the drier months of late summer due to less precipitation and in-flow and more surface evaporation, with the lowest elevations typically occurring in September and October. However, the water levels are also related to extended periods of dry conditions versus wet conditions, as well as seasonal variations.

Under Alternative 2, the reservoir would be operated in compliance with a state water right. As mentioned above, specific conditions in the Water Use Permit issued by TCEQ on June 26, 2015 would need to be revised to authorize operation of a downsized LBCR. In addition to diversions for water supply, a revised permit would require inflows to the reservoir to be passed through the LBCR Dam to Bois d'Arc Creek for downstream senior water rights and environmental flows, as in Alternative 1.

The environmental flow releases incorporated into the Water Use Permit already held by the NTMWD for Alternative 1 (the Applicant's Proposed Action) are based on the instream flow needs analysis and subsequent discussions with the TCEQ, and they are summarized in Table 2.2-2. These provisions would need to be revisited by TCEQ if Alternative 2 was selected for Section 404 permitting by the USACE; however, any modified provisions and conditions of a revised Water Use Permit would retain the mandate of providing for downstream water quality, quantity, and aquatic habitat. Under Alternative 2, approximately 34,500 AFY of additional water would flow downstream past the LBCR impoundment than in the case of Alternative 1. Much of this aggregate volume would be during high, ephemeral flows associated with storm events rather than during longer base flow periods. There would be ample opportunity to manage these flows for the benefit of instream conditions between the dam site and the confluence with the Red River, although not during periods of extremely low or environmental flows. At these times, as in the case of Alternative 1, environmental flows from the downsized reservoir would probably provide for limited instream habitat, but not for adequate water quality.

Under normal reservoir operations, it is anticipated that the full 86,100-AFY firm yield of the downsized LBCR would be 100 percent utilized within two to three years of its completion (i.e., by about 2028, see Figure 2.2-20), excluding the recommended reserve supply. If the recommended reserve supply is included, NMTWD's water need would already exceed the downsized LBCR's firm yield even before the reservoir's completion.

However, Alternative 2 includes an additional 28,700 AFY of blended Lake Texoma water, for a combined reliable supply of 114,800 AFY. Thus, Alternative 2's water supply would be fully utilized by approximately 2031 if the recommended reserve supply is excluded, and by 2026 – the year construction on the project is expected to be completed – if the recommended reserve supply is included.

Under Alternative 2, as under Alternative 1, some of the factors that could affect the operation of the downsized reservoir as part of NTMWD's water supply system include:

- Climatic conditions. During relatively wet times, NTMWD may decide to use less imported water if Lake Lavon is full, reducing power consumption costs.
- Available infrastructure. Initially, complete use of the LBCR may be limited by treatment and distribution capacity. At times, use of the LBCR could increase if another reservoir or other water transfer facilities are out of service which would limit the use from other supply sources.
- Other future water sources. As NTMWD adds more sources of supply to its system, the operation of the downsized LBCR with Texoma blending may change to accommodate the use of those other supplies, particularly if those sources are treated at the North WTP.

Under drought year conditions, demands on the downsized reservoir would likely be higher. Depending upon the conditions of NTMWD's other water sources, LBCR water levels, and locations of demands on NTMWD's system, the diversions from LBCR could increase to the maximum amount allowed from the smaller reservoir.

As was noted for Alternative 1, there are various potential operational options for the downsized LBCR under Alternative 2. Actual operation of the reservoir would depend on the extent of development of the NTMWD system, overall customer demands within the system, and local demands in Fannin County. As an example of other policies that might be used, the full permitted diversion from LBCR might be used even when the reservoir is drawn down two feet below the conservation pool level if NTMWD system demands are located close to available supplies and if new sources are being developed that would allow reduced diversions from LBCR in later years. NTMWD currently has six major sources of water (Lakes Lavon, Texoma, Chapman and Tawakoni and reuse at Wilson Creek and the East Fork), and anticipates adding several more over the next few decades.

Under Alternative 2, the downsized LBCR would also provide lake-based recreational opportunities, including boating, fishing, water-skiing, swimming, and other water sports. NTMWD would cooperate with county and state authorities to facilitate development of recreation infrastructure (e.g., docks, marinas, beaches, campgrounds, access roads, utilities) at the downsized LBCR. At this time, there are no plans for specific facilities, activities, designs or locations.

2.4 NO FEDERAL ACTION ALTERNATIVE

The No Action Alternative is one which results in no construction requiring a Corps permit. It may be brought about by 1) the applicant electing to modify its proposal to eliminate work under the jurisdiction of the USACE permit, or 2) the denial of the permit (33 CFR 325, Appendix B, 9.b(5)(b)).

In terms of the applicant's proposed project, there is no way to modify the proposal to eliminate the need for Section 404 authorization. Consequently, the No Action Alternative analyzed stems from the possible denial of the permit application.

Section 1502.14(d) of the Council on Environmental Quality's (CEQ) Regulations for Implementing the National Environmental Policy Act (NEPA) requires the alternatives analysis in the EIS to "include the alternative of no action." While there is more than one interpretation of "no action," depending upon the nature of the proposal being evaluated, in the present instance of a federal decision on a proposal for a project – whether or not to issue a Section 404 permit for the LBCR – "no action" means that the proposed activity would not take place. Thus, the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity (CEQ, 1981).

In this EIS, the No Action Alternative consists of not building the proposed Lower Bois d'Arc Creek dam and reservoir. In the Environmental Consequences sections of Chapter 4, the results of the No Action Alternative will be compared to the results of proceeding with the Proposed Action. In some ways, describing the results of the No Action Alternative is the same as describing the affected environment, because there will be no change from existing conditions. In other ways, however, as a result of ongoing ecological, economic and social trends and processes, the environment can be expected to change even in the absence of the proposed dam and reservoir.

It is important to specify that "existing conditions" refer to those that existed either in 2008, when the application for the Section 404 permit was first submitted, or in 2016, when additional surveys were conducted using the Hydrogeomorphic (HGM) approach. Based on the USACE's ongoing experience with this project, land use practices and habitat conditions have remained relatively constant. Therefore, the reservoir habitat evaluation using HEP (the Habitat Evaluation Procedure mentioned in Chapter 1 and described in more detail in Chapter 3) and the jurisdictional determination studies conducted in 2007-2008 remain applicable. These studies, along with the HGM field surveys conducted in 2016 constitute the baseline for evaluation of the No Action Alternative.

Analysis of the No Action Alternative in this EIS does not include any speculative action that NTMWD might undertake if the Section 404 permit was denied. CEQ indicates that when a choice of "no action" by the decision-making agency would result in predictable actions by others, then this consequence of the "no action" alternative should be included in the analysis. CEQ further provides the example of denial of permission to build a railroad to a facility; if this denial would then lead to construction of a road instead, and thus, increased truck traffic, CEQ stipulates that the EIS should analyze this consequence of the "no action" alternative (CEQ, 1981). However, at the present time, NTMWD does not have a viable back-up option to the proposed reservoir.

The impacts of the No Action Alternative are assessed by resource in Chapter 4 of this EIS.

2.5 ALTERNATIVES DISMISSED FROM DETAILED CONSIDERATION

Other alternatives were evaluated but are not carried forward for detailed consideration in the EIS. These include alternatives that do not require a Section 404 permit, alternatives that are not available to the applicant, and other alternatives that are available to the applicant. Summaries of these are included below, and more detailed discussion and the reasons for not carrying them forward for assessment in the EIS are included in Appendix O, "Alternatives Dismissed from Detailed Consideration."

2.5.1 Alternatives that Do Not Require a Section 404 Permit

Three alternatives – new groundwater supplies, desalination, and water conservation – would not have required NTMWD to apply for a Section 404 permit because they do not entail placing fill into waters of the United States under USACE jurisdiction.

New Groundwater Supplies

Under Senate Bill 2, passed in 2001, Texas began a groundwater Joint Planning effort. Previous groundwater regulation was strictly limited to the jurisdiction of the individual Groundwater Conservation Districts (GCDs). TWDB's Joint Planning effort created 16 Groundwater Management Areas (GMAs) in Texas based on hydrogeologic and aquifer boundaries; GMAs are intended to provide management guidance over common aquifers. The GMAs are comprised of the GCDs that fall within the boundary of the GMA. GMA 8 covers all of Region C except for Jack County, Henderson County, and a small portion of Navarro County (Region C Water Planning Group, 2010).

The GMAs are responsible for developing Desired Future Conditions (DFCs) for aquifers within their respective areas. DFCs are defined in the Texas Administrative Code as the desired, quantified condition of groundwater resources (such as water levels, water quality, spring flows, or volumes) for a specified aquifer within a management area at a specified time or times in the future. TWDB then quantifies Managed Available Groundwater (MAG) based on the DFCs provided by the GMAs. The MAG is the amount of groundwater that models predict may be produced under a permit to meet the DFC established by the GMA for that particular aquifer.

In Texas water planning, groundwater use cannot exceed MAG values. The GMAs have adopted the MAG values and they are included in the 2016 regional water planning process. For the 2011 regional water plans, only a few GMAs had adopted MAG values prior to the development of the plans. Consequently, water that may have been shown as available in the 2011 regional water plans may not be available at present.

The *2011 Region C Water Plan* identified two potential groundwater sources for NTMWD: 1) Roberts County groundwater from the Ogallala Aquifer, and 2) Brazos County groundwater from the Carrizo-Wilcox Aquifer. At present, neither of these projects is viable. Neither is listed as a recommended or alternative strategy in the *2016 Region C Water Plan* (Region C Water Planning Group, 2015).

Roberts County Ogallala Aquifer Groundwater Alternative

Roberts County is located in the panhandle of Texas. Prior to 2011, Mesa Water, Inc. controlled rights to groundwater in Roberts County with options for additional supply and had permits from the local groundwater conservation district to export groundwater. Mesa Water had been interested in selling groundwater from the Ogallala Aquifer in Roberts County to water suppliers in North Texas. Mesa Water sold these rights to the Canadian River Municipal Water Authority on June 23, 2011. With the completion of this sale, this water supply alternative is no longer available to NTMWD.

Brazos County Carrizo-Wilcox Aquifer Groundwater Alternative

The Carrizo-Wilcox Aquifer covers a large area of east, central, and south Texas, including Brazos County. Brazos County is about 150 miles from the NTMWD service area. Because of this distance over which a pipeline would have to be built and operated, including pumping costs, this alternative is a relatively expensive source of supply for the NTMWD. Moreover, the Bureau of Economic Geology (BEG) has identified a potential conflict for the Carrizo-Wilcox Aquifer in Brazos County in 2020 because the sum of the county's currently available supplies and water management strategies exceeds the MAG in that year (BEG, 2011). MAG values are smaller than previous estimates of availability and the water supply potentially available for export from the Carrizo-Wilcox Aquifer in Brazos County is thus reduced.

Overall, due to high cost considerations, uncertain availability, and competition for this water source, the Carrizo-Wilcox groundwater alternative is not considered a viable alternative to the Proposed Action.

Freestone and Anderson Counties Carrizo-Wilcox Aquifer Groundwater (Region I)

The *2016 Region C Water Plan* notes that development and export of water supplies from Freestone, Anderson, and surrounding counties has been under study, and that Dallas Metroplex wholesale water suppliers have been approached as possible customers (Region C Water Planning Group, 2015). The 2016 plan shows Carrizo-Wilcox groundwater from Freestone/Anderson counties as an alternative strategy for NTMWD. The quantity potentially available to NTMWD is listed as 42,000 AFY.

More recent analysis casts doubt on whether 42,000 AFY would be available from this alternative. The amount of water that could be permitted from both the Carrizo-Wilcox and Queen City aquifers under the current MAG value is about 21,000 AFY, only half of the proposed total quantity for this strategy. With the current MAG values, it is unclear whether this well field could be permitted without changes to the DFCs.

In conclusion, groundwater from Freestone and Anderson counties does not meet the quantity criterion of the purpose and need and may not meet the timeframe criterion either. Thus, this alternative is not considered a reasonable alternative.

Other Groundwater Supplies in Region C

Two major aquifers and four minor aquifers supply groundwater in Region C. The two major aquifers are the Trinity and the aforementioned Carrizo-Wilcox. The four minor aquifers are the Woodbine, Queen City, Nacatoch, and locally undifferentiated formations referred to collectively as the "other aquifer." The Nacatoch and Queen City aquifers are known to have limited supplies and water quality issues, and therefore are not utilized extensively.

In all of Region C, an estimated 146,152 AFY of groundwater is hypothetically available in perpetuity, which is more than the estimated firm yield of 120,665 AFY for the proposed LBCR. However, many providers and users already compete for this water, and little additional water supply is actually available from Region C aquifers. In addition, the TCEQ has designated a ten-county area within Region C as a priority groundwater management area (PGMA) due to excessive declines in groundwater availability in the region. Overall, there is little groundwater available to NTMWD for future development in Region C and the surrounding region.

In conclusion, groundwater supplies in general, including aggregate supplies from a number of potential sources from major and minor aquifers over a widespread geographic area, do not represent a reasonable alternative for NTMWD. The quantities potentially available are insufficient to meet the purpose and need, these quantities may be subject to reduction to conform with MAG values, and there is growing competition among users for these constrained groundwater supplies.

Desalination

Desalination of Lake Texoma Water

As described in Chapter 1 of this EIS, Lake Texoma is a 2.5 million acre-feet reservoir which straddles the Texas –Oklahoma border on the Red River. This large lake was built and is owned and operated by the USACE. It serves four important functions: flood control, hydropower, water supply, and recreation. The water in Lake Texoma is shared by the states of Texas and Oklahoma (Water Data for Texas, 2016).

Water in the upper reaches of the Red River, as well as from Lake Texoma itself, has naturally-occurring high concentrations of dissolved salts. Thus, if this water is to be used for municipal and drinking water purposes, it requires either advanced treatment (desalination) or blending with freshwater sources.

Lake Texoma's brackish water would be desalinated using reverse osmosis water treatment or another similar treatment method. Reverse osmosis is an expensive and energy-intensive process. Desalination can result in losses of up to one-third of the raw supply to the treatment process and requires disposal of large quantities of highly saline water. Disposal options include deep injection wells, discharge to a stream or the ocean, or evaporation ponds. Each of these disposal options would require additional environmental studies of potential impacts.

Desalination is also a more expensive strategy than blending, and there are considerable uncertainties in the operation and long-term costs of a large-scale desalination facility. The estimated costs for desalination of water from Lake Texoma are based on current cost information for large desalination facilities. According to the *2016 Region C Water Plan*, the cost of desalination is more than four times the cost for water from LBCR: $7.20 per thousand gallons for desalination versus $1.55 per thousand gallons for LBCR. However, because the method, cost, and regulatory requirements of brine disposal for such a facility are uncertain these costs should be regarded as more uncertain than other cost estimates developed for the potential alternatives.

Due to this uncertainty, brine disposal has the potential to significantly increase both the estimated cost for desalination and the time required to bring it online. Deep well injection would probably require multiple sites to accommodate the quantity of discharge required, and large-volume discharges of brine to surface water would be difficult to permit. Building a pipeline for disposal in the ocean would be prohibitively expensive due to its length and would still require analysis of environmental impacts. Detailed studies to better quantify the cost estimates and feasibility would be required if a large-scale desalination strategy is pursued.

In conclusion, the Lake Texoma desalination alternative is not a reasonable alternative. It fails to meet both the time and quantity elements of the purpose and need (see Appendix O for more detailed discussion of these issues). While Lake Texoma is a reliable source of water for which NTMWD already has a substantial water right, and while environmental impacts at the site of withdrawal and along pipeline routes would be relatively small, the fact that this alternative could only deliver an estimated 97,000 AFY of water and not until at least 2030 disqualifies it from further consideration in this EIS.

Desalination of Gulf of Mexico Seawater

The State of Texas has sponsored initial studies of potential seawater desalination projects, which may be a future supply source for the state in general. However, as noted above, desalination continues to be both costly and energy-intensive. If fossil fuels such as coal or natural gas are used to generate the electricity to power the desalination process, this would: 1) contribute to the cumulative depletion of fossil fuels; 2) contribute to localized air pollution from criteria pollutants such as particulates, sulfur dioxide, nitrogen oxides, and volatile organic compounds, and possibly the toxic heavy metal mercury; and 3) emit carbon dioxide (CO_2), thereby contributing in a small but non-trivial way to the cumulative buildup of this greenhouse gas in the atmosphere.

Furthermore, because of the long distance from NTMWD's service area to the Gulf of Mexico (about 300 miles), and the subsequent cost of laying and operating a pipeline over this distance, seawater desalination is not a viable source of water supply for NTMWD. While the water supply from seawater desalination is essentially unlimited, this is a high energy use strategy and the unit cost is much higher than the cost of other water management strategies for NTMWD – $8.46 per thousand gallons for treated water – more than five times as expensive as LBCR (Region C Water Planning Group, 2015). Thus, this is not a reasonable alternative to the Proposed Action.

Conservation

In the *2016 Region C Water Plan*, conservation is a recommended water management strategy for NTMWD. The *2016 Region C Water Plan* reaffirms the region's commitment to conservation and reuse. TWDB now mandates that each regional water planning group evaluate all water management strategies that it determines to be potentially feasible, including water conservation practices, reuse of treated wastewater effluent, and drought management measures. In response, the Region C Water Planning Group decided to incorporate water management strategies involving both water conservation and reuse of treated wastewater effluent as major components of the long-term water supply for Region C, to encourage planning and implementation of water conservation and reuse projects, and to monitor legislation and regulatory actions related to water conservation and reuse.

The USACE generally considers water conservation and reuse not as distinct, alternative methods or strategies of providing additional water, but rather as approaches and actions which make more efficient use of existing water supplies and thereby reduce per capita water consumption, partially offsetting the increasing municipal demand for water due to population growth. As such, in this EIS, water conservation and reuse are not considered alongside structural alternatives to the Proposed Action in Chapter 2 but are considered in the context of the purpose and need discussion in Chapter 1. NTMWD's conservation and reuse policies, programs, and projects will be implemented regardless of the USACE's permitting decision on the Proposed Action and alternatives.

2.5.2 Alternatives That Are Unavailable to the Applicant

Consistent with USACE Regulatory NEPA Regulations at 33 CFR 325 Appendix B, paragraph 9.b(5), alternatives that are unavailable to the applicant are to be included in the analysis of the No Federal Action alternative. The USACE considers the following two alternatives unavailable to NTMWD.

Importing Water from Oklahoma

Importing from Oklahoma is a possible alternative for NTMWD. The *2011 Region C Water Plan* estimated that it is comparable in cost with the proposed LBCR (Region C Water Planning Group, 2010) and the *2016 Region C Water Plan* states that "raw water from Oklahoma would be a relatively inexpensive supply and would have relatively low environmental impacts because of the use of existing sources" (Region C Water Planning Group, 2015).

However, in 2002, the Oklahoma Legislature placed a moratorium on out-of-state water sales. The moratorium was replaced in 2009 by a requirement that the Oklahoma Legislature approve any out-of-state water sales. The Tarrant Regional Water District (TRWD) subsequently filed a lawsuit in Federal Court against the Oklahoma's Legislature's moratorium, but the U.S. Supreme Court eventually ruled in favor of Oklahoma (Region C Water Planning Group, 2015). Thus, while Oklahoma is still a possible source of water supply for Region C, it is best regarded as a potential future source.

The *2016 Region C Water Plan* retains water from Oklahoma as a recommended strategy for NTMWD (Region C Water Planning Group, 2015). However, due to the lingering uncertainty regarding the Oklahoma moratorium on export of water to Texas, this strategy would likely not be able deliver water in a timely manner to meet the NTMWD's purpose and need (it is estimated to not be available before 2060). Therefore, this alternative is considered unavailable at present.

Lake O' the Pines

Lake O' the Pines is an existing USACE reservoir in the Cypress River Basin, about 81 miles upstream of its confluence with the Red River in Louisiana and 120 miles from the Dallas Metroplex. The *2016 Region C Water Plan* lists it as an alternative strategy for NTMWD at 87,900 AFY. However, because of the distance, the limited supply it would provide, and uncertainty concerning the need to reach agreements with existing water rights holders, this supply is highly uncertain and in essence, unavailable at the present time. Also, this alternative is incapable of providing NTMWD's needed 105,804 AFY of additional water supply by 2025.

2.5.3 Other Alternatives Available to the Applicant

Other potential alternatives to the LBCR project can be divided into development of new reservoirs and transporting water from existing reservoirs. The alternatives summarized in the following subsections were identified through the Texas water planning process, previous studies, and as part of the development of this EIS. See Appendix O for more detailed information and analysis.

Water Supplied from New (Undeveloped) Reservoirs

All of the potential alternatives to the Proposed Action reviewed in this section would entail discharges of dredged or fill material into waters of the United States. Thus, to some extent, each would replicate impacts associated with the LBCR on waters of the U.S. including wetlands, other natural habitats such as bottomland hardwood forests, and hydrology. In addition, a new Texas state water right would need to be obtained for any new dam, reservoir, and water diversion. Under Texas state law, a right to surface water is granted under a priority system, "first in time, first in right."

Also known as "prior appropriation," "first in time, first in right" is the legal doctrine that the first individual or entity to take a given amount of water from a water source for a "beneficial use" such as agriculture, industry, or municipal, has the right to continue to use that amount of water for that purpose. All subsequent users can utilize the remaining water of a source for their own beneficial uses, but if and only if they do not impinge on the established rights of previous users. This priority system is a factor in determining the magnitude of prospective yields available from any given project. It is why the yields of projects can vary depending on when or the order in which they are permitted.

Downsized LBCR without Blending of Lake Texoma Water

This alternative refers to the smaller dam and reservoir project located at the same site on Bois d'Arc Creek as Alternative 2 described above, but without supplemental water transported from Lake Texoma for blending with the downsized LBCR water at the North WTP. See the description of Alternative 2 in Section 2.3 above for more detailed information about the dam and reservoir. The firm yield of this downsized version of the LBCR would be approximately 86,100 AFY, or about 68 percent of the 120,665 AFY firm yield of the full-sized LBCR and 81 percent of the stated purpose and need of 105,804 AFY. This alternative does not meet the stated purpose and need of the Proposed Action – supplying at least 105,804 AFY of water by 2025 – and therefore, has been dismissed from further consideration.

Upper Bois d'Arc Creek Reservoir

Other potential dam site locations on Bois d'Arc Creek have been considered in previous studies. Most of these sites were studied as potential flood control measures to reduce flooding along Bois d'Arc Creek and in the City of Bonham. An Upper Bois d'Arc Creek (BDC) reservoir site was studied by the USACE in 1968, and subsequently reviewed again by the USACE in 2000 (USACE, 1968; USACE, 2000). The proposed Upper BDC Reservoir would be located about 3.5 miles south of the City of Bonham. The Upper BDC Alternative would yield only about 26 percent of the stated purpose and need; thus, it is insufficient to meet NTMWD's needs. Due to the need for detailed engineering and environmental studies, it is unlikely this alternative could be developed earlier than 2035. This alternative does not meet the stated purpose and need of the Proposed Action – supplying at least 105,804 AFY of water by 2025 – and therefore, has been dismissed from further consideration.

Marvin Nichols Reservoir Alternative

Located in Region D on the Sulphur River in Red River and Titus counties, the undeveloped Marvin Nichols Reservoir site is an alternative strategy included in the *2016 Region C Water Plan* for the NTMWD, TRWD, Upper Trinity Regional Water District (UTRWD), and the City of Irving.

Development of the Marvin Nichols Reservoir water supply would be influenced by decisions made concerning management of the existing Wright Patman Lake, also located on the Sulphur River downstream of the Marvin Nichols Reservoir site. The *2016 Region C Water Plan* recommends a combined strategy of developing Marvin Nichols Reservoir with the reallocation of flood storage to conservation storage in Wright Patman Lake, a combination known as the Sulphur Basin Supplies strategy. This combination strategy could allow the Marvin Nichols Reservoir to be developed with a smaller footprint.

Reallocation of flood storage at Wright Patman at the scale envisioned for the Sulphur Basin Supplies strategy would require recommendation by the USACE and approval by the U.S. Congress. Prior to making any such recommendation, the USACE would have to conduct a detailed evaluation of impacts associated with raising the conservation pool elevation at Wright Patman. Potentially significant impacts from such an action could include inundation of natural resources within the flood pool, compromised flood protection downstream, increased impacts to cultural resources inside the reservoir perimeter, effects on the Congressionally-established White Oak Creek Mitigation Area in the upper reaches of the Wright Patman flood pool, and reduced flexibility for International Paper's downstream effluent management operations. Wright Patman reallocation could also be constrained by dam safety issues.

The Marvin Nichols Reservoir would provide substantial amounts of new water supply to the North Texas region at a relatively low cost. However, due to its size, the development of this reservoir would likely entail much larger environmental impacts than the proposed LBCR. The area that would be inundated by Marvin Nichols Reservoir is more than four times the inundation area of the LBCR, and the impacts on natural habitats could be comparably greater. Initial estimates of impacted wetlands and bottomland hardwoods acreage for this alternative are considerably greater than the acreage impacted by the Proposed Action (TWDB, 2008).

Development of the Marvin Nichols Reservoir would also require multiple participants to effectively achieve the cost benefits and full utilization of the available supply. Consequently, the timing for this strategy is dependent upon the needs of the other participants. Furthermore, due to the permitting requirements and current opposition to this project, this project could not be permitted and developed by 2025.

This alternative does not meet the stated purpose and need of the Proposed Action and therefore, has been dismissed from further consideration. While it supplies more than enough water (NTMWD's allotted share among the partners would be 160,300 AFY), it is not expected to be implemented before 2070, well beyond the needed 2025 time frame.

Marvin Nichols Reservoir (Site 1A)

Marvin Nichols Reservoir Site 1A is a potential reservoir site located on the Sulphur River in Titus and Red River counties, in the same location as the Marvin Nichols Reservoir described above. If constructed, the raw water pipeline from this reservoir would be at least 84 miles from NTMWD's proposed North WTP.

This alternative consists of a smaller reservoir footprint. At a proposed conservation elevation of 313.5 feet MSL, the reservoir would store 744,300 acre-feet of water and impact 41,722 acres, less than two-thirds as much as the full-scale Marvin Nichols Reservoir. This strategy, in combination with reallocation of Wright Patman Lake, is a recommended strategy (labelled "Sulphur Basin Strategy" or "Sulphur Basin Supplies") in the *2016 Region C Water Plan* for NTMWD, TRWD, and UTRWD.

The Lake Ralph Hall site is located upstream of the project. Lake Ralph Hall has already received a state water right from the TCEQ and would have senior priority over Marvin Nichols Reservoir Site 1A. Lake Ralph Hall was included in the hydrologic model used to develop the yield of this project. With this and other assumptions taken into account, the firm yield of Marvin Nichols Site 1-A is estimated at 299,500 AFY, of which 239,600 AFY would be available to NTMWD. This supply would be delivered to NTMWD in two phases: the first phase would transport half of the yield (i.e., 120,000 AFY), while the second phase would carry the second half by means of a parallel pipeline.

This alternative as described above would be just for NTMWD. However, at the present time, the Marvin Nichols project is being considered by the sponsors of the Sulphur Basin Study, including NTMWD, TRWD, Dallas, Irving, Sulphur River Basin Authority (SRBA), and Upper Trinity Regional WD. If NTMWD were to pursue this project on its own, the other parties would have to develop other sources of water supply.

Based on recent experience, it is likely to take about 20 years to obtain the necessary permits, two years to design the reservoir project and three years to construct the project. If NTMWD had started pursuing the Marvin Nichols Reservoir in 2015, the expected online date would be 2040. This alternative does not meet the stated purpose and need of the Proposed Action, and therefore, has been dismissed from further consideration. While it supplies more than enough water, it cannot be implemented before 2040, and therefore does not fit within the 2025 time frame.

George Parkhouse Lake South (Parkhouse I) Alternative

The George Parkhouse Lake South alternative, also known as Parkhouse I, is a potential reservoir that would be located in Region D on the South Sulphur River in Hopkins and Delta counties, approximately 18 miles northeast of the city of Sulphur Springs. If constructed, it would be immediately downstream from Jim Chapman Lake. It is listed as an alternative strategy for NTMWD in the *2016 Region C Water Plan*, providing 108,480 AFY of water at a unit cost of $2.10 per thousand gallons (Region C Water Planning Group, 2015). With a conservation pool elevation of 401 feet MSL, Parkhouse I would inundate approximately 29,000 acres and store 652,000 acre-feet. The reservoir would have a total drainage area of 654 square miles (TWDB, 2008). It is estimated that it could not be built before 2035.

The yield of Parkhouse I would be reduced substantially by the development of Marvin Nichols Reservoir (Region C Water Planning Group, 2015). Yield studies conducted for TWDB as part of the Reservoir Site Protection Study indicate the yield of this lake would be reduced by 60 percent, to 48,400 AFY, if constructed after Marvin Nichols (TWDB, 2008).

This alternative does not meet the stated purpose and need of the Applicant's Proposed Action, and therefore, has been dismissed from further consideration. While it does supply the needed amount of water (an estimated 108,480 AFY, compared to the specified 105,804 AFY), it cannot be implemented before 2035, and therefore does not fit within the 2025 time frame.

George Parkhouse Lake North (Parkhouse II) Alternative

The George Parkhouse Lake North alternative, also known as Parkhouse II, is a potential reservoir that would be located in Region D on the North Sulphur River in Lamar and Delta counties, about 15 miles south of Paris, TX. If constructed, it would provide 148,700 AFY of water with 118,960 AFY available for Region C, but its yield would be reduced substantially by development of Lake Ralph Hall or Marvin Nichols Reservoir. Its development would require both a water right permit and an interbasin transfer permit. Parkhouse II is not a recommended water management strategy for any Region C wholesale water provider; however, like Parkhouse I, it is an alternative strategy for NTMWD and UTRWD (Region C Water Planning Group, 2015).

If constructed, Parkhouse II would be located approximately 50 miles from the proposed NTMWD North WTP. At a proposed conservation elevation of 410.0 feet MSL, the reservoir would store 330,871 acre-feet of water and inundate 14,387 acres. The firm yield of Parkhouse II (taking into account instream flow releases of 10 percent) is estimated at 111,780 AFY. Of this quantity, 89,400 AFY would be available to NTMWD. The remaining 20 percent of the yield would remain in the Sulphur Basin for local use.

This project, if built, would affect the yields of other projects being considered for development in the Sulphur Basin, including construction of the proposed Marvin Nichols Reservoir and the Wright Patman Lake reallocation. A sensitivity study of the reservoir yield found that the yield of Parkhouse II could range from 32,100 AFY (assuming both Lake Ralph Hall and Marvin Nichols Reservoir are constructed prior to Parkhouse II) to 117,400 AFY assuming only Lake Ralph Hall is constructed prior to Parkhouse II (TWDB, 2008). The reliability of this water supply source would be moderately high, but a drought worse than the drought of record could impact the reservoir yield.

This alternative does not meet the stated purpose and need of the Proposed Action, and therefore, has been dismissed from further consideration. It would not supply enough water to NTMWD, it cannot be implemented any sooner than 2035, and it therefore does not fit within the 2025 time frame.

Other New Reservoirs

Several other proposed reservoirs in the region were recommended or considered in the 2016 Region C Water Plan and 2017 Texas State Water Plan, but are not considered feasible for NTMWD because the water supply has already been committed to other users. These other proposed reservoirs included Lake Fastrill, Lake Columbia, Lake Tehuacana, and Lake Ralph Hall. Water from proposed Lake Fastrill was already committed to Dallas, but now it is no longer a viable option because in 2006 the Neches River National Wildlife Refuge was established at the proposed reservoir site, a decision upheld in federal court in 2010. Most of the water from proposed Lake Columbia is already committed to users in the Neches River Basin, and the remainder is insufficient for NTMWD's purpose and need. Proposed Lake Tehuacana is located adjacent to Richland- Chambers Reservoir, and would be used and operated by the TRWD. Lake Ralph Hall (for which a separate EIS is now under preparation by the Fort Worth District of the USACE) would be developed and used by the UTRWD (Region C Water Planning Group, 2015).

Transporting Water From Existing Reservoirs

This section examines the potential for augmenting NTMWD's water supplies by using or modifying existing impoundments rather than constructing entirely new impoundments. This may be accomplished in several ways: 1) building new pipelines or enlarging existing ones; 2) increasing the height of dams and thus the size, storage capacity, and firm yield of the reservoirs behind them; or 3) reallocating a portion of a reservoir's flood storage to water supply storage, which in effect, increases its capacity to store water for use in municipal or other purposes (e.g., irrigation, industry). However, this would decrease the flood control capacity of the reservoir.

Lake Lavon Alternative

Lake Lavon, owned and operated by the USACE, is located in the Trinity River Basin near the town of Wylie and near the headquarters and main WTP of the NTMWD. At present, Lake Lavon is permitted for 443,800 AF of storage for water supply and 118,680 AFY of diversions. At the current conservation pool elevation (492 feet MSL), there is approximately 275,600 AF of flood storage. If the water conservation pool elevation were to be raised by five feet to elevation 497 feet MSL, there would be an estimated 115,649 AF of additional storage available for water supply (Kiel, 2014).

To use this additional water, NTMWD would need to obtain a Texas water right. Using the Trinity River WAM, the additional amount of water that could be permitted for diversion from Lake Lavon with the increase conservation pool elevation of 492 feet MSL is estimated at 7,200 AFY, which does not represent a significant increase in water supply for NTMWD. Furthermore, under the Texas system of prior appropriation for surface water rights, nearly all of the water in the Trinity River Basin is: a) appropriated to existing water rights holders, or b) committed to environmental flows. A new water right accorded to NTMWD to divert additional water from Lake Lavon would be the most junior in priority. Thus, if a drought worse than the drought of record were to occur, this water right would be affected prior to more senior water rights.

Adding to the complexity of this alternative, because it is a USACE project, an Act of the U.S. Congress would be required to reallocate flood storage that exceeds 50,000 AF. Reallocating 115,649 AF of flood storage would necessitate such an action, and its approval is doubtful because Lake Lavon is located in a developed area next to Wylie. Conversion of some of the reservoir's flood storage to water supply would reduce the flood protection that Lake Lavon now provides for local residents, businesses, and facilities. Such a loss would need to be mitigated before an approval could be issued. Thus, it is doubtful that this project could be online in time to meet the 2025 deadline established in the purpose and need for the Proposed Action. The earliest year it is might be available is 2030.

Reallocating flood storage to water supply in Lake Lavon is not a viable alternative to the Proposed Action. It would only provide about seven percent of the water needed and it cannot be implemented by 2025.

Lake Jim Chapman Alternative

Lake Jim Chapman (also known as Cooper Lake), owned and operated by the USACE for both water supply and flood control, is situated in the Sulphur River Basin in Hopkins County. It is a current water source for NTMWD, the City of Irving, UTRWD, and the Sulphur River Municipal Water District. At the present time, the reservoir is permitted for 273,000 AFY of water supply. At its current conservation storage, the permitted total diversion from Lake Jim Chapman is 146,520 AFY. Of this amount, NTMWD's water right is 54,000 AFY (Kiel, 2014).

The flood pool of Lake Jim Chapman is between elevations 440 and 446.2 feet elevation. This storage has a volume of 130,000 AF and a footprint of 4,905 acres. If the entire volume of the flood storage pool were reallocated to conservation storage (water supply), the additional amount of water that could be diverted from Lake Jim Chapman would be almost 25,000 AFY (24,950 AFY to be exact), about one-sixth the amount that can be withdrawn under existing Texas water rights, and about one-fifth of the expected average annual diversions from the proposed LBCR.

These yields do not account for environmental flows in the Sulphur River Basin, which have not yet been developed by the State of Texas. With environmental flows applied, the additional yield would be less. To tap into this potential water supply, NTMWD would need to apply for a Texas water right both for the additional storage and the additional diversion. As in the case of Lake Lavon above, this water right would be the most junior in priority, so that if a drought worse than the drought of record were to occur, this water right would be affected prior to senior water rights.

This alternative would provide less than 20 percent of the yield of the proposed LBCR and it cannot be implemented within the timeframe needed for the water. To receive Congressional approval, conduct the necessary studies, and obtain a Texas water right could take 10 to 15 years, or by about 2030, assuming Congressional approval is granted.

Reallocating flood storage to water supply in Lake Jim Chapman is not a viable alternative to the Proposed Action. It would supply less than one-quarter of the water needed and it cannot be implemented within the 2025 timeframe.

Reallocation of Storage at Other Reservoirs in the Region

Other reservoirs in the general vicinity of the NTMWD service area include Lakes Ray Hubbard, Ray Roberts, Lewisville, Tawakoni, and Fork. The City of Dallas owns and operates Lake Ray Hubbard, Lakes Ray Roberts and Lewisville are owned and operated by the USACE, and the Sabine River Authority (SRA) owns and operates Lakes Tawakoni and Fork. All five lakes are used by the City of Dallas for water supply (Kiel, 2014).

Three of these lakes – Hubbard, Tawakoni and Fork – are used exclusively for water supply and do not have dedicated flood storage. These lakes are surrounded by developed land. The homes and businesses surrounding these lakes would be inundated if the water conservation pool were to be raised. This would almost certainly generate intense public opposition to raising the conservation pool water level to increase water supply storage. The two lakes owned and operated by the USACE, Lakes Ray Roberts and Lewisville, have dedicated flood storage; however, both are located in urban environments where flood protection is an important consideration. Conversion of flood storage to water supply would reduce the flood protection that these lakes currently provide.

Based on the analyses for Lakes Lavon and Jim Chapman, the anticipated increase in yield associated with increased storage for water supply at these existing lakes in the region would be relatively small compared to NTMWD's needs. This is because, as a rule, existing reservoirs are for the most part optimally sized and fully permitted. Reallocation of these reservoirs individually or as a group does not constitute a viable alternative to the Proposed Action because they can neither provide the amount of water supply needed, nor within the time period required. Also, there would probably be strong opposition both at the local level and in Congress and there would likely be an unacceptable increase in the flood hazard from any reallocation of storage capacity at these lakes.

Lake Texoma Alternatives

As described in Chapter 1 of this EIS, Lake Texoma is a large USACE reservoir on the Red River bordering Texas and Oklahoma. NTMWD has a 1986 water right to divert 84,000 AFY of water from Lake Texoma, and to use 77,300 of this amount through the bed and banks of Lake Lavon (after an allowance of 6,700 AFY in channel losses moving the water from Lake Texoma to Lake Lavon, a distance of approximately 54 miles. Water from Lake Texoma is relatively high in naturally-occurring dissolved salts, (i.e. it is brackish). This means it must be either blended with a freshwater source or desalinated before it can be used for drinking water. Currently, the NTMWD blends Lake Texoma water with its other sources to make it suitable for municipal use.

As explained in Chapter 1, because zebra mussels are now present in Lake Texoma, NTMWD is no longer blending Texoma water in Lake Lavon as it used to. Instead, Texoma water is now piped directly to the NTMWD Wylie WTP, where it is blended at a ratio of 4:1 (fresh: brackish) with water from other sources. This ratio is based on the current water quality of NTMWD's existing fresh water sources, which include Lakes Lavon and Chapman and a considerable amount of reuse supplies. NTMWD is able to utilize approximately 77,000 AFY of Lake Texoma water for blending with its current existing freshwater sources. Any additional use of Lake Texoma water with blending would require the development of a new freshwater source.

Blending Lake Texoma Water with New Fresh Water Supplies

The elevated dissolved salts in Lake Texoma would have certain environmental impacts whether the water is used by blending or by desalination. The NTMWD's preferred use of this water source is to blend the Texoma water with a new fresh water supply because of the environmental concerns and costs associated with large desalination projects. NTMWD anticipates blending Texoma water in a constructed balancing reservoir near a treatment facility and not in an existing lake or stream. This would reduce the potential impacts of adding high concentrations of dissolved solids to existing lakes or streams. It is assumed that NTMWD would use one part of Lake Texoma supply for every 1.7 to 3 parts of other fresh water, depending on the water quality of the source. NTMWD would deliver the water directly from Lake Texoma and/or from the Red River downstream of the lake. Downstream diversions offer the advantage of reduced levels of dissolved solids (Region C Water Planning Group, 2010).

Five potential alternative new sources of fresh water could be blended with Texoma water. These include the proposed LBCR (the Proposed Action), a smaller LBCR (Alternative 2 in this EIS, described in Section 2.3), George Parkhouse Lake North, Wright Patman, and Toledo Bend. Blending Lake Texoma water with water from Marvin Nichols Reservoir would be similar to Parkhouse North. The amount of water that can be blended is a function both of the water quality and available quantity of the fresh water source.

Table 2.5-1 lists the new freshwater sources, the blend ratios, and blended quantities of water that would be made available by each source. For this analysis, the TDS concentration for Texoma water is assumed to be 1,100 milligrams per liter (mg/L). This concentration is consistent with documented values of Lake Texoma water samples over the past eight years, as well as with previous reports. The blend ratios for each source were designed to achieve a maximum TDS level of 500 mg/L of the blended water (well within drinking water standards for public water supplies).

Table 2.5-1. Quantities of Water Supplied by Blending Lake Texoma Water with Selected New Freshwater Sources

Water Quality	New Freshwater Source				
	Full-sized LBCR	**Downsized LBCR**	**George Parkhouse North**	**Wright Patman**	**Toledo Bend**
TDS (mg/L)	300	300	300	150	200
Texoma TDS (mg/L)	1,100	1,100	1,100	1,100	1,100
Blend ratio	3	3	3	1.7	2
Supply (AFY)					
Freshwater source	120,000	86,100	89,400	105,360	130,000
Texoma	40,000	28,700	29,800	61,460	65,000
Total new supply	**160,000**	**114,800**	**119,200**	**166,820**	**195,000**

AFY = acre-feet per year; mg/L = milligrams per liter; TDS = total dissolved solids.

As shown in Table 2.5-1, blending new freshwater sources with existing Texoma supplies to which NTMWD already has a water right would increase the amount of water made available to NTMWD. The quantities range from 114,800 AFY for the smaller proposed LBCR up to 195,000 AFY for Toledo Bend. The smaller LBCR and George Parkhouse Lake North, both described above in this section, would provide less water to NTMWD even augmented by blending with Texoma water than the proposed full-sized LBCR would without any blending. Blending of Texoma water would be reliable because the NTMWD holds the water right to this source and Lake Texoma is large enough to be capable of supplying water reliably even during a severe drought.

The time to implement each blending alternative depends upon the availability of the freshwater supply (Table 2.5-2). The actual time to design and construct the blending infrastructure (pipeline(s) and balancing reservoir) would be under three years. The blending project would probably be initiated when additional supplies are needed above the amount provided by the freshwater source alone. In each of these alternatives, the year of implementation is influenced primarily by the estimated time it would take to conduct the requisite studies and acquire the needed permits and authorizations.

Table 2.5-2. Supply Size and Year of Availability of Selected Lake Texoma Blending Alternatives

	New Freshwater Source				
	Full-sized LBCR	Downsized LBCR	George Parkhouse North	Wright Patman	Toledo Bend
Total supply with blending (AFY)	160,000	114,800	119,200	166,820	195,000
Year of implementation	2020	2025-26	2035	2040	2030

AFY = acre-feet per year; LBCR = Lower Bois d'Arc Creek Reservoir.

In summary, the feasibility of the Lake Texoma blending alternative is contingent upon the ability to obtain fresh water from a new source. For those alternatives that cannot be implemented in time to meet NTMWD's near and mid-term term needs, blending Texoma water does not meet the purpose and need of the Proposed Action. As seen in Table 2.5-3, only the proposed (full-sized) LBCR and the smaller proposed (downsized) LBCR analyzed in this Revised DEIS could be developed and implemented in time, because each of the other alternatives would need considerably more time for studies, permitting, and authorization.

Toledo Bend Reservoir Alternative

Toledo Bend Reservoir is a large artificial lake located on the Texas state border with Louisiana, approximately 200 miles from NTMWD's service area. The Toledo Bend Project was originally conceived, licensed (in 1963), and developed primarily as a water supply reservoir, with hydroelectricity and recreation as secondary purposes. By surface area, Toledo Bend Reservoir is the largest man-made water body in Texas and the South, as well as the fifth-largest in the entire U.S., with water normally covering 185,000 acres; the reservoir has a controlled storage capacity of 4,477,000 AF (SRA, no date-b).

The reservoir is owned and operated by the SRA of Texas and the SRA of Louisiana for water supply and hydropower generation. According to the Texas State Water Plan, this lake has available water. Use of this water by NTMWD would require a contract with the SRA and an interbasin water right transfer to move the water from the Sabine River Basin to the Trinity River Basin. Due to the scale of the Toledo Bend pipeline alternative and its current conceptual status, planning, development, and implementation of this alternative would take an estimated 15 to 20 years. Thus, the earliest water from Toledo Bend could be made available is after 2030.

The Toledo Bend project would result in lower impacts than the proposed LBCR on both terrestrial and aquatic habitats, including waters of the U.S. However, it would have significantly higher capital costs, entail greater long-term energy usage and associated CO_2 (greenhouse gas) emissions, and incur higher long-term operating costs. In any case, it is not a viable alternative to the Proposed Action, because although it would provide about the same amount of water, it cannot supply this water in time to meet the purpose and need, that is, by 2025.

Wright Patman Lake Alternatives

Wright Patman Lake is an existing reservoir in the Sulphur River Basin approximately 150 miles from the NTMWD, owned and operated by the USACE. As discussed above under the Marvin Nichols' alternatives, in the *2016 Region C Water Plan*, Wright Patman Lake is considered under the heading of Sulphur Basin Supplies (Section 5B.3). Region C wholesale water providers interested in pursuing the development of these supplies include NTMWD, TRWD, City of Dallas, UTRWD, and City of Irving.

Along with the SRBA, these entities have created a Joint Committee on Program Development. Continuing Sulphur Basin feasibility studies are underway by the USACE, SRBA and the Joint Committee. These studies seek to address Region D concerns with respect to natural resources protection, environmental impacts, and the socioeconomic effects of water supply development within Region D and the Sulphur Basin. At present, Sulphur Basin Supplies are a recommended water management strategy for NTMWD, UTRWD, and TRWD (Region C Water Planning Group, 2015).

There are several different strategies by which water could be made available to NTMWD from Wright Patman Lake:

- Flood storage in Wright Patman Lake could be converted to conservation storage (raising the flood pool), and the NTMWD could use the increased yield.
- Water could be purchased from the City of Texarkana under its existing water right.
- Wright Patman Lake could be operated as a system with Jim Chapman Lake (aka Cooper Lake) upstream to further increase yield.

These strategies are summarized below.

Raise Flood Pool of Wright Patman Lake

Increasing the conservation storage in Wright Patman Lake to an elevation of 228.6 feet MSL and allowing for diversions to as low as an elevation of 215.3 feet MSL would increase the yield of the project to about 364,000 AFY; Region C Water Planning Group, 2015). In this analysis, it was assumed that 180,000 AFY of the additional supply developed could be made available to water suppliers in North Texas while the remainder of the supply would be reserved for local use. The studies found that increasing the elevation above 228.6 feet MSL would inundate portions of the White Oak Creek Mitigation Area, located upstream from Wright Patman Lake. Approximately 500 acres of the mitigation area are below an elevation of 230 feet MSL, and about 3,800 acres are below an elevation of 240 feet MSL. This strategy would require changes to the USACE operation of Wright Patman. Also, this strategy is recommended for the City of Dallas in the City's long-range water supply plan, the 2007 and 2012 Texas State Water Plans, and the *2011 Region C Water Plan*. Due to the available quantity of water from this source, it is unlikely that both NTMWD and Dallas would pursue this strategy.

The proposed Lake Ralph Hall would be located upstream of the Wright Patman Lake. Lake Ralph Hall has already received a state water right from the TCEQ and therefore, it would have senior priority over the reallocation of Wright Patman Lake. Wright Patman Lake water releases affect the operations of an International Paper (IP) paper mill at Queen City, TX, a large downstream user of water and a large employer in the area. The effect of reallocation of Wright Patman on IP operations is uncertain but is currently being investigated as part of the Sulphur Basin Feasibility Study. Greater releases from the reservoir may need to occur to mitigate the impact on IP, which could reduce the yield of this option. Twenty percent of the yield of the project was also assumed to be reserved for local use in the Sulphur Basin, an assumption based on an inter-local agreement. Reallocation of flood storage at Wright Patman to water supply would require congressional authorization.

Given the above assumptions, the firm yield of Wright Patman reallocation (taking into account instream flow releases) was estimated in 2015 at 131,700 AFY. Of this amount, 80 percent or 105,360 AFY would be available to NTMWD, with the remaining 20 percent of the yield staying in the Sulphur Basin for local use.

Feasibility studies have been conducted for the Wright Patman reallocation, but no detailed field studies; no permit applications have been submitted. Congressional authorization would be required to reallocate the flood storage at Wright Patman to water supply. The reallocation process requires substantial study and coordination with the USACE. After this authorization is obtained, a state water right permit, a USACE Section 404 permit, and the appropriate NEPA assessment would all be needed prior to construction. The state and federal permitting process could take10 to 15 years, depending upon the data developed during the reallocation authorization, permit applications, complexity of the project, and potential opposition to the project. It is expected to take 20 to 25 years to obtain the necessary authorizations and permits, two years to design the project and three years to construct it. If NTMWD were to pursue the Wright Patman reallocation starting in 2015, the expected online date would be in the 2040 to 2045 timeframe.

In conclusion, there is a good deal of uncertainty of reaching contractual agreements with existing water rights holders and there are potential conflicts with other regional wholesale water suppliers. The reallocation alternative would entail potentially substantial environmental impacts to the White Oak Mitigation Area and other forested wetlands from raising the flood pool. It would also involve higher operational costs than the Proposed Action. However, the principal reason that water supply from Wright Patman Lake is not considered a viable alternative to the Proposed Action is that it would not be able to provide the needed amount of 105,802 AFY of water by 2025.

Purchase Water from City of Texarkana

This alternative pertains to the potential availability of water for NTMWD from Wright Patman Lake under existing contracts and authorizations that define two operating policies for water supply from the reservoir. The City of Texarkana obtains most of its water from Wright Patman Lake, which serves both flood control and water supply functions. This reservoir can provide a very large amount of water; however, the amount available depends greatly on how the reservoir is operated. An interim federal contract with the City of Texarkana governs current water supply operation of the reservoir. Proposed operation of the reservoir is defined by a different contract which has never been implemented.
Under the current operation regime – the Interim Curve – and assuming, 1) storage between 220 feet MSL and the Interim Curve and, 2) a constant 10 cfs release, the current firm yield of Wright Patman Lake is 40,263 AFY. If the 96 cfs release from May through October is used instead, the yield would be reduced by about 30,000 AFY, resulting in a firm yield of just 10,000 AFY. This yield would be insufficient to sustain even current use from the reservoir, much less meet current obligations for water supply from the City of Texarkana. Therefore, there is no water available for other interested parties from the City of Texarkana under current operations.

Under the proposed operation regime – the Ultimate Curve – a constant 10 cfs release from Wright Patman Lake would result in a firm yield of about 145,000 AFY. According to the *2015 Region D Plan*, 136,000 AFY of this water is reserved for the City of Texarkana or contracted to its customers, leaving only about 9,000 AFY uncommitted. This quantity is below 10 percent of the yield of the proposed LBCR and does not come close to meeting the need of the Proposed Action.

Thus, purchasing Wright Patman water from Texarkana is not a viable alternative to the Proposed Action. It would supply only about eight percent of the quantity stated in the purpose and need.

Operate Wright Patman Lake and Jim Chapman Lake as a System to Increase Combined Yield

System operation of Wright Patman Lake and Jim Chapman Lake could increase the joint yield from the two projects by about 108,000 AFY. The combination of purchasing water from Texarkana, converting flood storage to conservation storage, and system operation with Jim Chapman Lake could potentially make 390,000 AFY available from Wright Patman Lake. The *2012 State Water Plan* and the *2011 Region C Water Plan* and *2016 Region C Water Plan* assume that this strategy would be developed jointly with multiple water providers in North Texas. The amount of supply for the NTMWD would be 130,000 AFY. Other suppliers have not committed to participating with this strategy.

In addition to the inherent uncertainty associated with a multiplicity of possible participants, this option would have the same implementation and environmental concerns noted for the other Wright Patman alternatives – contractual changes between the USACE and Texarkana, willing sellers, impacts to the White Oak Mitigation Area, changes to USACE operations of the lake, and conflicts with other potential users.

Lake Livingston Alternative

Lake Livingston is an existing reservoir on the Trinity River in Region H. Most of the lake is located in Polk and San Jacinto Counties. The Trinity River Authority (TRA) and the City of Houston hold the water rights for this reservoir. The TRA has indicated that as much as 200,000 AFY of water from Lake Livingston might be available to water suppliers in Region C (Region C Water Planning Group, 2010). However, according to the 2007 and 2012 State Water Plans, much of this available supply is expected to be used to meet projected needs in the greater Houston area and would not be available for NTMWD. Furthermore, the *2011 Region C Water Plan* indicates that water from Lake Livingston is not a recommended strategy for any Region C supplier. The *2016 Region C Plan* does not list it as either a recommended or alternative strategy for NTMWD (Region C Water Planning Group, 2015).

Lake Livingston is located about 180 miles from the North Texas service area. Because it is an existing supply from an existing reservoir, the on-site environmental impacts of utilizing this water management strategy would be non-existent to low (Region C Water Planning Group, 2010). However, due to the distance to NTMWD, and the need to build and operate a lengthy raw water pipeline, this alternative would cost more than twice as much as the proposed LBCR (Region C Water Planning Group, 2010). It would also entail greater energy use (for pumping) and greenhouse gas emissions.

Overall, this alternative is not viable because of the much greater distance, unit cost, greenhouse gas emissions, and uncertain future availability. Therefore, it cannot meet the purpose and need of the Proposed Action.

Sam Rayburn Reservoir/Lake B.A. Steinhagen Alternative

Sam Rayburn Reservoir is an existing USACE reservoir on the Angelina River in the Neches River Basin. Lake B.A. Steinhagen is located on the Neches River downstream from Sam Rayburn Reservoir. During the development of the *2007 Texas State Water Plan*, the Lower Neches Valley Authority, which holds Texas water rights in both reservoirs, indicated that as much as 200,000 AFY from these reservoirs might be available to water suppliers in North Texas. The Lower Neches Valley Authority wants the water to be diverted from Lake B.A. Steinhagen, which is about 200 miles from the North Texas region, in order to preserve hydropower generation from Sam Rayburn Reservoir. These reservoirs are more than 150 miles from the NTMWD service area. Because of the long distance, they would be relatively expensive sources of water supply for NTMWD. There also has been recent interest in supplies from Sam Rayburn Reservoir/Lake B.A. Steinhagen from other users.

This strategy was considered in the *2007 Texas State Water Plan* but was not listed in the *2011 Region C Water Plan* or the *2016 Region C Water Plan* due to excessive cost and unavailability for water suppliers in Region C. As with the other alternatives involving the need to construct and operate long water pipelines with attendant pumping stations, this strategy would entail greater greenhouse gas emissions than the Proposed Action.

Other Existing Lakes

Other existing lakes in the vicinity of NTMWD service area include Lake Grapevine, Cedar Creek Reservoir, Richland-Chambers Reservoir and Lake Palestine. However, each of these sources is fully committed to its existing customers. Lake Grapevine and Lake Palestine are water supply sources for the City of Dallas, and these sources are needed to meet the demands of Dallas, its customers, and other holders of water rights in the lakes. Cedar Creek and Richland-Chambers reservoirs are owned and operated by the TRWD. These water sources are fully committed to meeting the water demands of the TRWD. Therefore, none of these existing lakes is able to meet the purpose and need of the Proposed Action.

2.5.4 Comparison of Alternatives

Figures 2.5-1 and 2.5-2 compare the main alternatives discussed above with Alternatives 1 and 2 according to quantity of water provided and cost.

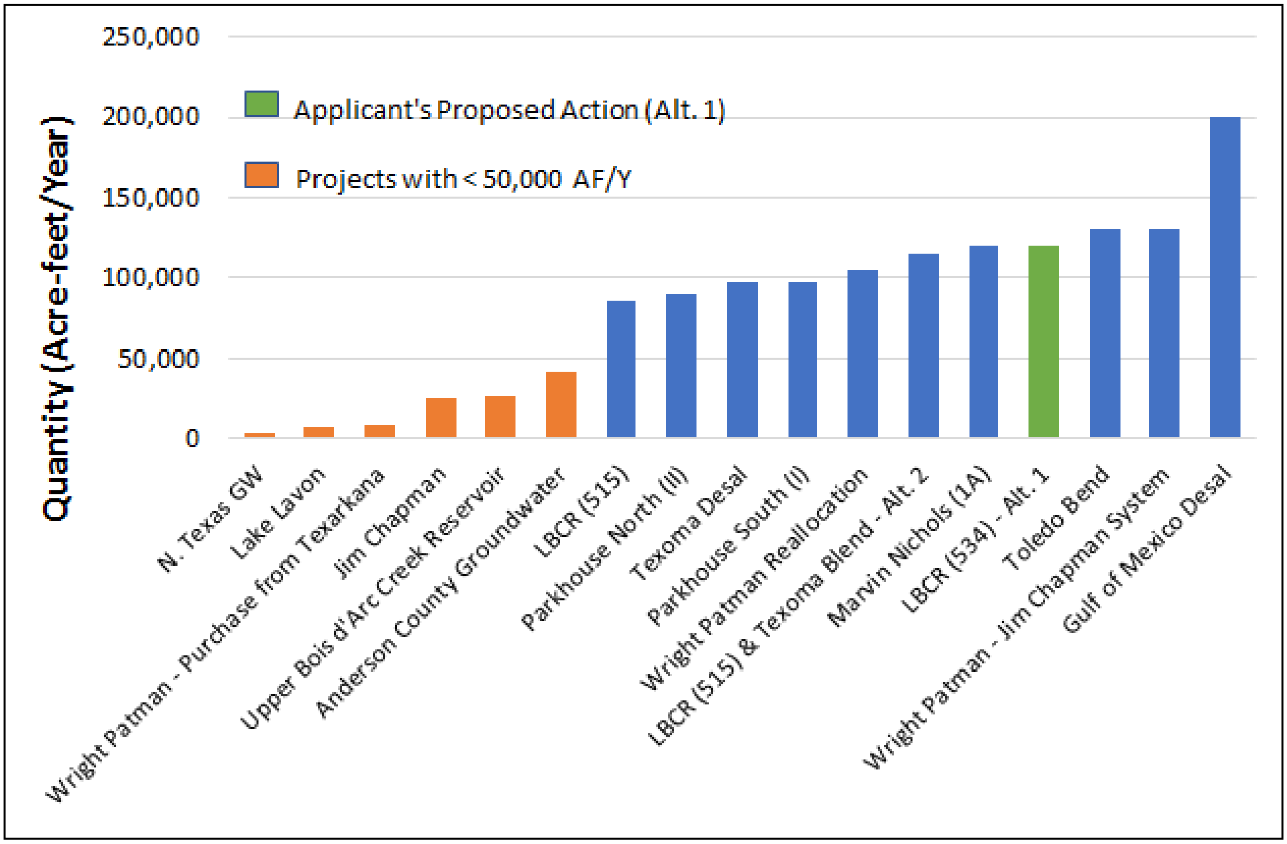

Figure 2.5-1. Quantity of Water Supplied by Selected Alternatives Considered in Chapter 2

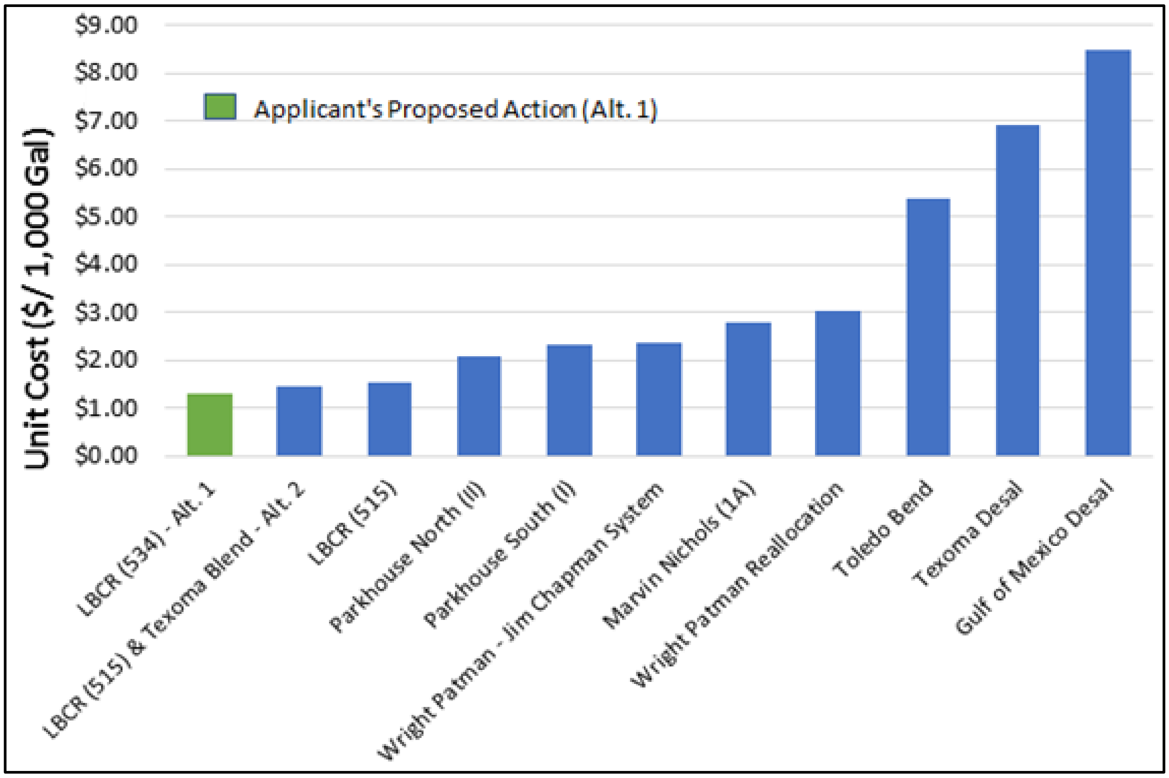

Figure 2.5-2. Unit Cost Comparison of Selected Alternatives Considered in Chapter 2

2.5.5 Meeting the Purpose and Need

Table 2.5-3 evaluates each alternative discussed above on the basis of whether it is capable of meeting the fundamental purpose and need of the Proposed Action: supplying at least 105,804 AFY of water to NTMWD by 2025. Those alternatives that meet both the quantity and timing criteria of the purpose and need are assessed in more detail in Chapter 3 (Affected Environment) and Chapter 4 (Environmental Consequences) of this Revised DEIS. Those alternatives that do not meet both the quantity and timing of the purpose and need are not considered reasonable or viable at this time and are thus dismissed from more detailed consideration in this Revised DEIS. Appendix O contains more detailed information from which this table was derived.

Table 2.5-3. Ability of Alternatives Considered to Meet the Purpose and Need

Alternative	Purpose and Need				Assess in More Detail or Dismiss from Detailed Consideration
	Quantity of Water Available (AFY)	At Least 105,804 AFY?	Year Available	Available by at Least 2025?	
Alternative 1 – Applicant's Proposed Action (Applicant's Preferred Alternative)					
Full-scale LBCR	120,665	Yes	2020	Yes	Assess in more detail
Alternative 2 – Downsized LBCR with Lake Texoma Blending					
Downsized LBCR with Lake Texoma Blending	114,800	Yes	2026	No[a]	Assess in more detail[a]

Alternative	Purpose and Need				Assess in More Detail or Dismiss from Detailed Consideration
	Quantity of Water Available (AFY)	At Least 105,804 AFY?	Year Available	Available by at Least 2025?	
Alternatives that Do Not Require a Section 404 Permit					
New Groundwater Supplies					
Ogallala Aquifer groundwater in Roberts County	0	N/A	N/A	No	Dismiss
Carrizo-Wilcox Aquifer Groundwater in Brazos County	uncertain	No	unknown	No	Dismiss
Carrizo-Wilcox Aquifer in Freestone and Anderson Counties	Up to 42,000	No	N/A	N/A	Dismiss
Other Groundwater Supplies in Region C and Nearby Counties	uncertain	No	N/A	N/A	Dismiss
Desalination					
Desalinate Lake Texoma Brackish Water	97,000	No	2030	No	Dismiss
Desalinate Gulf of Mexico Seawater	Unlimited	Yes	N/A	No	Dismiss
Alternatives Unavailable to the Applicant					
Importing Water from Oklahoma	50,000	No	2060?	No	Dismiss
Lake O' the Pines	87,900	No	unknown	No	Dismiss
Other Alternatives Available to the Applicant					
Water Supplied from New (Undeveloped)Reservoirs					
Downsized LBCR without Blending of Lake Texoma Water	86,100	No	2025	Yes	Dismiss
Upper Bois d'Arc Creek Reservoir	26,900	No	2035	No	Dismiss
Marvin Nichols Reservoir	160,300	Yes	2070	No	Dismiss
Marvin Nichols Reservoir (Site 1A)	239,600	Yes	2040	No	Dismiss
George Parkhouse Lake South (Parkhouse I)	108,480	Yes	2035	No	Dismiss
George Parkhouse Lake North (Parkhouse II)	89,400	No	2035	No	Dismiss
George Parkhouse North Lake with Lake Texoma Blending	119,200	Yes	2035	No	Dismiss
Lake Frastrill	0	No	N/A	No	Dismiss

Alternative	Purpose and Need				Assess in More Detail or Dismiss from Detailed Consideration
	Quantity of Water Available (AFY)	At Least 105,804 AFY?	Year Available	Available by at Least 2025?	
Lake Columbia	unknown	No	unknown	No	Dismiss
Lake Ralph Hall	0	No	N/A	No	Dismiss
Lake Tehuacana	0	No	N/A	No	Dismiss
Transporting Water from Existing Reservoirs					
Lake Lavon Reallocation	7,200	No	2030	No	Dismiss
Lake Jim Chapman Reallocation	24,950	No	2030	No	Dismiss
Lake Ray Hubbard Reallocation	N/A	No	N/A	No	Dismiss
Lake Ray Roberts Reallocation	N/A	No	N/A	No	Dismiss
Lake Lewisville Reallocation	N/A	No	N/A	No	Dismiss
Lake Tawakoni Reallocation	N/A	No	N/A	No	Dismiss
Lake Fork Reallocation	N/A	No	N/A	No	Dismiss
Lake Texoma Without Blending	0	No	N/A	No	Dismiss
Toledo Bend Reservoir	130,000	Yes	2030	No	Dismiss
Toledo Bend Reservoir with Lake Texoma Blending	195,000	Yes	2030	No	Dismiss
Wright Patman Lake: Raise Flood Pool	105,360	No	2040	No	Dismiss
Wright Patman Lake: Raise Flood Pool with Lake Texoma Blending	166,820	Yes	2040	No	Dismiss
Wright Patman Lake - System Operation with Lake Jim Chapman	130,000	Yes	2040	No	Dismiss
Purchase Water from Texarkana	9,000	No	unknown	No	Dismiss
Lake Livingston	Up to 200,000	Yes	unknown	No	Dismiss
Sam Rayburn Reservoir/ Lake B.A. Steinhagen	200,000?	Yes	unknown	No	Dismiss
Lake Grapevine	0	No	N/A	No	Dismiss
Cedar Creek Reservoir	0	No	N/A	No	Dismiss
Richland-Chambers Reservoir	0	No	N/A	No	Dismiss
Lake Palestine	0	No	N/A	No	Dismiss

AFY = acre-feet per year; LBCR = Lower Bois d'Arc Creek Reservoir; N/A = not available.
[a] Although Alternative 2 (downsized LBCR with Lake Texoma blending) may miss the 2025 purpose and need criterion by one year, this is close enough that it will be considered in more detail in this EIS.

2.5.6 Alternatives to be Considered in More Detail in this EIS

In Table 2.5-3, only two of the alternatives listed meet the purpose and need stated in Chapter 1: supplying a minimum of 105,804 AFY of water to NTMWD by the year 2025. These are the Proposed Action (the LBCR project) and a downsized version of the LBCR in combination with blended water from Lake Texoma. In the USACE's judgment, none of the other alternatives is reasonable or viable at this juncture.

Three alternatives will therefore be examined in more detail in the following chapters: the No Action Alternative, Alternative 1 – the Applicant's Proposed Action (LBCR), and Alternative 2 – a downsized version of the LBCR in combination with Lake Texoma blending.

Chapter 3 of this Environmental Impact Statement addresses the affected environment of the Proposed Action (Alternative 1), Alternative 2, and the No Action Alternative. Chapter 4 of this EIS covers the potential environmental consequences of these three alternatives. Chapter 5 reviews cumulative impacts, those which could occur due to the incremental impact of the action alternatives in combination with other past, present, and reasonably foreseeable future actions and trends.

3.0 AFFECTED ENVIRONMENT

This chapter of the Revised DEIS describes the environment that would be affected by Alternatives 1 and 2. Resources that may be affected by the alternatives include land use; topography, geology, and soils; water resources; biological resources (including wetlands, aquatic biota, wildlife, and habitats); air quality; the acoustic environment; recreation; visual resources; utilities; transportation; socioeconomics; environmental justice; and cultural resources. The affected environment is described by resource below.

The geographic area of the affected environment for this analysis extends from the reservoir site to encompass Fannin County and the surrounding five counties (see Figure 3-1). However, most of the resources potentially affected by Alternatives 1 and 2 are located within the boundaries of Fannin County because most of the project components for Alternatives 1 and 2 will be located in Fannin County; the dam and reservoir; the raw water pipeline and road rights-of-way; and the footprint of the water treatment plant (WTP). This analysis assumes that there are no major differences between the affected environments for Alternatives 1 and 2, because they include the same major components: dam, reservoir, road and bridge replacement, raw water pipeline(s), and water treatment plant (WTP).

The information provided in this chapter includes summary descriptions of studies that were conducted to describe the affected environment. These studies were carried out as part of the USACE permit application process. They include:

- Habitat Evaluation Procedure (HEP) – HEP was developed by the USFWS in 1974 to provide a habitat-based evaluation methodology for use as an analytical tool in impact assessments and project planning (USGS, 2010). It is a species-habitat analysis of the ecological value of a study area. For the proposed LBCR project, HEP was conducted at the proposed reservoir site footprint to measure the magnitude of impacts and at the proposed Riverby Ranch mitigation site to characterize its existing conditions and evaluate the potential for habitat creation, restoration, and overall "ecological uplift." The HEP report for the proposed LBCR site (Freese and Nichols, 2008e) is included as Appendix J to this Revised DEIS.
- Hydrogeomorphic Approach (HGM) – Developed as a tool to be used with the Section 404 Regulatory Program (Williams et al., 2010), the HGM approach is applied to wetland sites to derive functional indices as well as the protocols to apply these indices to the assessment of wetland functions. HGM can be applied to analyze project alternatives, minimize impacts, assess unavoidable impacts, determine mitigation requirements, and monitor the success of compensatory mitigation. The HGM process and report for this Revised DEIS were developed in direct response to comments from EPA on the 2015 DEIS. The HGM report (Camp et al., 2016) is included in this Revised DEIS as Appendix K.
- Rapid Geomorphic Assessment (RGA) – RGA is a tool for making preliminary evaluations of channel stability and sensitivity to an alteration in the sediment-flow regime. RGA was used to quantitatively characterize the existing conditions in Bois d'Arc Creek and its tributaries within the proposed reservoir footprint. The initial RGA report was revalidated and expanded as a result of comments on the 2015 DEIS and recommendations of cooperating agencies. These two RGAs (Freese and Nichols, 2008d; Coffman and Cardenas, 2016) conducted at the proposed reservoir site are included in this Revised DEIS as Appendix L.

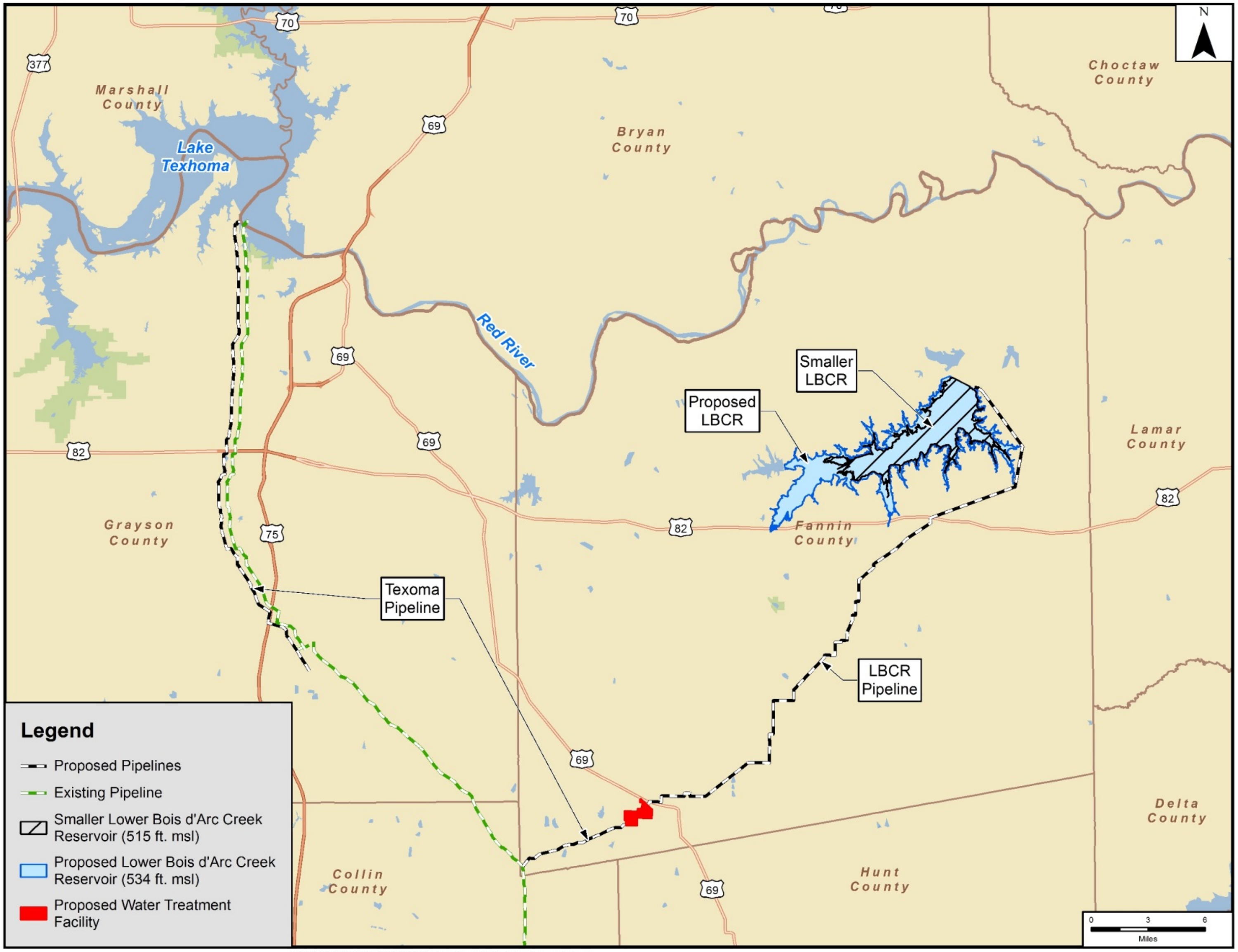

Figure 3-1. Geographic Area of the Affected Environment for Alternatives 1 and 2

- Instream Flow Study – An Instream Flow Study was conducted on Bois d'Arc Creek for this project. The primary purpose of the Instream Flow Study was to characterize baseline stream conditions within the footprint of the proposed reservoir site and downstream of the proposed reservoir. The Instream Flow study also predicted conditions in the reservoir pool and developed a proposed instream flow regime to safeguard a sound ecological environment downstream of the dam. The instream flow regime considers the four technical components described in the TWDB's *Texas Instream Flow Studies: Technical Overview*: fluvial geomorphology, hydrology and hydraulics, water quality and biology. The Instream Flow Study (Freese and Nichols, 2010a) is attached to this Revised DEIS as Appendix M.
- Economic Studies – Dr. Terry Clower, director of the Center for Economic Development and Research at the University of North Texas, conducted a study and two updates on the economic, fiscal, and development effects of the Proposed Action (Clower and Weinstein, 2004; Clower and Weinstein, 2007; Clower, 2012). These are included in this Revised DEIS in Appendix G.
- Cultural Resources Studies – An ongoing series of archeological and cultural resources surveys and studies have been conducted by AR Consultants, Inc. (e.g., see references AR Consultants, 2013; AR Consultants, 2014) under the direction of the four parties to the LBCR Programmatic Agreement: NTMWD, USACE, THC (the SHPO in Texas), and the Caddo Nation of Oklahoma. Surveys have been carried out at the proposed reservoir site, primary mitigation site (Riverby Ranch), FM 1396 relocation alignment, and raw water pipeline route. These studies and surveys are not included as appendices to this Revised DEIS because of the sensitivity of the information and data they contain.

3.1 LAND USE

The proposed reservoir of Alternatives 1 and 2 would be built in Fannin County, Texas. Fannin County is a rural county in north Texas near the Texas-Oklahoma border. The total land area of Fannin County is approximately 570,597 acres (892 square miles). Fannin County is sparsely populated with most residents spread out among the various agricultural lands that surround the City of Bonham, which is the county seat. The county's land use is predominantly hay and pasture land. Row crops are found more in the eastern half of the county. Other land uses include forest land, residential, light industrial and commercial (TCOG, no date).

3.1.1 Historical Land Use

According to the 1946 Soil Survey of Fannin County, historical land uses have been primarily cropland and pastureland. In 1939, harvested cropland represented almost half of the area of the county; cotton and corn were two of the dominant crops. Most of the remaining land within the county was used for pasture. During this time, practically all of the highly productive land was cultivated, except for the lower floodplain of Bois d'Arc Creek. Although these areas could not be cultivated, a considerable amount of rough lumber was cut, especially bois d'arc wood (Osage orange) (NRCS, 2001).

3.1.2 Current Land Use

Based on the 2001 National Land Cover Dataset, there are 570,597 acres of land in Fannin County. Seventy-one percent of the land is agricultural, making this the predominant land use in the county at present. Forest cover accounts for 21 percent of the land in the county. Other types of land use in the county are developed land (6 percent), open water (1.27 percent), wetlands (0.42 percent), barren land (0.15 percent), and shrub/scrub (0.06 percent). Figure 3.1-1 shows land use and land cover in Fannin County.

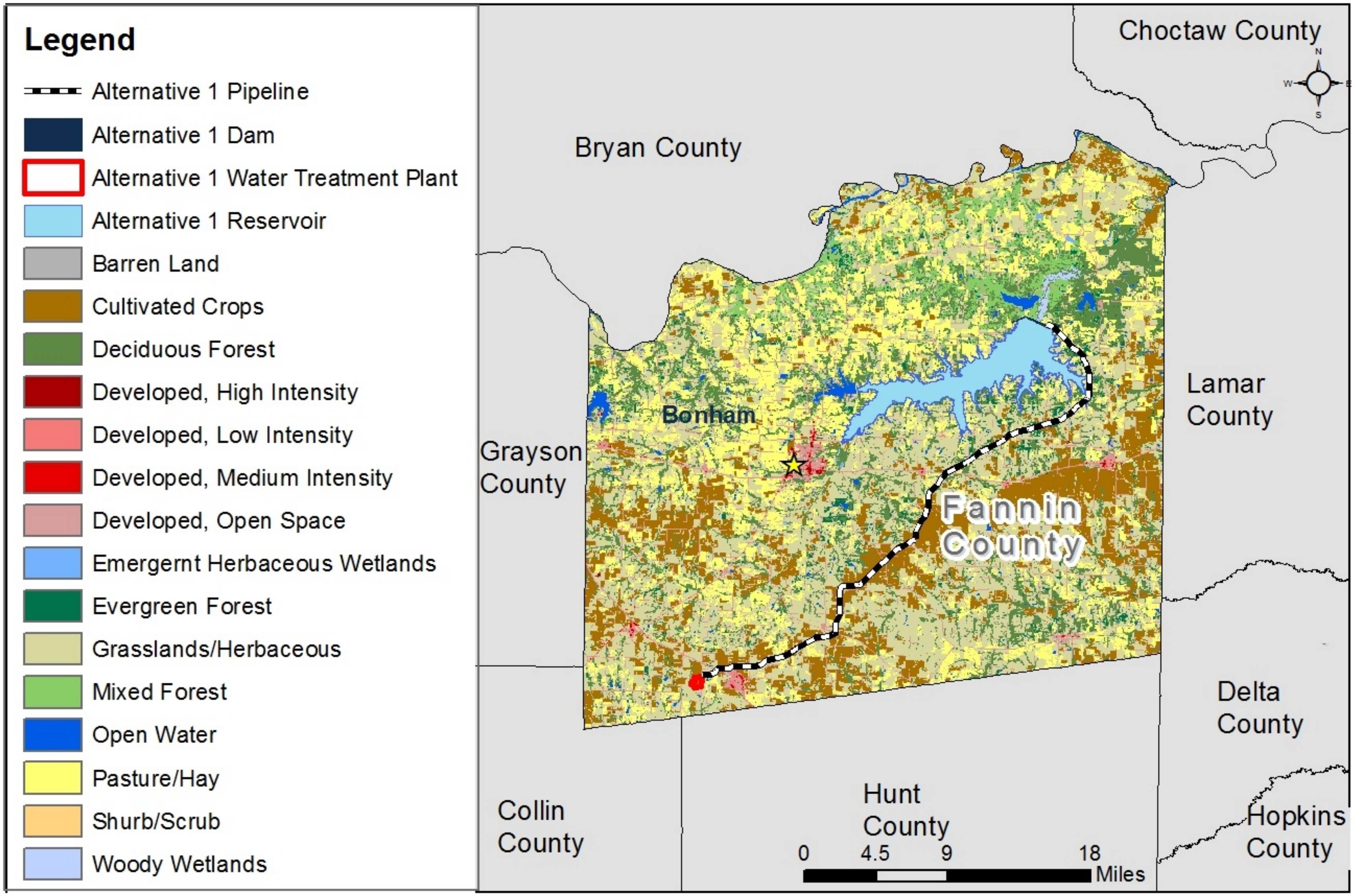

Figure 3.1-1. Land Use and Land Cover Map of Fannin County

The reservoir, dam, and spillway described in Alternatives 1 and 2 would be located on bottomland and adjacent upland habitat along Bois d'Arc Creek and on upland areas within Fannin County. The land affected by the proposed alternatives is predominantly undeveloped and includes agricultural land with grassland or old field succession. Most of the remaining land is undeveloped, consisting of natural or previously disturbed vegetative cover types. A very small portion of the affected land is in transportation, utility corridor, and scattered single family residential use. Land use of the adjoining properties does not differ substantially from that found within the boundaries of the proposed alternatives, with most of the area being agricultural or undeveloped land. Since the adjoining areas are not within the floodplains of Bois d'Arc Creek and contain a smaller component of wetlands, a higher portion of the adjoining area is in agricultural land use instead of undeveloped land and a greater proportion of the undeveloped lands have been cleared.

The Caddo National Grasslands is a federally-designated Wildlife Management Area (WMA) within Fannin County. The jurisdictional boundaries of the Grasslands cover 17,785 acres and contain three lakes. The Caddo National Grassland is comprised of two units, the Bois d'Arc Unit and the Ladonia Unit. The Bois d'Arc Unit is located just north of the proposed reservoir site and the Ladonia Unit is located Northeast of the site. Public recreational facilities are not present within the proposed LBCR area (USFS, 2008).

3.1.3 Agricultural Land

Agricultural land is land that is suitable for agricultural production, both crops and livestock. Agricultural land can be divided into the following components, all of which can be found in Fannin County:

- Arable land – land under annual crops, such as corn, cotton, and technical crops, potatoes, vegetables, and melons. It also includes land left temporarily fallow.
- Orchards and vineyards - land under permanent crops.
- Meadows and pastures – areas for natural grasses and grazing of livestock.

The first two components, arable land and orchards and vineyards, are cultivable lands. The croplands in the project area are primarily planted with oats (*Avena sativa*), soybeans, and hay crops, which are often alternated with winter wheat (*Triticum aestivum*) cover. Trees and shrubs are excluded from these areas, but are often present in adjacent fencerows. The agricultural land cover type makes up about 1,757 acres of the larger reservoir site.

In the 2000s, the area in and surrounding the identified alternatives has lost agricultural land to industrial and urban uses. From 1997 to 2012, Texas had a net conversion of 1.1 million acres of working lands to non-agricultural uses, which is correlated with population growth (Texas Land Trends, 2014). Working lands including privately owned farms, ranches, and forests that produce food and fiber, support rural economies, and provide environmental and recreational benefits (Texas Land Trends, 2014). Texas is currently leading the nation in the loss of total acres of working lands (Texas Land Trends, 2014).

3.1.4 Rural Residential

Most housing in Fannin County consists of single family residences. Scattered single family residential land use occurs within the affected areas for Alternatives 1 and 2. Approximately 20 single family homes fall within the footprint of Alternatives 1 and 2.

3.2 TOPOGRAPHY, GEOLOGY, AND SOILS

This section describes the topography, geology, and soils of the affected environment for Alternatives 1 and 2. These resources are discussed in relation to construction of the proposed dam and reservoir.

3.2.1 Topography and Geology

Most of the project components of Alternatives 1 and 2 as well as their connected actions will be in Fannin and Grayson County, Texas. These counties are considered part of the Gulf Coastal Plain physiographic province (USGS, 2003). This region is characterized by elevation levels varying from 478 feet MSL near the confluence of Bois d'Arc Creek and the Red River to 767 feet MSL in southwestern Fannin County (NRCS, 2001). A further subdivision of the Gulf Coastal Plain places the site of the proposed alternatives in the Blackland Prairies subprovince. Specifically, the Blackland Prairies have a maximum elevation of 1000 feet and a minimum elevation of 450 feet MSL. Most of the terrain features low, gently rolling hills growing progressively flatter moving from west to east. Figure 3.2-1 shows a physiographic map of Texas with the location of the proposed alternatives added.

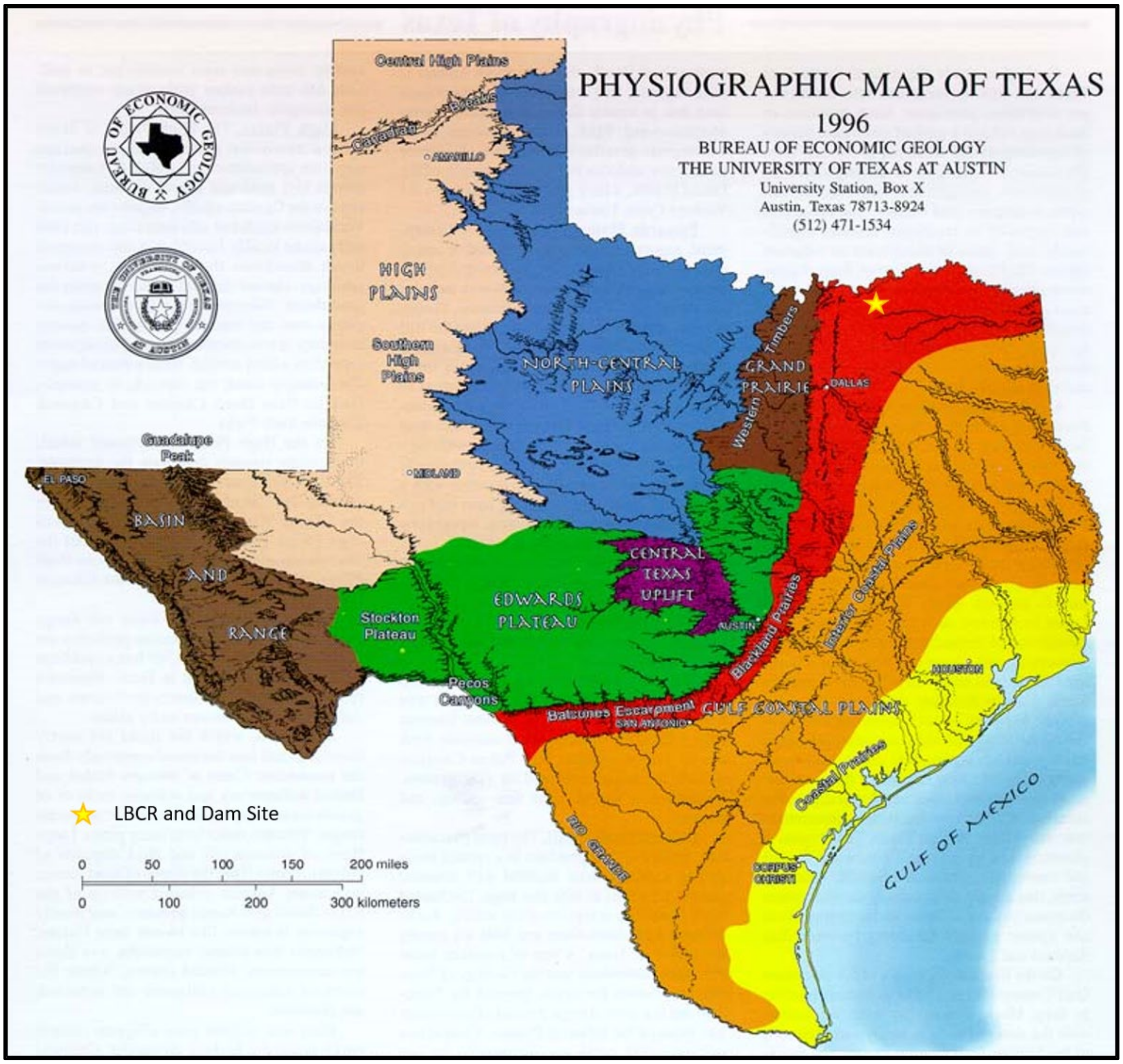

Figure 3.2-1. Physiographic Map of Texas

Note: The proposed LBCR and dam site was added on to the original map.

Over geologic time, and like other streams in the region, Bois d'Arc Creek and its tributaries have created a broad, gently-sloping valley rimmed by low hills. Maximum relief across the proposed dam site is approximately 86 feet and the elevation of the valley floor at the proposed dam site is approximately 476 feet MSL. The confluence of tributary Honey Grove Creek, entering from the southeast, with Bois d'Arc Creek is approximately 1,800 feet downstream from the proposed centerline of the dam. A broad, nearly flat floodplain separates the two creeks near the proposed dam's centerline. The proposed project area is in the Red River Basin.

Table 3.2-1 lists the geologic units at the proposed reservoir site. Cretaceous outcroppings are evident throughout Fannin County and dip south and southeast (Henderson et. al, 1973). Much of the subsurface geology is made up of fluvial, or river-sourced, deposits from both present and past streams. The first three feet of subsurface geology are deposits from floodplains and streams from relatively recent geologic history. Following the most recent deposits are much older deposits of the same nature, also floodplain and stream in origin. These can extend to a depth of 30 feet before reaching the Ozan or Bonham formation, which is Upper Cretaceous in age. This formation continues to a depth of about 425 feet and is comprised mainly of muds and clays that are alternately bedded (USGS, 2011d). Excavation for the proposed dam and reservoir would not exceed the depth of the Ozan formation listed on Table 3-2.

Table 3.2-1. Geologic Units at the Proposed Lower Bois d'Arc Creek Reservoir Site

Age	Unit	Thickness (feet)	Description
Recent	Alluvium	3+/-	Floodplain and stream deposits
Pleistocene	Fluviatile terrace deposits	30	Terrace deposits generally sands and gravel
Upper Cretaceous	Ozan Formation	425+/-	Poorly bedded calcareous clay, weathers light brownish gray
	Austin Group, Roxton Limestone	10	Sandy, red limestone
	Austin Group, Gober Chalk	400+/-	Argillaceous Chalk weathers white
	Austin Group, Brownstone Marl	30	Massive calcareous clay, weathers light gray to yellowish gray
	Austin Group, Blossom Sand	20	Quartz sand, weathers brown and red
	Austin Group, Bonham Marl	400+/-	Marl and Clay, weathers light gray to yellowish gray
	Austin Group, Ector Chalk	35	Chalk, weathers white
	Eagle Ford Formation	300-400	Medium to dark gray shale
	Woodbine Formation, Templeton Member	70-80	Gray shale
	Woodbine Formation, Lewisville Member	75-95	Glauconitic sandstone, gray to brown, and yellowish brown
	Woodbine Formation, Red Branch Member	25-80	Sandstone, shale, and lignite, gray, brown, yellowish brown and grayish black

Source: adapted from Henderson, et al., 1973

In support of their application to the TCEQ for a Texas Water Right, NTMWD conducted preliminary subsurface investigations in 2006 and 2008 at the proposed Lower Bois d'Arc Creek reservoir site. The subsurface investigations consisted of six borings to depths of approximately 50 to 70 feet along the proposed dam alignment as shown in Figure 3.2-2. Samples of rock and soils obtained in the field investigations were subjected to laboratory tests to classify the materials and evaluate pertinent engineering properties. Classification and index property tests included water content, dry unit weight, sieve tests, and liquid and plastic limits. In addition, unconfined compression tests were conducted to evaluate the strength of the bedrock.

Figure 3.2-3 presents a map showing the surficial geology of the proposed dam site (UTX, 1996). According to the Texarkana Sheet of the *Geological Atlas of Texas*, the right abutment of the proposed dam is underlain by Pleistocene-age Qt (Quaternary) 1 and Qt 4 Fluviatile terrace deposits. Qt1 deposits are mostly sand and silt, with some clay. They are moderately well bedded, and mostly red to tan in color. The Qt1 deposits are surface scrolled with a maximum thickness of 30 feet, and a top surface of about 17 feet above the floodplain. Qt 4 Fluviatile terrace deposits consist of gravel, sand, and silt. They are characterized by basal gravel grades upward to sand and silt, and are tan and gray in color. They are surface smooth on large outcrops, generally dissected with exposed bedrock at the edges, and locally sheet-washed at the head of gullies. The maximum thickness of the Qt4 deposits is 30 feet, with the top surface about 11 feet above the floodplain.

The Fluviatile terrace deposits at the proposed dam and reservoir site are underlain by the Bonham Formation (listed as the Ozan Formation in Table 3.2-2) of Upper Cretaceous Age. The Bonham Formation is composed of marl and clay, and grows progressively sandier towards the east. Glauconite (a green, iron potassium silicate) is abundant locally. The Bonham Formation is waxy, greenish gray and weathers yellowish gray and has a clay bed near the middle, is calcareous, and abundantly glauconitic. Marine megafossils (large fossils) are common in the Bonham Formation, which has a thickness that ranges from 375 to 530 feet.

Borings associated with the preliminary subsurface investigations indicated that the proposed left abutment of the dam consists of 50 to 60 feet of very stiff to hard plastic clays underlain by about 10 feet of sand and clayey sands. Beneath the sands lies unweathered shale of low permeability. The lower slope of the left abutment has about 15 feet of lean sandy clay underlain by about 10 feet of clayey or silty sands. Shale is found beneath these sands, with a thin weathered zone, approximately one foot thick, atop the shale.

Based on the preliminary 2006 geotechnical survey at the site, it appeared that medium plastic clays to highly plastic clays for the dam core might be available in sufficient quantities from the proposed reservoir areas within the floodplain and at the left abutment. An additional 2008 boring in the floodplain (Boring D-5 on Figure 3.2-2) confirmed the presence of approximately 24 feet of medium to highly plastic clays. Based on this and two other borings in each abutment, it appears there are sufficient quantities of clay for the proposed dam core and outer zones of the dam from the proposed reservoir areas within the floodplain and the proposed abutments. Silty sand may be available in the lower slope of the proposed left abutment for soil cement to protect the upstream slope of the dam.

Figure 3.2-2. Location of Geotechnical Borings at Proposed LBCR Dam Site

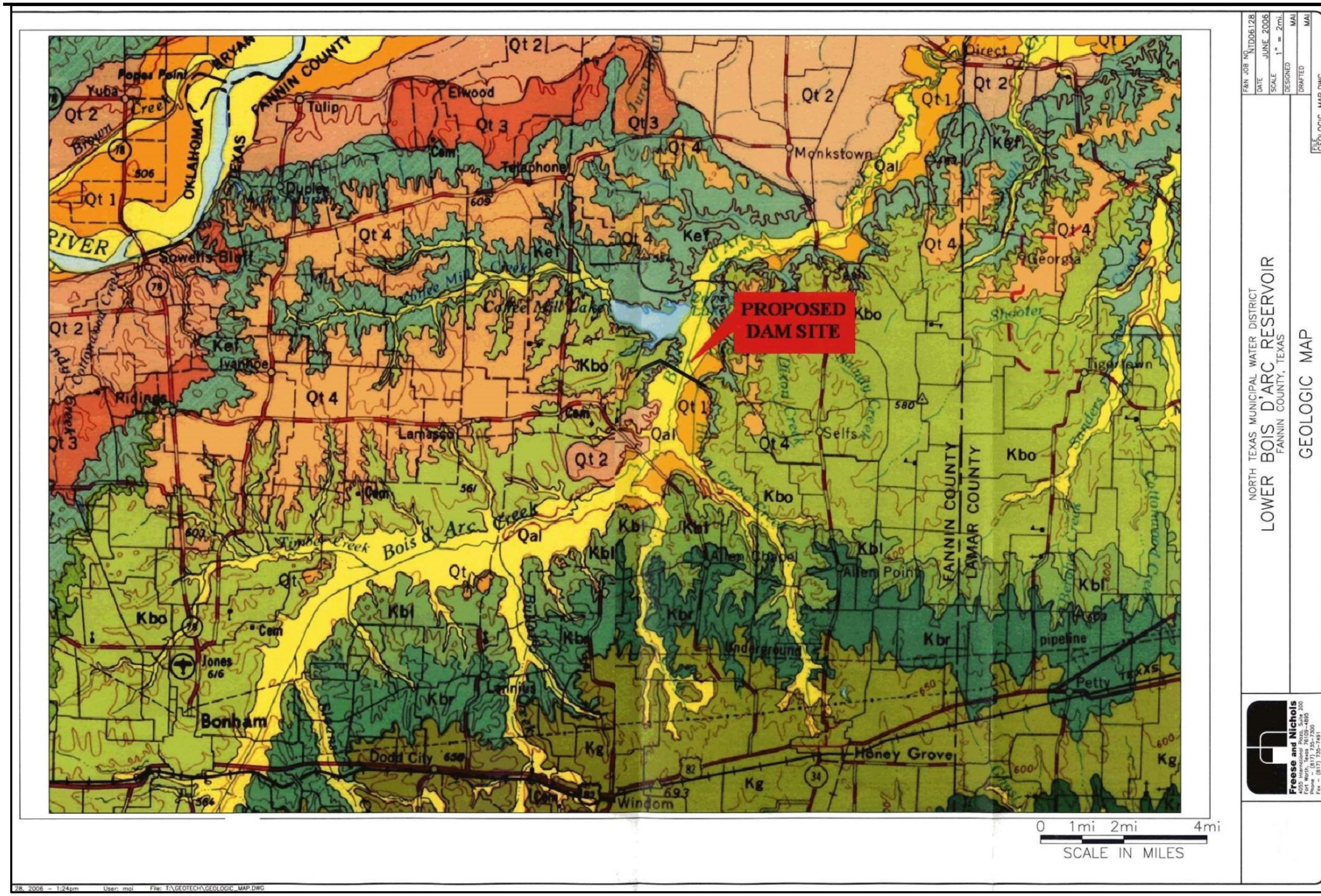

Figure 3.2-3. Geologic Map Depicting Surficial Geology of the Proposed LBCR site

Source: Geotechnical Investigation, Appendix C, Texas Water Rights Application

Overall, the preliminary geotechnical investigations concluded that long-term seepage loss of water from the reservoir is expected to be small. Excavations to construct the spillway would encounter unweathered shale with reasonable load-bearing pressures at depths of about 50 feet, reducing the scale of excavation and the quantity of roller-compacted concrete needed.

In 2014, an additional geotechnical study was conducted in support of the proposed dam design process. This study consisted of a total of 152 borings, including 73 embankment borings, 21 borrow borings, 18 service spillway chute borings, 28 emergency spillway borings, and 12 service spillway borings. Thirteen (13) standpipe piezometers were installed at selected boring locations to study groundwater conditions within the embankment foundation. A geophysical survey was also carried out on the right abutment to supplement the borings and map the extents of sandy terrace deposits.

The 2014 geotechnical study confirmed that the proposed dam site is covered with alluvial/fluvial terrace deposits that overlie bedrock of the Ector Chalk and Bonham Clay formations (both are of the Austin Group). The alluvial/fluvial deposits are primarily fat clays, with some lean clays and clayey sands, which are suitable for use in the proposed dam's core. These studies also concluded that there is sufficient clay in the proposed borrow areas within the reservoir footprint for use in construction of the dam. The rocks that are present are primarily chalky limestone with some clayey zones and shale layers. These kinds of soil and rock deposits are typical for this physiographic region, and these findings are generally consistent with the findings and recommendations of the 2006 preliminary study. The 2014 study did not identify any geotechnical issues that would impede development of the proposed alternatives.

3.2.2 Soils

This section characterizes the soils found in the areas of the proposed reservoir and dam, the proposed pipelines, water treatment plant, and terminal storage reservoir. Table 3.2-2 provides definitions for important soil science terms that are key factors in determining the appropriate location and building materials for reservoirs and dams.

Table 3.2-2 Important Soil Science Terms and Definitions

Term	Definition
Permeability	The ability of a substance to allow another substance to pass through it, especially the ability of a porous rock, sediment, or soil to transmit fluid through pores and cracks. Geologic permeability is usually measured in millidarcies.
Shrink-swell potential	The relative change in the volume of a soil to be expected with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Building foundations, roads, and other infrastructure may be harmed by shrinking and swelling soils.

Term	Definition
Soil Plasticity	The capability of soils to retain volume while changing shape due to constant pressure. After the pressure is removed, said shape is retained.

Source: Dictionary.com, 2002

Proposed Lower Bois d'Arc Creek Reservoir Site

Soil texture is determined by the proportions of different-sized particles – sand, silt, and clay – found in a particular soil sample. Figure 3.2-4 shows a diagram of soil textural classes depicted by the percentage of clay, silt, and sand in the soil. The soils in the proposed project area include many clays and loam combinations. Figure 3.2-5 shows the soil types within the footprint of both proposed reservoirs. Bois d'Arc Creek and the footprint of the proposed reservoir traverse the Tinn Soil Series. This series is moderately well drained, has very slow permeability, and features clay soils. Development of this type of soil occurs on floodplains and the soils are frequently to occasionally flooded. Since clay is the largest component of this series, there is very high shrink-swell potential. Typically, clay soils have very low erosion potential (Alan Plummer Associates, 2008).

Following the flow direction of the Bois d'Arc Creek on the south side of the proposed reservoir is a long strip of Frioton silty clay loam. This strip, which also developed on a floodplain, is occasionally flooded. The shrink-swell potential is high and the erosion potential is low. It is moderately well drained with low permeability (NRCS, 2001).

The north side of the proposed reservoir contains large areas of Dela loam, Porum loam, Derly silt loam, and the Derly-Raino complex. These complexes are all moderately well drained with moderate to slow permeability. The Dela and Porum series are subject to flooding. The Derly series is commonly subject to ponding (formation of shallow, temporary ponds) during rainy periods due to its location in depressions, slow permeability, and negligible runoff. The Derly Raino complex has the same characteristics of the other classes found at the site with low permeability and low runoff (NRCS, 2001).

In the preliminary geotechnical investigation, Borings D-5, D-6, and D-7 (shown in Figure 3.2-2) encountered Tinn Clay, Ellis Clay and Porum Loam, respectively. The Tinn Series is described as "very deep, moderately well drained, very slowly permeable, clayey soils on flood plains along streams. These soils formed in clayey alluvium." The Ellis Series soils are, "very deep, well drained, very slow permeable, clayey soils on uplands. These soils formed in clay and shale." The Porum Series soils include: "very deep moderately well drained, slowly permeable, loamy soils on terraces along the Red River. These soils formed in loamy sediments" (NRCS, 2001).

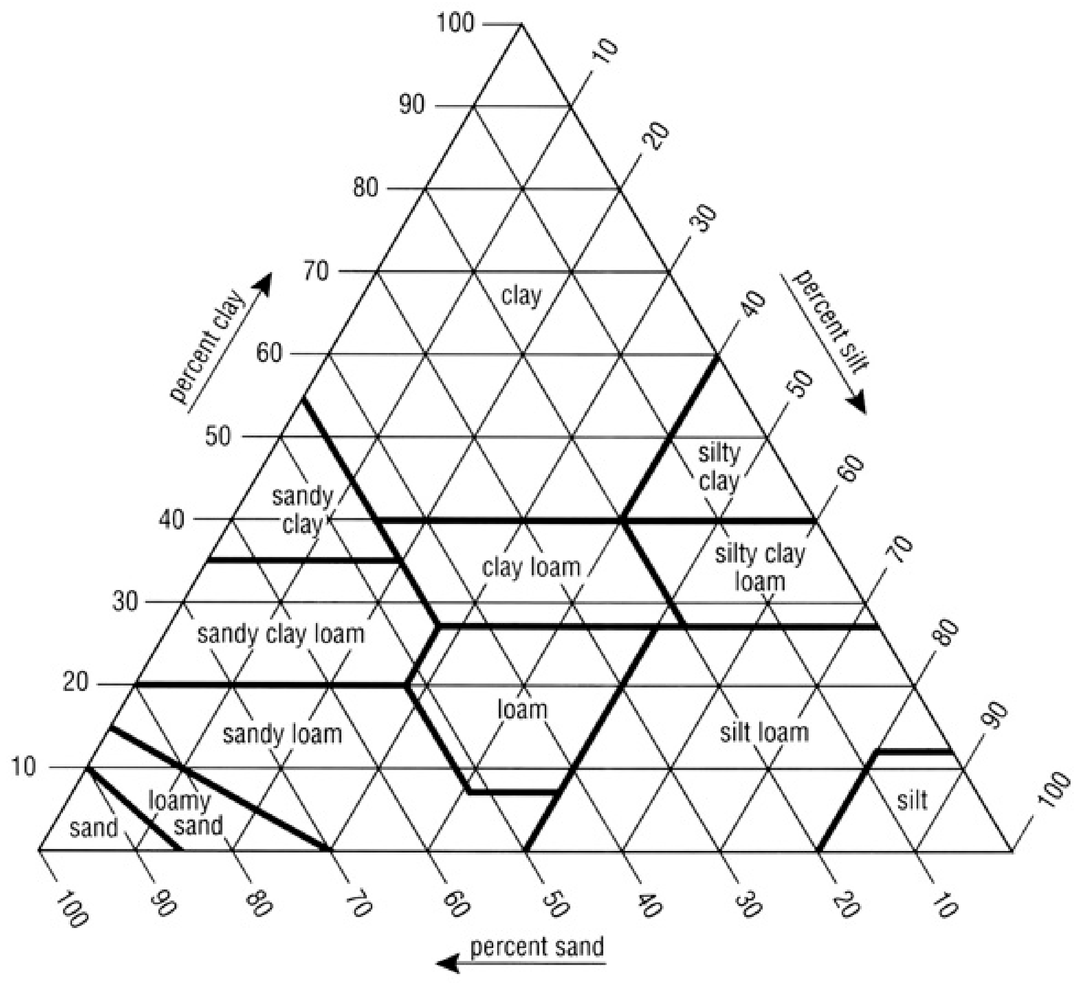

Chart showing the percentages of clay, silt, and sand in the basic textural classes.

Figure 3.2-4. Diagram Depicting Soil Textural Classes

Source: NRCS, no date

Borings D-5 and D-6 (shown in Figure 3.2-2) in the preliminary geotechnical investigation encountered clay soils at the ground surface. These contained varying amounts of silt with traces of sand and gravel and ranged from low to high plasticity. They extended to depths of about 10 to 24.2 feet below ground surface (bgs), and were underlain by weathered shale. Boring D-7 (see Figure 3.2-2) encountered sandy soils at the ground surface which extended to a depth of about 3 feet bgs and were underlain by clayey and sandy soils. The sandy soils were fine to medium grained, and the clayey soils ranged from low to high plasticity. The sandy and clayey soils extended to a depth of about 42.5 feet bgs and were underlain by weathered shale. Moisture content for the sandy soils ranged from 3 to 19 percent with the lower moisture contents encountered near the ground surface. Moisture content for the clayey soils ranged from 12 to 37 percent with the lower moisture contents obtained in the sandy clays and the higher moisture contents obtained in the high plastic clays. Liquid limits for the clayey materials ranged from 36 to 85 and plasticity indices in the clayey materials ranged from 22 to 59. Based on the Fannin County Soil Survey, it appears that sandy soils and lean clays are present along the west valley slope and on top of the

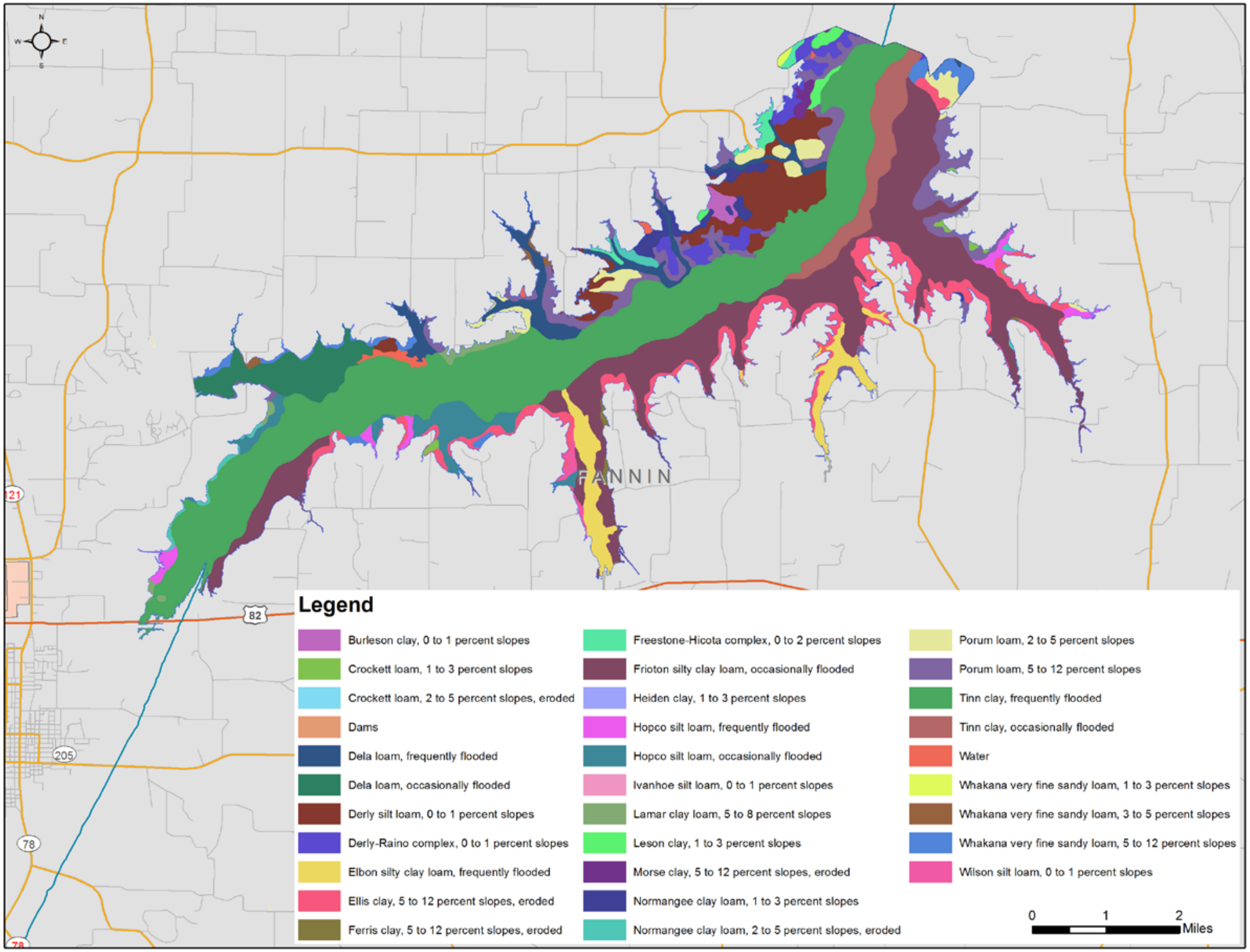

Figure 3.2-5. Soil Types Within Larger Reservoir Footprint

right abutment area of the proposed dam. These soils could be used in the outer zones of the dam, but additional borings would be required to determine the type and quantity of soils in the embankment available for use.

Proposed Raw Water Pipeline Routes, WTP, and TSR

The soils found along the proposed raw water pipeline routes, as well as the soils found at the site of the proposed WTP and the adjacent TSR fall mainly under the classification of "clayey and loamy slightly acid to moderately alkaline soils on uplands" (NRCS, 2001). Nearly 30 distinct soil units occur, including the following:

- Austin silty clay loam, 1 to 3 percent slopes
- Crockett loam, 1 to 3 percent slopes
- Crockett loam, 2 to 5 percent slopes, eroded
- Dela loam, frequently flooded
- Derly-Raino complex, 0 to 1 percent slopes
- Ellis clay, 5 to 12 percent slopes, eroded
- Fairlie clay, 0 to 1 percent slopes
- Fairlie-Dalco complex, 1 to 3 percent slopes
- Ferris clay, 5 to 12 percent slopes, eroded
- Freestone-Hicota complex, 0 to 2 percent slopes
- Frioton silty clay loam, occasionally flooded
- Heiden clay, 1 to 3 percent slopes
- Heiden-Ferris complex, 2 to 6 percent slopes, eroded
- Hopco silt loam, frequently flooded
- Houston Black clay, 1 to 3 percent slopes
- Howe-Whitewright complex, 3 to 5 percent slopes
- Leson clay, 1 to 3 percent slopes
- Normangee clay loam, 1 to 3 percent slopes
- Normangee clay loam, 2 to 5 percent slopes, eroded
- Porum loam, 2 to 5 percent slopes
- Porum loam, 5 to 12 percent slopes
- Stephen silty clay, 1 to 3 percent slopes
- Tinn clay, occasionally flooded
- Tinn clay, frequently flooded
- Whakana very fine sandy loam, 5 to 12 percent slopes
- Whitewright-Howe complex, 5 to 12 percent slopes, eroded
- Wilson silt loam, 0 to 1 percent slopes

The percent slope refers to the unit of measurement for the slope gradient ranging from Nearly Level (0-2) to Very Steep (>35) (Purdue Extension, no date). The term eroded indicates the removal of soil by water, wind, or both. These units are shown in 35 detailed maps included in a supplemental report titled *Supporting an Application for a 404 Permit for Lower Bois d'Arc Creek Reservoir (SWT-0-14659)*, (Freese and Nichols, 2013b).

The major soil groups along the pipeline routes and at the site of the WTP and TSR include the Fairlie-Delco complex, Houston Black clay, Howe-Whitewright complex. The Fairlie-Delco complex consists of deep soils with surface and subsoil layers reaching about 54 inches in depth. These are moderately alkaline soils that are also clayey and are used as cropland. They tend to have high shrink-swell potential, which decreases their potential for urban and industrial uses. Slopes are low, averaging 0 to 3 percent (NRCS, 2001). The Houston Black clays are very deep and can have a total depth of up to 80 inches. As with the Fairlie-Delco complex, these soils are well suited for use as cropland. The shrink-swell potential is high due to the high concentration of clay in the complex. Slopes are low, with ranges from 1 to 3 percent (NRCS, 2001). The Howe-Whitewright complex soils are shallower than the previous two soil types discussed. These soils usually reach a depth of 20 inches, and are followed by grey chalk parent materials. These soils can be found on slopes of 3 to 12 percent. This complex is useful as rangeland and sometimes improved pasture. There is a high concentration of lime, which can have a negative effect on certain crops. There is a high shrink-swell potential, which limits options for soil use (NRCS, 2001).

The soils in the footprint of the site of the proposed WTP and TSR are similar to those found along the pipeline route. Figures 3.2-6, 3.2-7, and 3.2-8 illustrate the variety of soils found at this location.

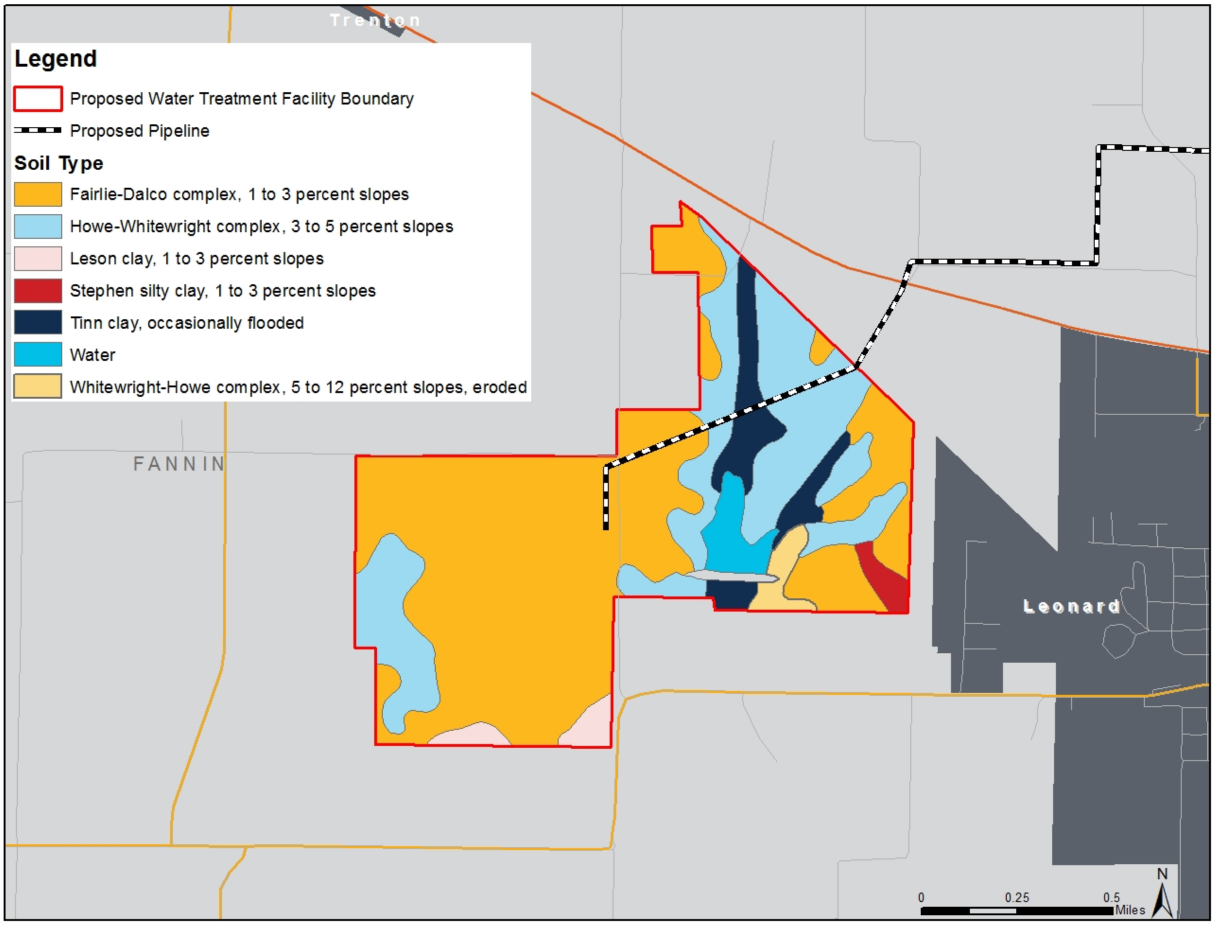

Figure 3.2-6. Location Map of Soils Found at the Site of the Proposed WTP and TSR

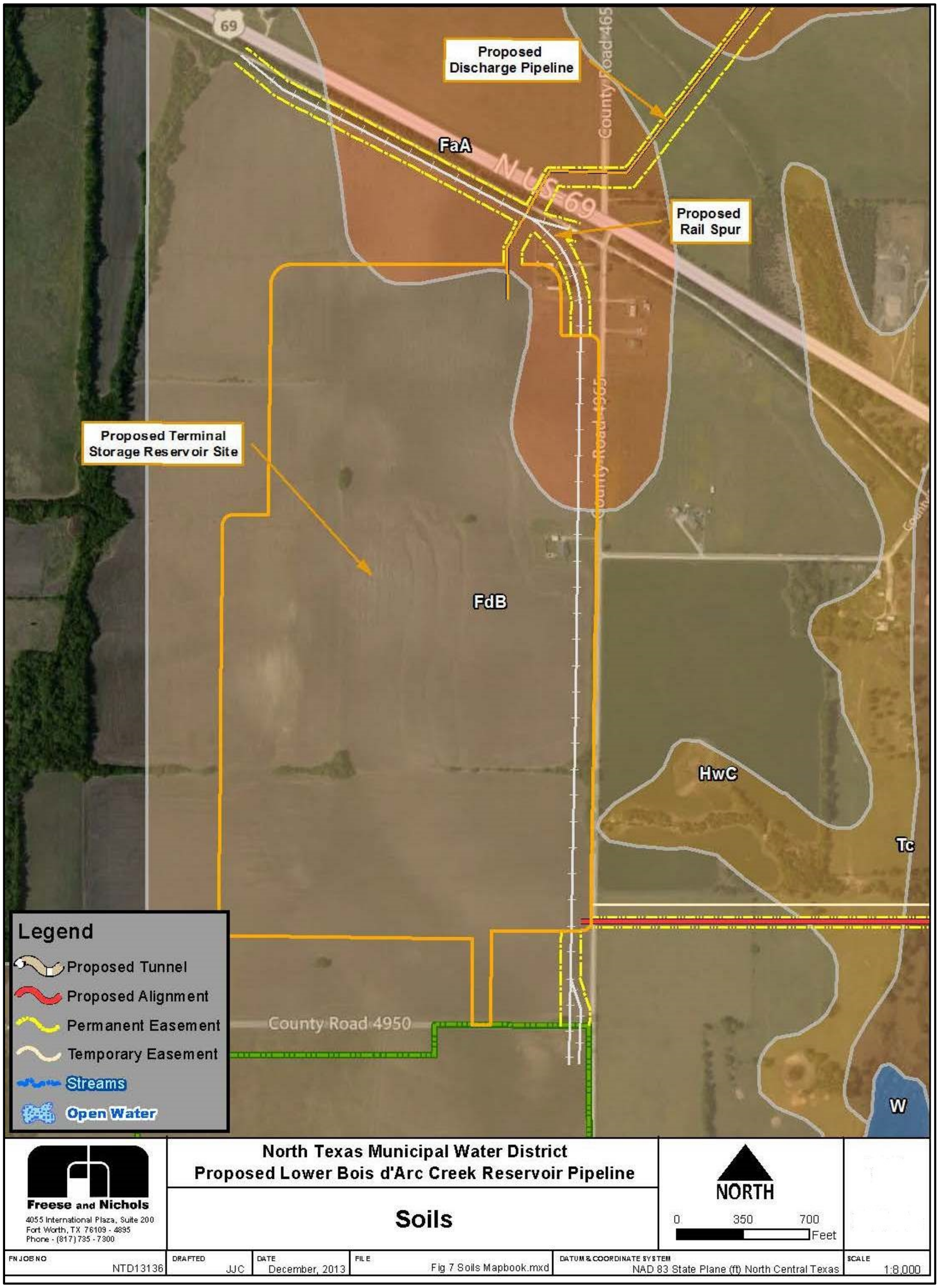

Figure 3.2-7. Vicinity Map of Soils Found at the Site of the Proposed TSR

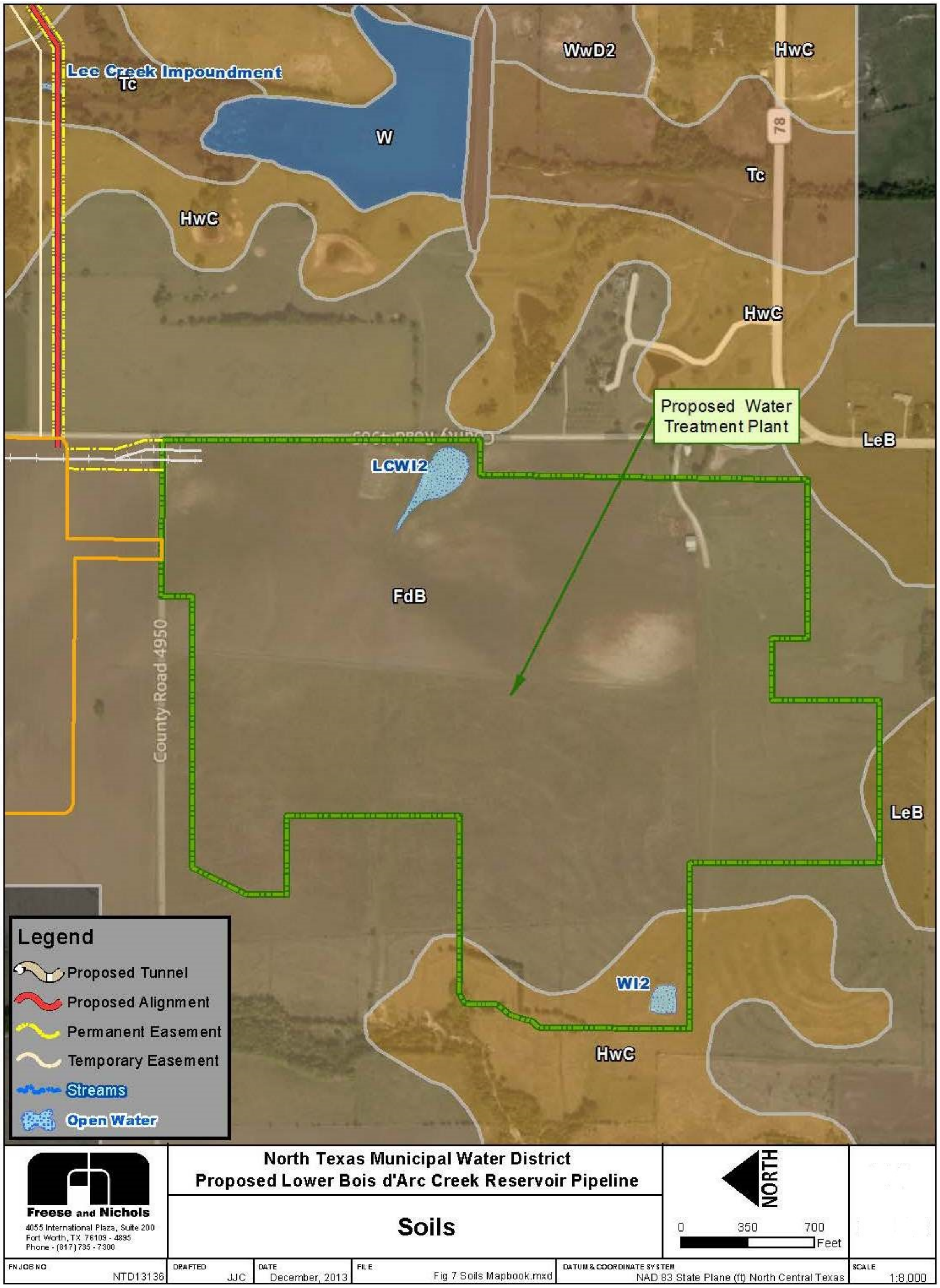

Figure 3.2-8. Vicinity Map of Soils Found at the Site of the Proposed WTP

3.2.3 Prime Farmland

Within the proposed reservoir site, there are 13 soils considered Prime Farmland. Prime Farmland soils are defined by the United States Department of Agriculture (USDA) in section 622.04 of the National Cooperative Soil Survey (NCSS) Standards as soils containing the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops.

The 13 soils at the site of the proposed reservoir that are designated as Prime Farmland by the USDA include (NRCS, 2001).

- Austin silty clay loam, 1 to 3 percent slopes
- Burleson clay, 0 to 1 percent slopes
- Dela loam, occasionally flooded
- Fairlie clay, 0 to 1 percent
- Fairlie-Delco complex, 1 to 3 percent slopes
- Freestone-Hicota complex, 0 to 2 percent slopes
- Frioton silty clay loam, occasionally flooded
- Heiden clay, 1 to 3 percent slopes
- Houston black clay, 1 to 3 percent slopes
- Leson clay, 1 to 3 percent
- Tinn clay, occasionally flooded
- Whakana very fine sandy loam, 1 to 3 percent slopes
- Whakana very fine sandy loam, 5 to 12 percent slopes.

3.3 WATER RESOURCES

This section discusses the existing conditions for water resources that would be affected by Alternatives 1 and 2. A brief description of the methodology used to characterize the affected environment is provided. The affected area for water resources is generally the Bois d'Arc Creek watershed.

3.3.1 Methods

Water resources are described and quantified in this chapter based on information obtained from several different methods, including field sampling, water and sediment transport models, and database searches.

<u>Surface Waters</u>

Bois d'Arc Creek Watershed

The United States Army Corps of Engineers (USACE) river channel floodwave routing model, HEC-RAS, and site-specific data were used to estimate the water surface along Bois d'Arc Creek under different rainfall conditions. Elevation contour data from aerial photography and LiDAR mapping were used to develop more than 100 cross-sections along 22 miles of Bois d'Arc Creek for the HEC-RAS model. The 2-year and 100-year floodplains were mapped. A detailed description of the HEC-RAS modeling is presented in Appendix Q.

Bois d'Arc Creek and Red River Surface Flow

Surface flows were obtained from United States Geological Survey (USGS) gaging stations on Bois d'Arc Creek and the Red River (USGS, 2017). An Instream Flow Study for Bois d'Arc Creek was also conducted where some additional baseline flow conditions within the study area were characterized The complete Instream Flow Study is presented in Appendix M. Downstream baseline conditions were characterized using USGS stream gage data supplemented with recently collected data. As part of the study, a RiverWare model was assembled to simulate the response of the watershed to changing stream conditions over time. RiverWare is a hydrologic model that simulates management of reservoir and stream segments. It was originally developed by the Center for Advanced Decision Support for Water and Environmental Systems, a division of the University of Colorado at Boulder. The Bois d'Arc Creek RiverWare model was used to characterize the existing baseline conditions of the watershed as well as to assess future conditions with a dam and reservoir in place. Flows for the RiverWare model are based on data from the nearby North Sulphur River near Cooper gage (USGS 07343000) and the Texas Council on Environmental Quality (TCEQ) Red River Basin Water Availability Model. The Bois d'Arc Creek RiverWare model uses a daily time step, and it covers the half-century period from 1948 to 1998.

During the Instream Flow Study, Freese and Nichols personnel and cooperating agency participants from USACE, Texas Commission on Environmental Quality (TCEQ), and the Texas Parks and Wildlife Department (TPWD) collected data from May through July 2009 at locations along the mainstem of the Bois d'Arc Creek. Data were collected at locations above and below the proposed reservoir site at Highway 82, at County Road (CR) 2645, at Farm-to-Market (FM) 1396, at FM 409, and on United States Forest Service (USFS) property located downstream of FM 100. Flow measurements and field activities were not random but rather targeted for specific flow events. The hydrology/hydraulics field methods included measuring discharge, velocity, and depth at low flow at the FM 1396 and FM 409 sites. Information available from TCEQ that classifies stream channels as intermittent and /or ephermeral was also incorporated as appropriate (TCEQ, 2016a).

Stream Channel Characterization (Fluvial Geomorphology)

In 2008, a Rapid Geomorphic Assessment (RGA) was conducted on Bois d'Arc Creek and four major tributaries (Honey Grove Creek, Sandy Creek, Ward Creek, and Bullard Creek) within the inundation pool of the proposed reservoir (detail of the RGA are available in Appendix Q). An RGA is similar to Step 1 of a Texas Instream Flow Study. The RGA methodology integrates field data and desktop sources to quantify the features that affect stream stability and aquatic habitat potential. The RGA classified each stream segment as "good," "fair," or "poor" rating the segment's state of equilibrium and stream stability. A "good" rating indicates a relatively stable channel in which sediment transport capacity is balanced with sediment supply, while a "poor" rating implies disequilibrium with unstable, eroding channel sections and degraded instream habitats. A "fair" rating indicates a moderately stable channel reach, in which the sediment transport capacity is not in balance with the sediment supply.

Additional RGA surveys and data collection were carried out at the proposed reservoir site in 2016. Figure 3.3-1 shows the locations identified for RGA data collection in 2007 and 2015 that were subsequently sampled in 2008 and 2016. For the 2016 RGA survey, the USACE and cooperating agencies identified 10 additional smaller tributaries within the footprint of the proposed reservoir for additional data collection. These tributaries included Allen's Creek, Burns Branch, Fox Creek, Onstott Creek, Pettigrew Branch, Sandy Branch, Stillhouse Branch, Timber Creek, Thomas Branch, and Yoakum Creek. The 2016 RGA also included additional sampling points on Honey Grove Creek, Sandy Creek, and Ward Creek. Fieldwork to gather the supplemental RGA data occurred in January 2016. Cooperating agency members were invited to participate in the field data collection effort. The supplemental RGA data were collected using the same RGA methodology as the previous investigations at the proposed reservoir footprint in 2008.

Bois d'Arc Creek Water Quality

Water quality sampling was used to assess Bois d'Arc Creek. Water quality samples were collected at seven sites on Bois d'Arc Creek, including sites located upstream of the proposed reservoir site (at FM 78 and U.S. 82), within the proposed reservoir site (at CR 2645 and FM 1396), and downstream of the proposed reservoir site (at FM 409, FM 100, and USFS). These water quality sampling sites are shown on Figure 3.3-2.

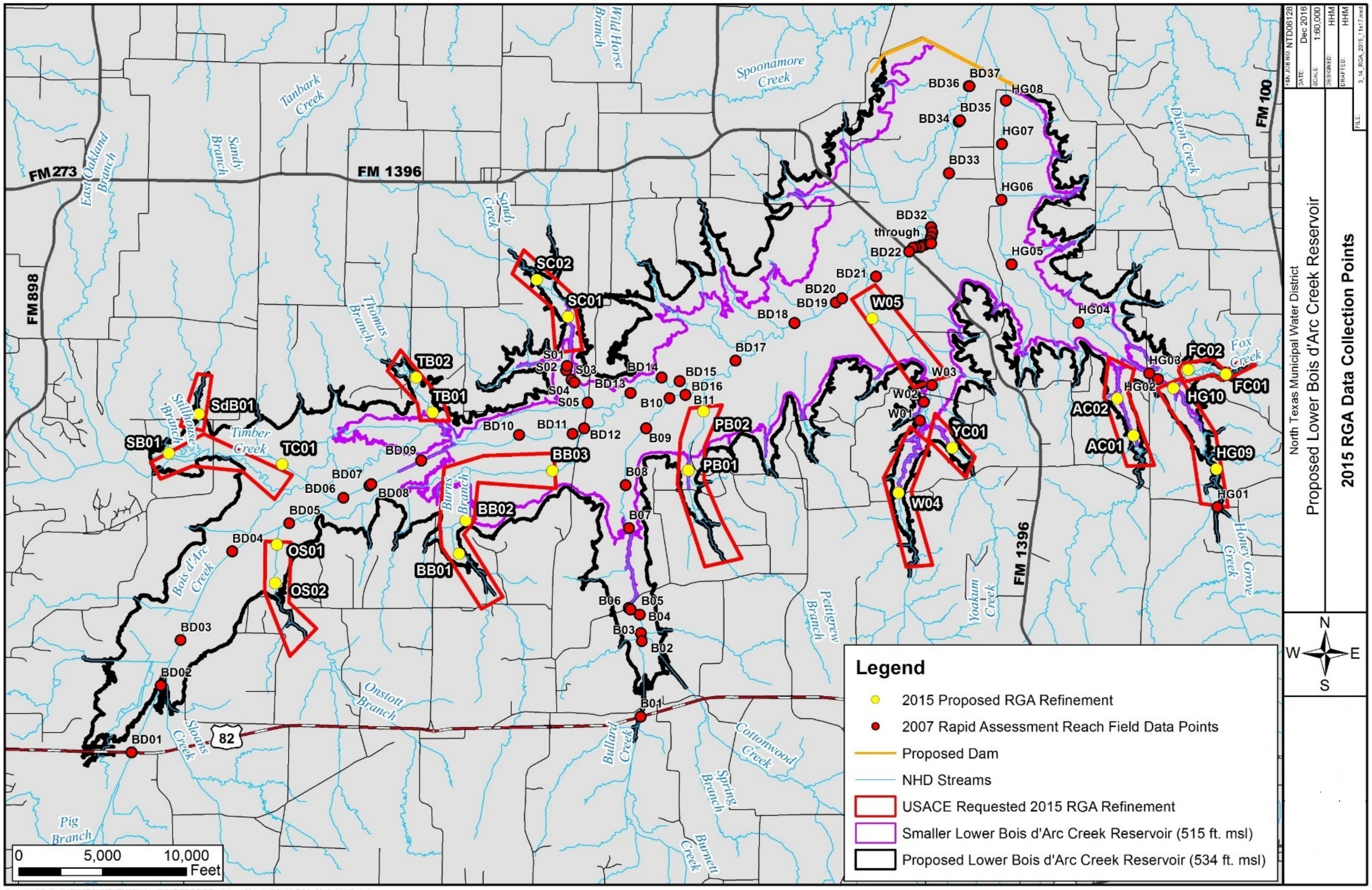

Figure 3.3-1. Rapid Geomorphic Assessment Data Collection Sites

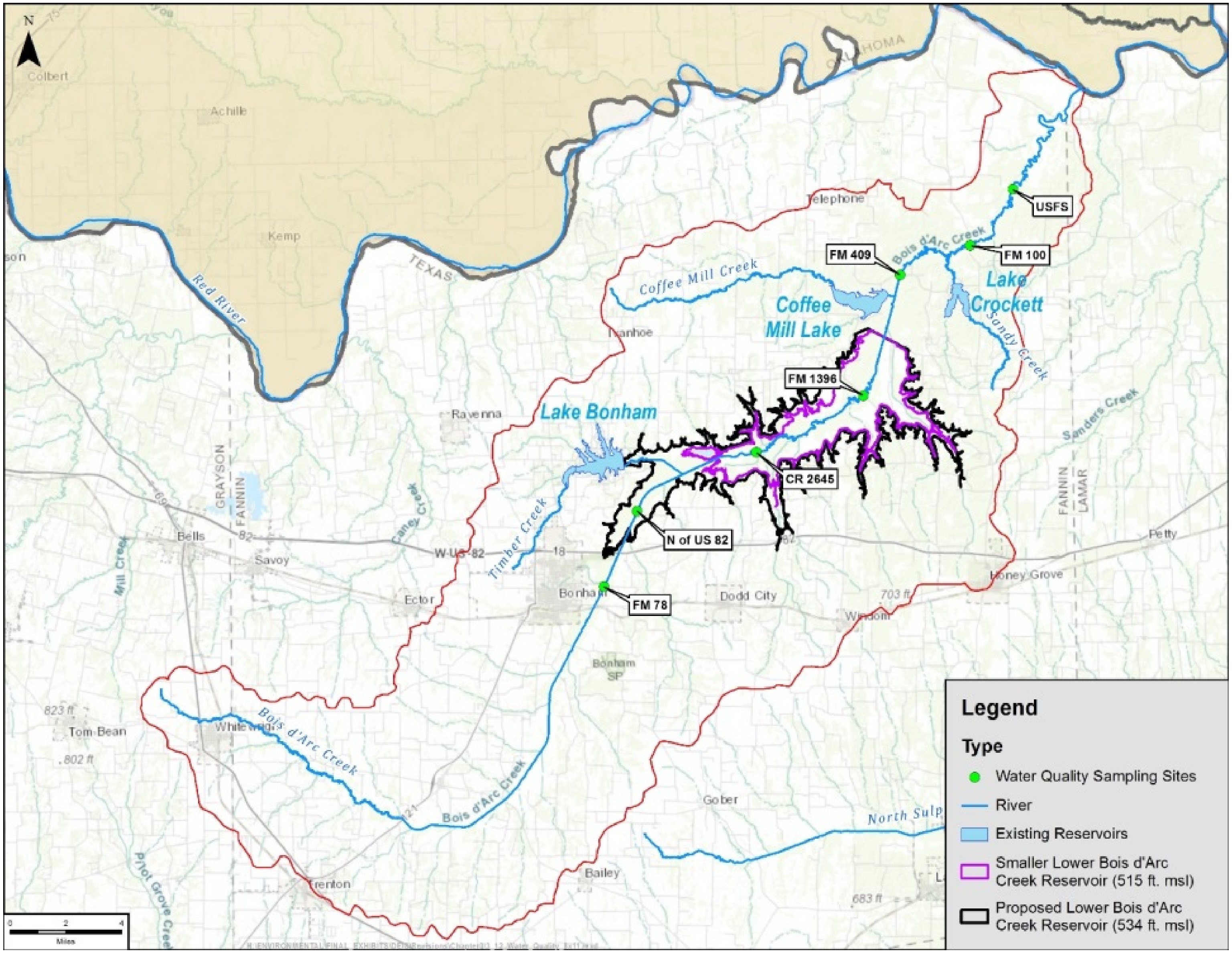

Figure 3.3-2. Water Quality Sampling Sites Along Bois d'Arc Creek

Bois d'Arc Creek water quality sampling included:

- FM 100 site by the Red River Authority between 1997 and 2006
- FM 78 site by the Red River Authority in 2004 and 2005
- FM 1396 and FM 409 site by the USGS between 2006 to present
- U.S. 82, FM 1396, and FM 409 sites by the NTMWD between June 2007 and December 2008
- U.S. 82, CR 2645, FM 1396, FM 409, and USFS sites in June and July 2009

Also, for historical reference, water quality results from 1996 to 2006 were summarized for 13 water quality sampling stations within the Red River Basin as a part of the North Texas Municipal Water District's (NTMWD) report supporting an application for a Texas water right for the Lower Bois d'Arc Creek Reservoir. The Instream Flow Study also collected water quality data from other sources (USGS, TCEQ, and Red River Authority (RRA)).

Groundwater

The analysis of groundwater conditions in the study area are based on records obtained from the Texas Water Development Board (TWDB) groundwater database (TWDB, 2017). Although this database includes only a small percentage of wells in the state, it is the most comprehensive source of data on groundwater wells in the state and is reliable for the purposes of this analysis because the data are representative of groundwater conditions. Thus, while the use of this database will provide valuable information upon which to base aquifer descriptions, it does not include all of the wells that have actually been drilled or are currently present in the affected area.

3.3.2 Surface Waters

Surface waters located in the affected environment for Alternatives 1 and 2 fall within three river basins: Red River, Sulphur and Trinity. Surface waters in the Red River Basin are associated with the reservoir and pipeline footprints in Fannin County while surface waters in the Sulphur and Trinity Basins are associated solely with the pipelines' footprints. Surface waters within the project footprint in the three basins for Alternative 1 include approximately 120 acres (286,139 linear feet) of existing intermittent streams, 99 acres (365,002 linear feet) of intermittent/ephemeral streams, and 78 acres of open water, 1.91 acres of upland, off-channel open waters (ponds, stock tanks, etc.), and 0.10 acre of on-channel open waters. Alternative 2 includes these waters plus Lake Texoma, which has a surface area of 86,910 acres.

River Basins

Texas river basins are illustrated in Figure 3.3-3. The affected environment for Alternatives 1 and 2 covers three drainage basins. The Red River Basin is the fourth largest river basin in Texas, with a drainage area of 24,297 square miles in Texas. Additionally, the Red River is the second longest river associated with Texas, with 695 miles of the river located in Texas. From its headwaters in eastern New Mexico, the Red River flows across Texas, along the Texas–Oklahoma border, and into Arkansas before reaching its confluence with the Mississippi River in Louisiana. The Red River Basin is area number 2 in Figure 3.3-3. The Sulphur River basin (area number 3 in Figure 3.3-3) has the largest average watershed yield of any river basin in Texas with 3,558 square miles in Texas. From the eastern state line of Texas, the Sulphur River flows into Arkansas and joins with the Red River. The Trinity River basin (area number 8 in Figure3.3-3) is the largest river basin whose watershed is entirely within the State of Texas and the third largest river in Texas by average flow volume (TWDB, 2017). The Trinity River is formed in the northern part of the state and flows southeasterly into the Trinity Bay and into the Gulf of Mexico (TWC, 1963). The drainage area is 17,969 square miles at the mouth (USGS, 1963).

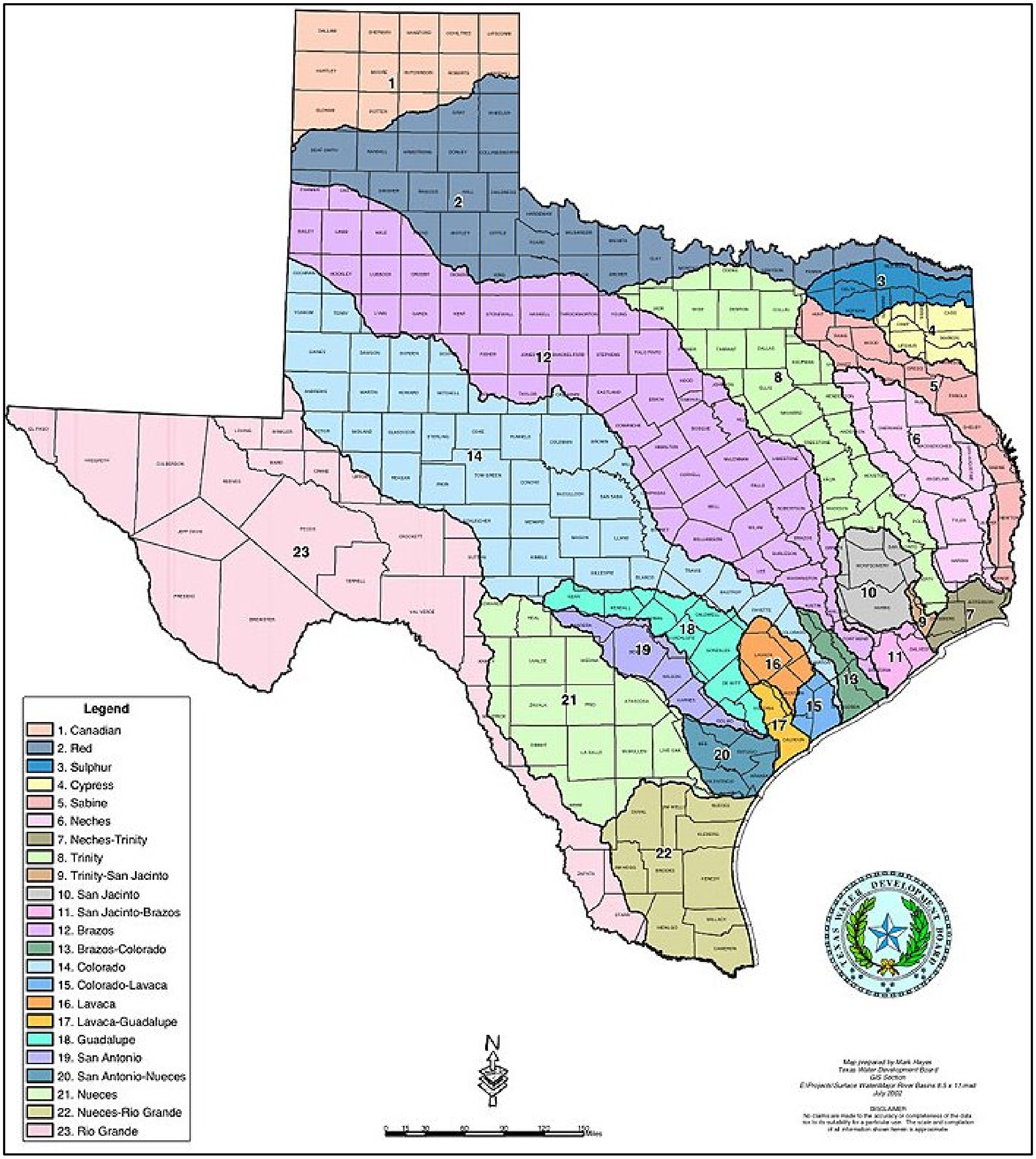

Figure 3.3-3. Texas River Basins

Precipitation and Evaporation

Hydrological variability over time in a catchment basin or watershed is influenced by variations in precipitation over daily, seasonal, annual, and decadal time scales. The frequency of low flows within a river basin is primarily affected by changes in the seasonal distribution and year-to-year variability of precipitation and the occurrence of prolonged droughts. Evaporation from the land surface includes evaporation from open water, soil, shallow groundwater, and water stored on vegetation, along with transpiration through plants. The rate of evaporation from the land surface is driven by meteorological controls, mediated by the characteristics of vegetation and soils, and constrained by the amount of water available. Climate change has the potential to affect all of these factors in a combined way that affects each evaporation component differently but is not yet clearly understood (IPCC, 2013).

Average annual precipitation in the region of the proposed project is 45 inches per year as shown in Figure 3.3-4. Most of the rain falls in May (an average of 5.55 inches), June (an average of 5.31 inches), and October (an average of 5.08 inches) (U.S. Climate Data, 2017). In the extremely wet year of 2015, the area received over 76 inches of rain. During the growing season, the median rainfall is 1.63 inches per two-week period. Weather records from nearby Bonham, Texas indicate the four highest consecutive rainfall periods are from the end of April through mid-June, with median rainfall levels ranging from 2.69 to 2.25 inches over 14 days. The total median rainfall over this 8-week period is nearly 10 inches (Watters and Kiel, 2016).

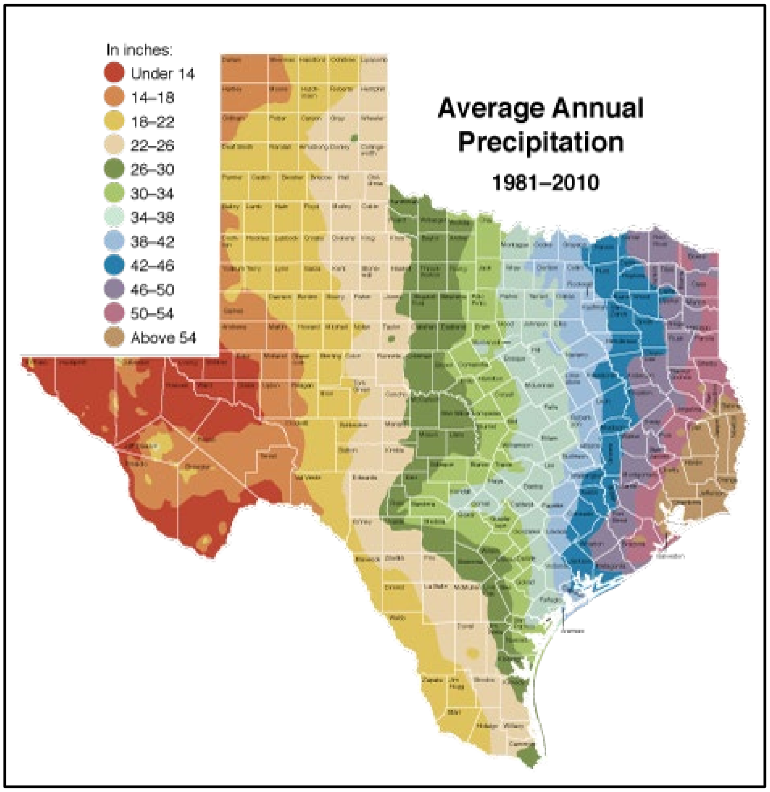

Figure 3.3-4. Average Annual Precipitation in Texas

Texas has experienced several droughts in modern history. A record drought occurred in the State from 1950–1957. This seven-year drought was a turning point in Texas history that led to the formation of the TWDB (TWDB, 2017). Since then, Texas has faced several droughts, including the most recent and most severe drought from 2010 to 2011. In north-central Texas, precipitation during a 12-month period (September 2010 to August 2011) was only 64 percent of normal, the driest September–August period since 1956.

The State experienced a short and rainy respite in the winter and spring of 2012, but by the fall of 2012, dry conditions had returned to much of the State. Dry conditions persisted until late in the summer of 2013, when a sustained rainy period lowered the percentage of the State experiencing drought (NPR, 2017). However, dry conditions have remained in the study area. The U.S. Drought Monitor currently shows north-central Texas to be in a "severe drought" (National Drought Mitigation Center, 2017).

Rivers and Streams

Red River

The Red River's name comes from its color, which in turn comes from the fact the river carries large quantities of red soil during floods. The drainage area of the Red River in Texas is 30,700 square miles. In 1944, Denison Dam was completed on the Red River to form Lake Texoma. Principal tributaries of the Red River, exclusive of its various forks, include the Pease and Wichita Rivers in north central Texas, and the Sulphur River in northeast Texas.

There are no USGS gages on the Red River in Fannin County. The closest USGS gage on the Red River downstream of its confluence with Bois d'Arc Creek is located at Arthur City (USGS 07335500). Approximately half the flow at this gage originates as releases from Lake Texoma, which are mostly related to operation of a hydropower electric generating plant and can vary substantially on any given day. In recent years, on average, approximately 3 to 4 percent of the total flow at the Arthur City gage originated from the Bois d'Arc Creek watershed above the proposed dam site.

Table 3.3-1 shows daily average flow rates of the Red River at Arthur, Texas and near De Kalb, Texas during the eight years between July 2006 and June 2014, a recent period for which data are available at this site. Minimum daily average flows for the selected gages range from approximately 177 cfs to 351 cfs, and maximum daily average flows ranged from approximately 80,800 cfs to 97,800 cfs. The median flow of 2,150 cfs at Arthur City is that which is exceeded half of the time; by the time the Red River reaches De Kalb, the median flow has grown to 3,510 cfs, as a result of inflows from tributaries.

Table 3.3-1. Daily Average Flow Rates of the Red River at Arthur Texas and Near De Kalb, Texas, July 2006 to June 2014

Relative Total Water Flow	Red River Flow at Arthur City, TX (cfs)	Red River Flow near De Kalb, TX (cfs)
Maximum	80,800	97,800
90%	17,590	28,490
75%	5,288	9,265
Median	2,150	3,510
25%	873	1,623
10%	456	850
Minimum	177	351

Source: Albright, 2014b.

The "Red River near De Kalb, Texas" (USGS 073368270) gage is located 112 river miles downstream of the Bois d'Arc Creek–Red River confluence in Bowie County near the state line. Daily mean discharge values were compiled for this gage for its period of record (1969 to 2010), yielding an average annual discharge at this point on the Red River of 10.3 million acre-feet (USGS, 2011b). That is, on average, 10.3 million AF of water flow past this point every year.

Bois d'Arc Creek

Bois d'Arc Creek is a tributary of the Red River and has a drainage area of425 square miles. The Bois d'Arc Creek watershed has three existing reservoirs: Lake Bonham, Coffee Mill Lake, and Lake Crockett. Surface flows in the watershed are characterized by three USGS stream gages:1) station number 07332600, Bois d'Arc Creek near Randolph, Texas, which operated between December 1962 and September 1985; 2) station number 07332620, Bois d'Arc Creek at FM 1396 near Honey Grove, Texas, which began collecting data in June 2006; and 3) station number 07332622, Bois d'Arc Creek at FM 409 near Honey Grove, Texas, which began collecting data in June 2009. The existing reservoirs and the locations of the two currently existing stream gages are shown in Figure 3.3-5.

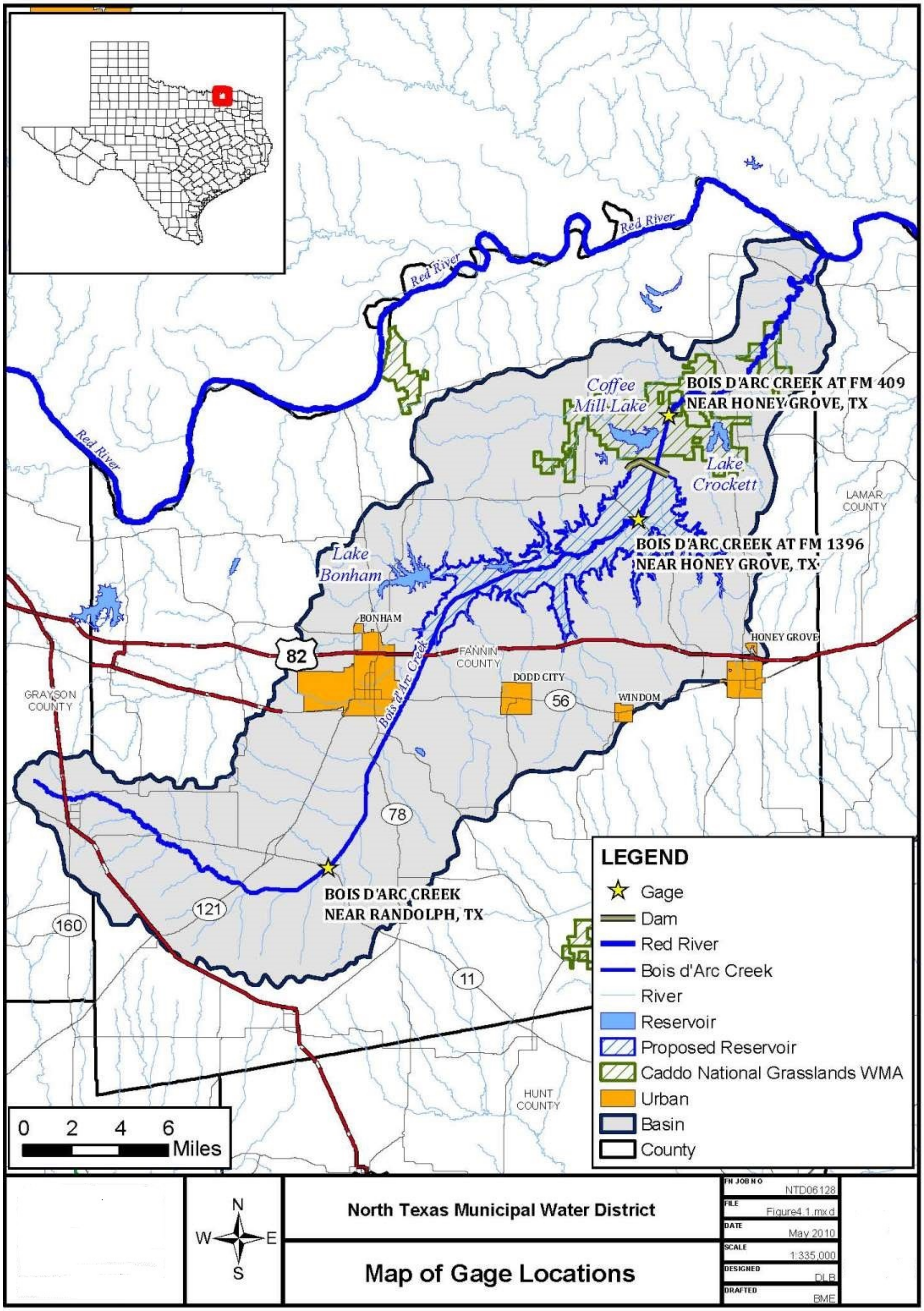

Figure 3.3-5. Stream Gages within the Bois d'Arc Creek Watershed

Bois d'Arc Creek is categorized as an intermittent stream with perennial pools. The creek has historically experienced periodic flooding, especially adjacent to the Highway 56 bridge located 19 miles upstream of the proposed dam site, as well as along the creek banks and in the City of Bonham (Appendix Q). The creek is channelized within approximately two-thirds of the project area and has been characterized as flashy, showing rapid response to rainfall events with extended periods of little or no flow, as shown by the Instream Flow Study (Appendix M). This "flashiness" is evident in the historical flow data for Bois d'Arc Creek. The highly channelized and straightened nature of Bois d'Arc Creek has resulted in considerable erosion of its bed and banks, limited habitat and biotic diversity in channelized sections, and minimal lateral migration. The channelized condition is also responsible for the current hydrological behavior and geomorphological processes (mechanisms of erosion and deposition) that are prevalent in this stream.

Bois d'Arc Creek near Randolph, Texas (USGS 07332600)

Three stream flow gages are have been placed on Bois d'Arc Creek; these form the basis of our understanding of the creek's seasonal flow patterns and its year to year variations. Historical surface water flow data for the Bois d'Arc Creek watershed are available from the USGS Bois d'Arc Creek near Randolph, Texas gage (station number 07332600) for December 1962 to September 1985, which recorded flows for a drainage area of 72 square miles (Appendix Q). Although the Randolph gage only measures flow for 22 percent of the proposed reservoir's drainage area, historical flows at the Randolph gage are considered equivalent to naturalized conditions for the watershed, because there are no water rights or significant return flows upstream from this gage. Naturalized datasets are derived by backing out any human impacts to a watershed, such as surface water diversions and return flows.

Daily mean discharge statistics for the period of record (December 1962 to September 1985) for the Bois d'Arc Creek near Randolph, Texas gage are shown in Table 3.3-2. Annual flows were below 0.12 cubic feet per second (cfs) at the Randolph gage 25 percent of the time (Q_{25}) during the period of record. Based on these figures, the average annual discharge was 39,845 acre-feet per year.

Table 3.3-2. Bois d'Arc Creek near Randolph, Texas Gage (USGS 07332600)

Daily Mean Discharge Statistics December 1, 1962 to September 30, 1985										
	Daily Mean Discharge (cfs)					Percentile Flows (cfs)				
Month	Minimum	Median	Average	Maximum	Standard Deviation	10th	25th	50th	75th	90th
January	0	8.5	30	2,230	127	0.09	1.5	8.5	24	46
February	0	16	73	4,520	304	0.71	5.1	16	37	84
March	0	17	74	6,000	325	1.7	7.2	17	45	96
April	0.10	12	82	6,940	375	2.0	5.0	12	29	81
May	0.03	12	105	10,600	580	2.3	5.3	12	38	141
June	0	4.7	51	3,190	250	0.06	1.1	4.7	15	54
July	0	0.39	13	3,750	150	0	0	0.39	2.5	8.4
August	0	0	5.1	2,640	99	0	0	0	0.36	2.1
September	0	0	54	5,410	364	0	0	0	1.9	21
October	0	0.27	68	6,360	418	0	0	0.27	9.2	41
November	0	5.0	46	3,170	236	0	0.06	5.0	17	52
December	0	7.9	59	7,510	342	0.02	0.53	7.9	30	60
Annual	0	4.6	55	10,600	328	0	0.12	4.6	19	55

Note: "Percentile Flow" indicates the percentage of time Bois d' Arc Creek flows were at or below the indicated values shown in cubic feet per second (cfs).

Source: USGS, 2012.

Bois d'Arc Creek at FM 1396 (USGS 0733260)

The Bois d'Arc Creek at FM 1396 gage is located just upstream of the proposed dam site as shown in Figure 3.3-5 and measures flow for a drainage area of 270 square miles, or approximately 83 percent of the proposed reservoir's drainage area (Appendix Q). The USGS has adjusted the rating curve for this gage several times due to horizontal and vertical changes in the channel bed since its installation, which is an indication of the dynamic, eroding nature of this stream channel.

Daily mean discharge statistics for July 1, 2006 to June 30, 2016 for the Bois d'Arc Creek at FM 1396 gage are shown in Figure 3.3-6 and Table 3.3-3. Annual flows were below 0.02 cfs at the FM 1396 gage 25 percent of the time during the period of record. Based on these figures, the average annual discharge at this location is approximately 170,970 AFY.

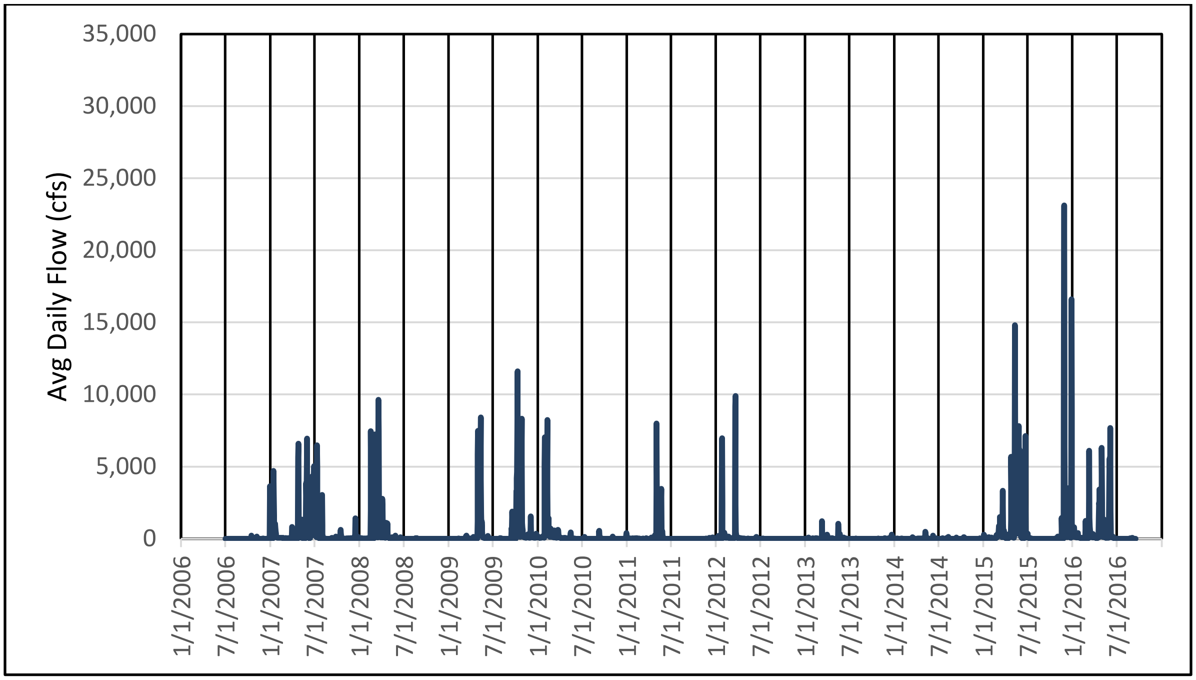

Figure 3.3-6. Historical flow data for Bois d'Arc Creek at FM 1396 (USGS 07332620) (Appendix M)

Table 3.3-3. Bois d'Arc Creek at FM 1396 Gage (USGS 07332620)

Daily Mean Discharge Statistics July 1, 2006 to June 30, 2016										
	Daily Mean Discharge (cfs)					**Percentile Flows (cfs)**				
Month	**Minimum**	**Median**	**Average**	**Maximum**	**Standard Deviation**	**10th**	**25th**	**50th**	**75th**	**90th**
January	0.04	21.5	195	7,030	791	0.2	4.6	21.5	86.75	205
February	0.01	31	191	8,240	796	1.5	6.85	31	67	263
March	0	47	395	9,900	1,270	1.1	9.28	47	189	632
April	0.10	38	267	6,600	881	4.0	14	38	97	345
May	0	60	668	14,800	1,696	0.7	10.25	60	287	2,363
June	0	12.5	302	7,670	1,027	0.1	0.91	12.5	62	374
July	0	0.06	107	6,480	614	0	0	0.06	6.0	53

Daily Mean Discharge Statistics July 1, 2006 to June 30, 2016										
	Daily Mean Discharge (cfs)					Percentile Flows (cfs)				
Month	Minimum	Median	Average	Maximum	Standard Deviation	10th	25th	50th	75th	90th
August	0	0	18	3,030	181	0	0	0	0.35	10
September	0	0	29	1,880	155	0	0	0	1.1	26
October	0	0	267	11,600	1,200	0	0	0	2.6	130
November	0	0.50	214	23,100	1,756	0	0	0.5	11	93
December	0	6.65	209	16,600	1,163	0	0.4	6.65	69.75	207
Annual	0	6	236	23,100	1,108	0	0.02	6.0	52	232

Note: "Percentile Flow" indicates the percentage of time Bois d' Arc Creek flows were at or below the indicated values shown in cubic feet per second (cfs).

Source: USGS, 2012.

Long-Term Hydrologic Modeling using RiverWare at FM 1396 (USGS 07332620)

The available USGS gage data at the reservoir site show flow conditions in Bois d'Arc Creek for only a short period of time. As described in the methods section above, a RiverWare model was developed to estimate the response of the watershed to changing stream conditions over a longer period of time . The model was used to estimate the reservoir yield associated with Alternatives 1 and 2 as well as the total annual discharge from the Bois d'Arc Creek drainage. Figure 3.3-7 shows the layout of the RiverWare model.

Table 3.3-4 summarizes the modeled flows at FM 1396. For this analysis, there are three seasons per year based on the flow characteristics of the watershed. April, May, and June are typically high flow months associated with spring rains. July and August are typically low-flow months associated with high summer temperatures and lower rainfall, and these low flows tend to persist through September and October, which also tend to be relatively dry. From November through March the creek has variable flows, but the flows are typically higher than in the summer season. The median flow for an entire year is about 9 cfs. Note that the July- October flows are significantly less than the other two seasons, with flows less than 1 cfs about 60 percent of the time and less than 10 cfs about 80 percent of the time. Outside of the July- October season, flows are less than 1 cfs from 12 to 15 percent of the time and less than 10 cfs about 36 percent of the time. Based on RiverWare, the total discharge at FM 1396 is approximately 167,347 acre-feet per year.

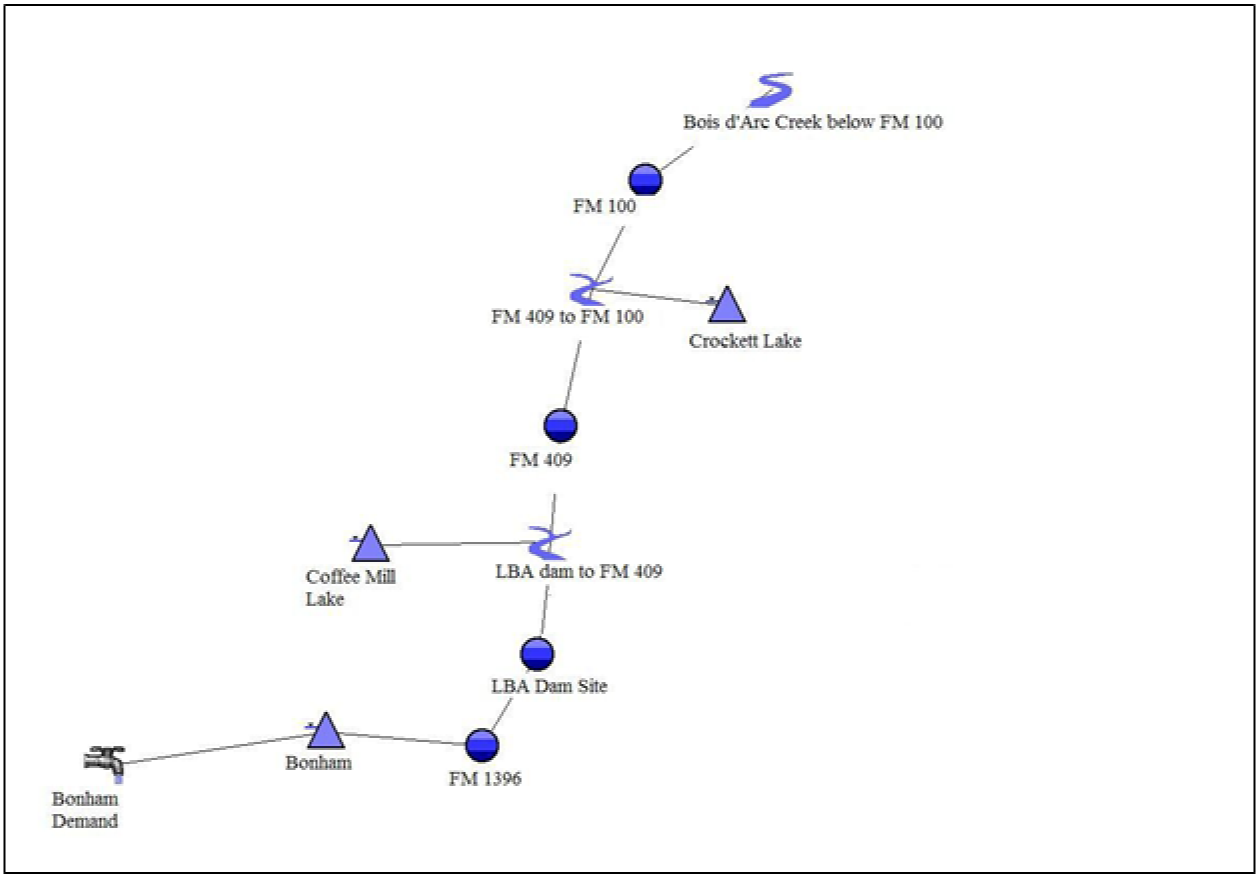

Figure 3.3-7. RiverWare Model Layout

Table 3.3-4. Modeled Flow Statistics for Bois d'Arc Creek at FM 1396 (USGS 07332620)

Statistic	Modeled Flows, 1948-1998, in cfs			
	Full Period	April-June	July-October	November-March
Average	231	341	104	268
Minimum	0.0	0.0	0.0	0.0
15%	0.0	2.0	0.0	1.1
30%	1.2	7.2	0.0	6.2
Median	9.2	19.3	0.3	22.1
70%	38.1	63.5	3.2	67.7
85%	145	246	20	234
Maximum	39,914	34,914	30,163	28,091

Bois d'Arc Creek at FM 409 (USGS 07332622)

The Bois d'Arc Creek at FM 409 gage is located just downstream of the proposed dam site as shown in Figure 3.3-5 and measures a drainage area of 370 square miles (Appendix M). Like FM 1396, the USGS has adjusted the rating curve for this gage several times due to horizontal and vertical changes in the channel bed since its installation, which is an indicator of the dynamic nature of the stream channel at this site; specifically, it indicates that the stream is undergoing rapid erosion and deposition.

Daily mean discharge statistics for June 4, 2009 to June 30, 2016 for the Bois d'Arc Creek at FM 409 gage are shown in Figure 3.3-8 and Table 3.3-5. Annual flows were below 0.19 cfs at the FM 409 gage 25 percent of the time during the period of record. Based on these figures, the average annual discharge at this location is 168,796 AFY.

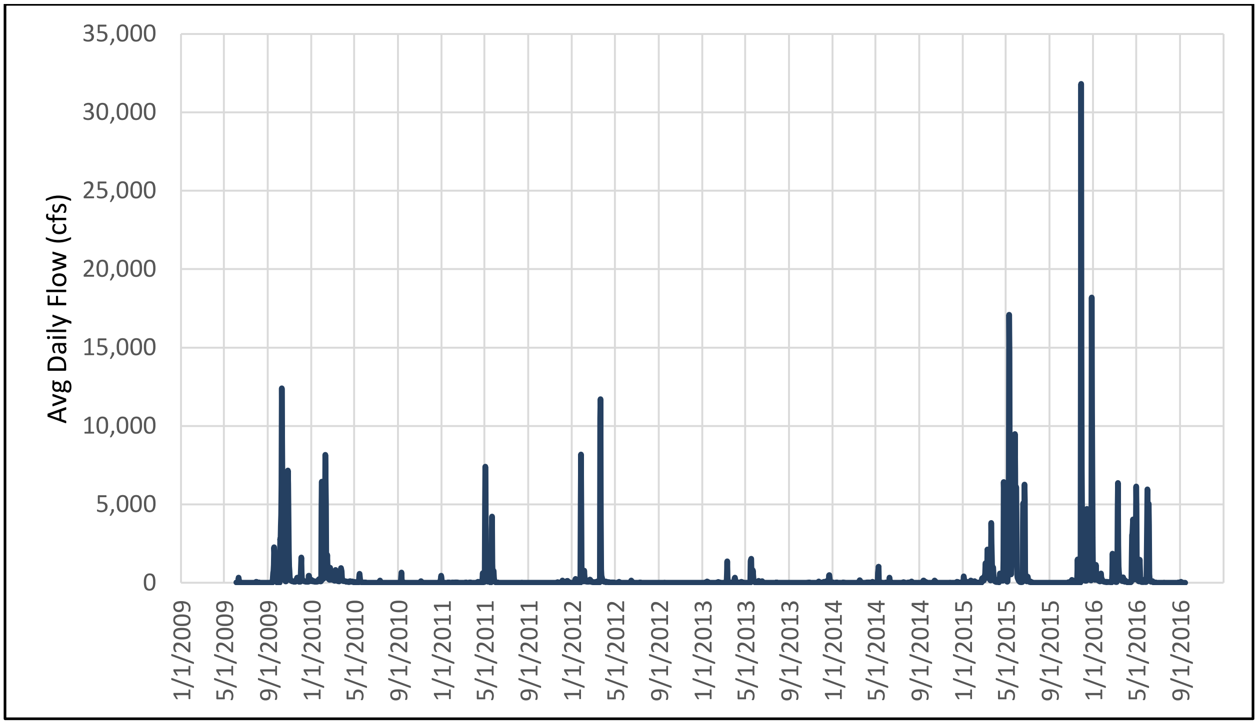

Table 3.3-8. Historical flow data for USGS Gage 07332622
Bois d'Arc Creek at FM 409 (Appendix M)

Table 3.3-5. Bois d'Arc Creek at FM 409 near Honey Grove, Texas Gage (USGS 07332622)

Daily Mean Discharge Statistics June 4, 2009 to June 30, 2016										
	Daily Mean Discharge (cfs)					Percentile Flows (cfs)				
Month	Minimum	Median	Average	Maximum	Standard Deviation	10th	25th	50th	75th	90th
January	0.7	21	226	8,190	909	2.6	8.4	21	110	254
February	1.5	36	230	8,170	783	4.2	8.95	36	117	450
March	0.9	74	408	11,700	1,271	2.6	8.1	74	290	821
April	2.2	47	262	6,430	860	7.2	18	47	91	416
May	0.4	47	811	17,100	2,147	3.2	9	47	356	2,786
June	0	10	245	6,260	948	0.6	1.9	10	44	175
July	0	0.5	11	390	38	0	0.04	0.5	4	22
August	0	0	2	96	9	0	0	0	0.47	3
September	0	0	50	2,270	240	0	0	0	0.9	33

Daily Mean Discharge Statistics June 4, 2009 to June 30, 2016										
Month	Daily Mean Discharge (cfs)					Percentile Flows (cfs)				
	Minimum	Median	Average	Maximum	Standard Deviation	10th	25th	50th	75th	90th
October	0	0.01	372	12,400	1,398	0	0	0.01	3.1	403
November	0	2.3	370	31,800	2,666	0	0.11	2.3	33	119
December	0.04	20	320	18,200	1,555	0.46	1.9	20	123	377
Annual	0	5.1	233	31,800	1,327	0	0.19	5.1	42	209

Note: "Percentile Flow" indicates the percentage of time Bois d' Arc Creek flows were at or below the indicated values shown in cubic feet per second (cfs).

Source: USGS, 2012.

Tributaries to Bois d'Arc Creek

Over 16 main tributaries contribute flows to Bois d'Arc Creek. These tributaries are characterized in Table 3.3-6 and are classified as intermittent/ephemeral or intermittent. While no specific flow measurements were made on tributaries , the contributions of tributaries between USGS gage 07332600 near Randolph, TX, located upstream of the proposed reservoir site, and the FM 1396 gage (USGS 07332620), located just upstream of the dam site and within the proposed reservoir footprint for both alternatives, could amount to as much as 131,000 acre-feet per year. While no empirical information was collected, these contributions likely follow similar flow patterns as those recorded for Bois d'Arc Creek.

Table 3.3-6. Intermittent/Ephmeral Stream Channels in the Bois d'Arc Creek Watershed

Stream Name	Length (feet)	Stream Type
Allens Creek	11,781	Intermittent
Allens Creek Unnamed Tributary	1,843	Intermittent/Ephemeral
Bois d'Arc Creek	80,690	Intermittent
Bois d'Arc Creek Unnamed Tributary	172,907	Intermittent/Ephemeral
Bullard Creek	25,221	Intermittent
Bullard Creek Unnamed Tributary	6,621	Intermittent/Ephemeral
Burns Branch	18,589	Intermittent
Burns Branch Unnamed Tributary	24,126	Intermittent/Ephemeral
Cottonwood Creek	4,079	Intermittent
Fox Creek	7,593	Intermittent
Fox Creek Unnamed Tributary	6,124	Intermittent/Ephemeral
Honey Grove Creek	37,432	Intermittent
Honey Grove Creek Unnamed Tributary	61,967	Intermittent/Ephemeral
Onstott Branch	7,807	Intermittent
Onstott Branch Unnamed Tributary	351	Intermittent/Ephemeral
Pettigrew Branch	12,227	Intermittent
Pettigrew Branch Unnamed Tributary	4,040	Intermittent/Ephemeral
Sandy Branch	4,982	Intermittent
Sandy Branch Unnamed Tributary	3,578	Intermittent/Ephemeral
Sandy Creek	15,416	Intermittent
Sandy Creek Unnamed Tributary	15,264	Intermittent/Ephemeral
Sloans Creek	1,698	Intermittent

Stream Name	Length (feet)	Stream Type
Sloans Creek Unnamed Tributary	655	Intermittent/Ephemeral
Stillhouse Branch	3,445	Intermittent
Stillhouse Branch Unnamed Tributary	1,163	Intermittent/Ephemeral
Thomas Branch	9,567	Intermittent
Thomas Branch Unnamed Tributary	31,837	Intermittent/Ephemeral
Timber Creek	13,311	Intermittent
Timber Creek Unnamed Tributary	19,449	Intermittent/Ephemeral
Ward Creek	26,602	Intermittent
Ward Creek Unnamed Tributary	14,927	Intermittent/Ephemeral
Yoakum Creek	5,851	Intermittent

Source: Coffman, 2016

It is also important to note that tributaries below the proposed dam site will continue to contribute flows to Bois d'Arc Creek. The entire Bois d'Arc Creek drainage area is 425 square miles. The drainage area below the dam is 98.2 square miles, which represents approximately 23 percent of the watershed. As such, the total discharge from the Bois d'Arc Creek watershed at its confluence with the Red River could be as much as 232, 876 AFY, which includes the approximately170,000 AFY at the point of the dam plus 52,876 acre-feet per year from the tributaries below the proposed dam site.

Streams in the Sulphur River and Trinity Basins

From the confluence of the North and South Sulphur rivers in East Texas, the Sulphur River flows to its confluence with the Red River in Arkansas. Smaller streams in the Sulphur River basin include the North, Middle, and South Sulphur rivers, and White Oak Creek. From the confluence of its Elm and West Forks near Dallas, the Trinity River flows to Trinity Bay, which drains to the Gulf of Mexico. Smaller streams within the Trinity River basin include the Clear, East, Elm, and West forks of the Trinity River and Cedar, Chambers, and Richland creeks.

Reservoirs

Lake Bonham

Lake Bonham is located three miles northeast of Bonham in Fannin County. Developed by the City of Bonham, it was impounded in 1969 and has a surface area of 1,020 acres. The Lake Bonham water right transferred to NTMWD in November 2010, and the lake is now utilized for water supply by NTMWD. This lake furnishes the raw water for NTMWD's supply of potable water to the City of Bonham, which used approximately 1,760 AFY in 2011, more than half the firm yield. However, this source is not connected to NTMWD's primary water supply system and can only be used to meet the City of Bonham's water demands and potential new local demands in Fannin County. Considering this constraint, the available supply from Lake Bonham is limited by the projected demand on this source. In 2020, Lake Bonham is expected to supply 2,511 AFY, increasing to 3,195 AFY by 2030. These supply estimates differ from those in the *2011 Region C Water Plan*, which show the full 3,195 AFY yield of Lake Bonham as available to meet NTMWD's water demands (Kiel and Gooch, 2015).

Coffee Mill Lake

Coffee Mill Lake is a reservoir located approximately 15 miles northeast of Bonham, in the Caddo National Grasslands, under the authority of and managed by the USFS. It was impounded in 1939, has a surface area of 630 acres at its conservation pool elevation of 496 feet MSL, and a maximum depth of 30 feet. The water surface level fluctuates very little even though outflow from the lake is uncontrolled.

Discharge from Coffee Mill Lake flows into Bois d'Arc Creek about two miles downstream of the dam site of the proposed LBCR. There are no stream gage data on its discharge.

Lake Crockett

Lake Davy Crockett is a reservoir located approximately 20 miles east-northeast of Bonham, in the Caddo National Grasslands, under the authority of and managed by the USFS. It was impounded in 1938, has a surface area of 355 acres at its conservation pool elevation of 487 feet MSL, and a maximum depth of 20 feet. The water surface level fluctuates moderately with the seasons and rain events. As with Coffee Mill Lake, outflow from the Lake Crockett is uncontrolled. It flows into Bois d'Arc Creek about four miles downstream of the dam site of the proposed LBCR. There are no stream gage measurements on its daily, seasonal, or annual discharges.

Lake Texoma

Denison Dam and Lake Texoma were authorized for construction by Congress in 1938 for flood control and hydroelectric power generation. The dam, spillway, and outlet works were begun in 1939 and completed in 1944. Lake Texoma is the largest USACE reservoir in the Tulsa District and 12th-largest USACE reservoir in the country. Impounded by the Denison Dam on the Red River in Bryan County, Oklahoma and Grayson County, Texas, Lake Texoma has a normal surface area of 86,910 acres (136 sq. miles), a volume of 2,516,232 acre feet , and 580 miles of shoreline. The dam is 726 miles upstream from where the Red River discharges into the Atchafalaya and Mississippi Rivers, and the drainage area above the dam is 39,719 square miles. The reservoir is located at the confluence of the Red River and Washita River. The dam site is approximately five miles northwest of Denison, Texas, and 15 miles southwest of Durant, Oklahoma (USACE, no date-b).

NTMWD's water right in Lake Texoma is 197,000 AFY, but actual use has never approached this quantity due to several constraints. Beginning in 1990, NTMWD began importing water from Lake Texoma to Lavon Lake because Lake Texoma water is naturally high in total dissolved solids (TDS) and is therefore not usable as potable water on its own. The water is discharged into a tributary of Lavon Lake (Sister Grove Creek) and blended in Lavon Lake to reduce salinity. The water from Lavon Lake is subsequently diverted for treatment at NTMWD's Wylie water treatment plant (WTP). According to the Region C Water Planning Group, the water supply available to NTMWD from Lake Texoma in 2020 will be 70,623 AFY and the same amount will still be available in 2060 (Region C Water Planning Group, 2015).

3.3.3 Bois d'Arc Creek Channel Form

Bois d'Arc Creek is a threshold bedrock channel that has been incised into weathered clays, marls, and shales with limited sources of coarser sediments (Appendix M). The 2-year and 100-year floodplains along Bois d'Arc Creek within the proposed reservoir footprints are depicted in Figure 3.3-9. For Alternative 1, the 2-year floodplain covers approximately 43 percent of the proposed reservoir footprint, and the 100-year flood plain extends over 55 percent of the proposed reservoir footprint (Appendix Q). Because the reservoir for Alternative 2 is smaller, these estimates would be higher.

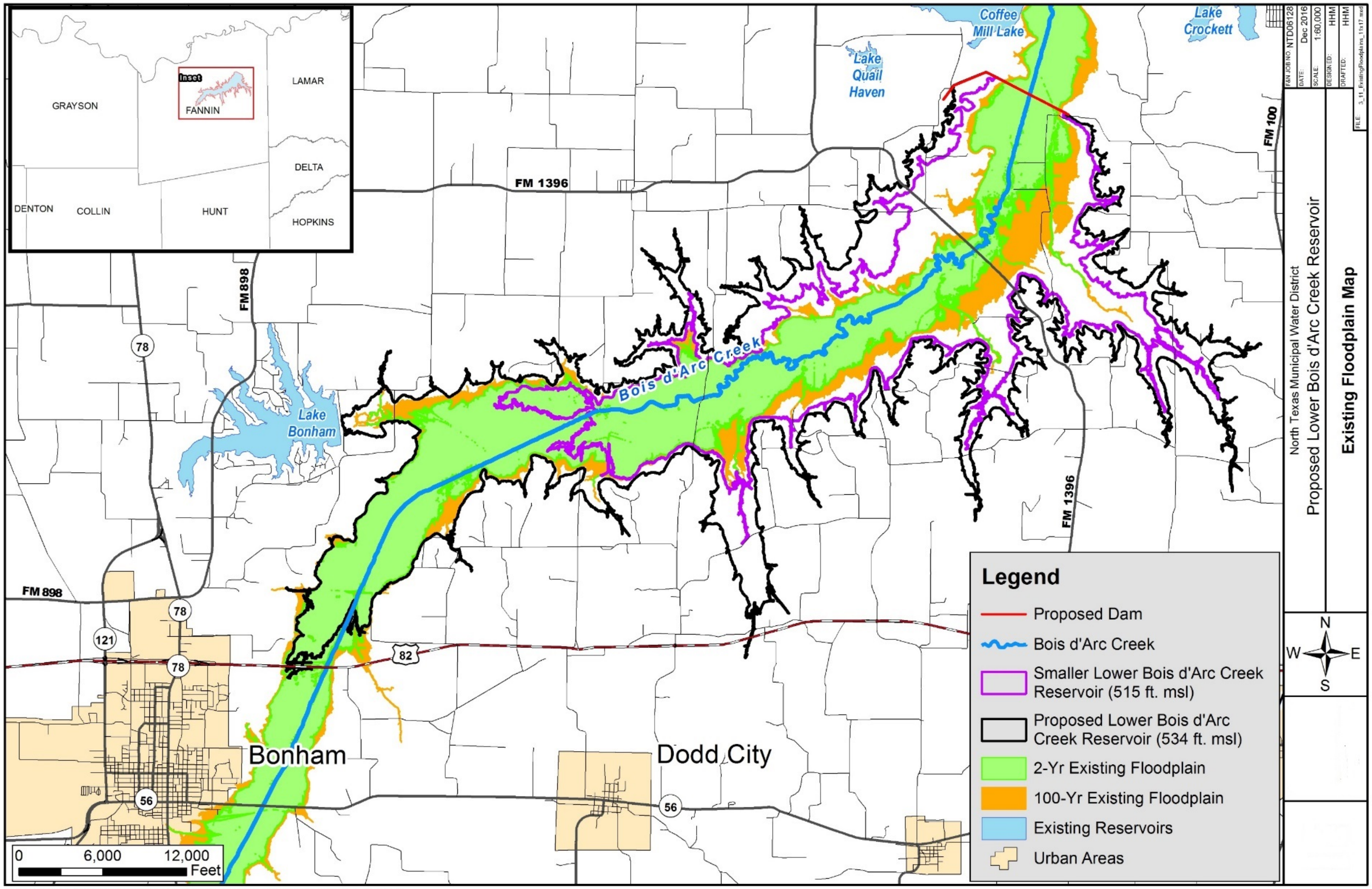

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Figure 3.3-9. Floodplains Along Bois d'Arc Creek

Bar deposits of sand and gravel can be found dispersed along the creek. The Instream Flow Study compared a 1915 watershed map to the current system and found that Bois d'Arc Creek has lost over 20 stream miles from channelization. The channelization has resulted in more rapid transport of stream flow and bed materials that has compromised the stream ecology (Appendix M).

The Bois d'Arc Creek has been identified as a highly-channelized stream system (approximately 62 percent of the length of Bois d'Arc Creek within the proposed reservoir site has been channelized), which has contributed to sudden high-flow events and reductions in base flows, erosion of the stream bed and bank areas, and a deficiency in habitat diversity. The Instream Flow Study found flows of less than 1 cfs could transport fine sediments, and gravel would be transported at flows of 25 cfs or more. The hydrologic and geomorphic analyses conducted in the Instream Flow Study also demonstrated Bois d'Arc Creek was in disequilibrium with increased downcutting and erosion and decreased lateral migration or meandering, and stream conditions were generally considered poor (Appendix M).

Alterations of the natural stream channel in Bois d'Arc Creek began prior to 1915, and substantial portions of the stream have been channelized over the past century. Archival aerial photographs show that channelization within the Bois d'Arc Creek system continued all the way into the 1970s. An important question is whether the system has re-established equilibrium since the time it was channelized and the riparian vegetation buffer changed. Determining the state of the channel is accomplished by determining if the channel is in dynamic equilibrium or if the sediment supply and stream power are out of balance. Over the years, many studies of incised channels within alluvial materials have shown that, following channelization, the altered channel geometry evolves through a predictable sequence of channel stages (Appendix Q). These channel evolution sequences/models offer a method for interpreting the current stage of the channel morphology by evaluating the existing channel form and geomorphic processes. The evolution model also provides a means for predicting future channel evolution/channel processes.

Figure 3.3-10 depicts the sequential stages of channel form, starting with the channelized reach, which disrupts the dynamic equilibrium, through major stages of disequilibrium and channel evolution back to a state of dynamic equilibrium. As shown in the diagrams, the channel incises (i.e., cuts down through alluvium or sediments), and then widens as a result of bank failure and mass wasting. As the channel becomes over-widened, it will begin to aggrade (i.e., accumulate sediments on its bed, raising the elevation of the bed once more), because the stream power is insufficient to carry the existing sediment load. Eventually a new channel will form within the over-widened section with sufficient stream power to carry the total sediment supply, and a new dynamic equilibrium will be reached (Appendix L). The entire process can take many decades.

The 2008 RGA documented that all of the surveyed reaches of Bois d'Arc Creek and its tributaries have been affected by human activities; none of them has yet reached a new state of dynamic equilibrium. The 2008 RGA classified 54 percent of Bois d'Arc Creek within the inundation pool of the proposed reservoir as "poor" with the remaining 46 percent being classified as "fair." Eighty-six percent of Honey Grove Creek within the inundation pool was classified as "fair" with the remainder classified as "good" (8%) or "poor" (6%). Ward Creek was classified mostly as "fair" (84%) with the remaining 16 percent classified as "poor." Majorities of Bullard Creek (82%) and Sandy Creek (83%) were classified as "poor" with the remainder of both streams classified as "fair".

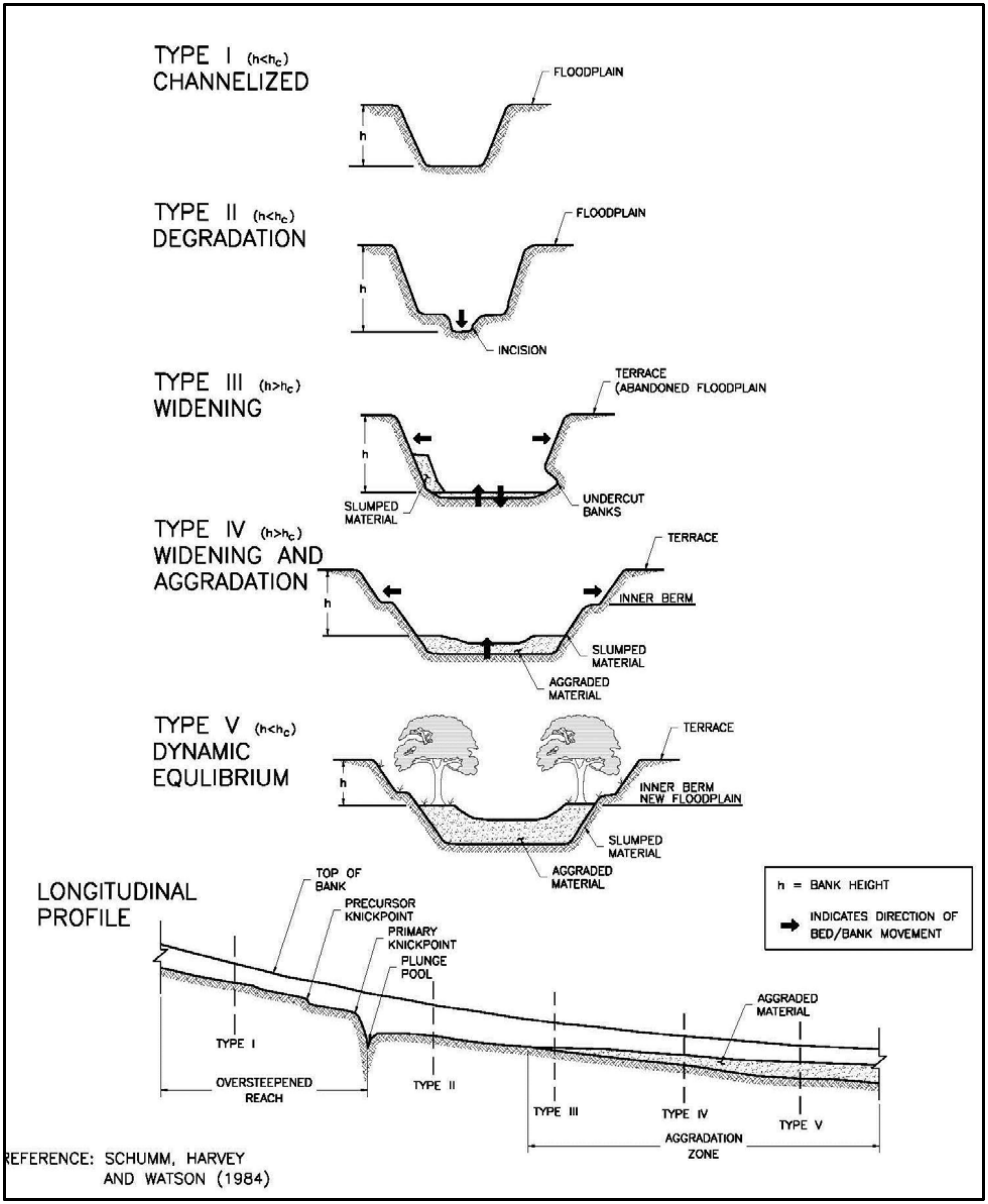


Figure 3.3-10. Incised Channel Evolution Process

Source: Figure 3-1 in Appendix L

The Instream Flow Study looked at planform stability (planform is the contour of a shape viewed from above) and inferred lateral migration rates by analyzing historical photographs of Bois d'Arc Creek. The study found that the banks of Bois d'Arc Creek were actively eroding and channel widening was occurring as a result, with limited meander development within the incised straightened channel. The studied reaches in Bois d'Arc Creek were found to be increasing in cross-sectional area due to mass failure of bank material that was induced by scouring and removal of lower bank material leading to over-steepening of banks and subsequent bank collapse. Higher amounts of fluvial erosion occurred on the sparsely vegetated, exposed banks at the FM 1396 site than the FM 409 site (Appendix M). Abandoned channels or artificial oxbows have been created from the channel straightening, and bank loss was estimated at 0.5 foot per year. Reduced habitat has resulted from channelization and bank instability as peak flows scour away gravel bars and low flows reduce the connectivity along the stream with little to no flow during dry times (Appendix M).

3.3.4 Bois d'Arc Creek Water Quality

TCEQ has adopted Texas Surface Water Quality Standards in order to protect the quality of the state's water, and these standards include both general and site-specific criteria (TCEQ, 2010c). According to TCEQ, Bois d'Arc Creek is not a classified stream segment as defined in Appendix A of their standards, although Appendix D does list a site-specific standard for dissolved oxygen for the reach that runs from the confluence with Sandy Creek upstream to the confluence of Pace Creek; this reach is upstream of the proposed reservoir site (TCEQ, 2010c). In the absence of site-specific standards, water quality standards apply from the segment downstream from where the stream is located; the site-specific criteria outlined in Appendix A for the Red River below Lake Texoma segment apply to Bois d'Arc Creek (TCEQ, 2010c). The water uses associated with the site-specific criteria for the Red River below Lake Texoma segment include primary contact recreation, high aquatic life, and public water supply (TCEQ, 2010c).

Some of the TCEQ surface water quality standards that are applicable to Bois d'Arc Creek are summarized in Table 3.3-7. The criteria listed for chloride, sulfate, and total dissolved solids are maximum annual averages, and the dissolved oxygen criterion is a minimum 24-hour mean (TCEQ, 2010c). Criteria for specific toxic materials for the protection of aquatic life and human health have not been included in this table but are listed in Tables 1 and 2 of the full water quality standards (TCEQ, 2010c).

Table 3.3-7. Applicable Water Quality Standards for Bois d'Arc Creek

Site-specific Uses and Criteria for Classified Segments [a,]	
Chloride, maximum annual average (mg/L)	375
Sulfate, maximum annual average (mg/L)	250
Total dissolved solids, maximum annual average (mg/L)	1,100
Dissolved oxygen, minimum 24-hour mean (mg/L)	5.0
pH (standard units)	6.5-9.0
E. coli (colony forming units per 100 mL)	126
Temperature (°F)	93
Site-specific Criteria for Unclassified Water Bodies [, c]	
Dissolved oxygen (mg/L)	4.0

[a] = Applicable site-specific criteria are for the Red River below Lake Texoma segment.

[c] = Applicable unclassified water body standard is for Bois d'Arc Creek between the Sandy Creek and Pace Creek confluences (located upstream of the proposed reservoir).

Source: TCEQ, 2010c

Water quality results from 1996 to 2006 were summarized for 13 water quality sampling stations within the Red River Basin as part of the NTMWD's report supporting an application for a Texas water right for the proposed reservoir (Appendix R). A summary of these data are provided in Table 3.3-8. Samples from these sampling stations had average concentrations between 6 and 302 mg/L for chloride, 14 and 286 mg/L for sulfate, and 101 and 930 mg/L for total dissolved solids (Appendix R). One sampling station (Red River below Denison Dam) had an average sulfate concentration of 286 mg/L and exceeded the water quality criterion for sulfate. No other sampling stations exceeded these water quality criteria.

Table 3.3-8. Red River Basin Water Quality Data, 1996-2006

Sampling Location	Average concentration		
	Chloride (mg/L)	Sulfate (mg/L)	Total dissolved solids (mg/L)
Lake Texoma near Dam	297	237	930
Red River below Denison Dam	302	286	NA
Red River at SH 78 (Bonham)	301	222	927
Red River at U.S. 271 (Arthur City)	211	194	817
Red River at SH 37 (Clarksville)	178	167	684
Post Oak Creek (2 sites)	57	130	447
Choctaw Creek (2 sites)	179	206	808
Bois d'Arc Creek at FM 100	31	61	343
Pine Creek (2 sites)	86	114	336
Pat Mayse Lake	6	14	101

Notes:
NA = no data available.
Source: Appendix R

Table 3.3-9 provides a summary of Bois d'Arc Creek water quality data collected for the proposed reservoir project and the applicable water quality criteria. Water quality data collected during the Instream Flow Study and from other sources (i.e., USGS, TCEQ, RRA) indicate Bois d'Arc Creek meets its High Aquatic Use classification, meaning that water quality is high enough to protect aquatic life (Appendix M).

Table 3.3-9. Summary of Bois d'Arc Creek Water Quality Data

Water Quality Parameter	Applicable Criteria	Sampling Site						
		FM 78	U.S. 82	CR 2645	FM 1396	FM 409	FM100	USFS
Sampling date or range	NC	3/2004 to 7/2005	6/2007 to 7/2009	6/2009 to 7/2009	6/2009 to 7/2009	6/2009 to 7/2009	10/1997 to 1/2006	7/9/2009
Number of samples	NC	10	24	7	34	32	10	4
Mean (or range in) flow (cfs)	NC	0.0375 to 52	0 to 0.4 [a]	0.6 to 1.6	0.1 to 3.1 [a]	0.1 to 2.5 [a]	---	0 to 0.3
Mean (or range in) temperature (°C)	33.9	19.2	4.30 to 30.0	28.6 to 30.9	3.72 to 33.1	3.55 to 31.2	---	26.5 to 25.8

Water Quality Parameter	Applicable Criteria	Sampling Site						
		FM 78	U.S. 82	CR 2645	FM 1396	FM 409	FM100	USFS
Mean (or range in) specific conductance (µS/cm)	NC	542	123 to 665	502 to 511	255 to 567	278 to 872	---	650 to 654
Mean (or range in) pH (standard units)	6.5 to 9.0	8.1	6.32 to 9.04	7.5 to 7.8	6.3 to 8.31	7.71 to 8.26	---	7.3 to 7.4
Mean (or range in) dissolved oxygen (mg/L)	5	8.1	2.48 to 11.5	5.2 to 6.2	3.4 to 13.0	3.53 to 11.5	---	6.3 to 6.8
Mean (or range in) turbidity (NTU)	NC	9.4	3.15 to 1,950	---	3.66 to 1,290	5.02 to 822	---	---
Mean (or range in) chloride (mg/L)	375	---	5.77 to 75.1	---	9.45 to 37.0	10.6 to 82.8	31	---
Mean (or range in) sulfate (mg/L)	250	---	8.45 to 67.3	---	20.6 to 54.1	19.5 to 131	60	---
Mean (or range in) total dissolved solids (mg/L)	1,100	---	142 to 390	---	150 to 346	158 to 526	343	---

Notes:
NC = No criterion.
--- = no data.
[a] Flow for 7/2009 water quality data only.
Sources: Appendix R and M; TCEQ, 2010c.

3.3.5 Groundwater

The site of the proposed reservoir is underlain by several aquifers. An aquifer is an underground layer of saturated, permeable (capable of being penetrated by liquids or gases), porous rock or unconsolidated materials (gravel, sand, or silt) that can contain or transmit water. Groundwater may be extracted from aquifers and put to beneficial use by means of water wells drilled from the ground surface down into the aquifer. Aquifers may occur at widely varying depths beneath the ground surface. Those closer to the surface are not only more likely to be used for water supply and irrigation, but are also more likely to be responsive to local rainfall patterns, rising during periods of high rainfall and falling during droughts. The upper boundary of unconfined aquifers is the water table, the upper surface level of the zone of saturation, above which lie unsaturated rock and/or soil. Water in confined aquifers is blocked from upward movement by a layer of low hydraulic-conductivity (or relatively impermeable) rock above the aquifer.

Some of the aquifers in the proposed project area, such as the Northern Trinity Aquifer and Woodbine Aquifer, are significant regional aquifers and recognized by the State of Texas as major or minor aquifers. Other aquifers in the area are less important regionally, although groundwater may be produced from local sources to meet a variety of needs. In addition to the Northern Trinity and Woodbine aquifers, groundwater in Fannin County is also produced from the Austin Chalk formation, the Blossom Aquifer, and the Red River alluvial aquifer, as well as an unnamed, shallow aquifer present beneath the proposed reservoir site. A generalized stratigraphic section (showing underlying rock strata or layers) of all the major geologic formations that are present underneath Fannin County is shown in Table 3.3-10, and a generalized cross-section showing geologic formations through the region is shown in Figure 3.3-13.

Woodbine Aquifer

The Woodbine Aquifer is a Cretaceous age sandstone aquifer that crops out or reaches the ground surface in northern Fannin County along the Red River. The Woodbine Aquifer is a significant source of groundwater supply in Fannin County and accounts for a majority of the wells in the county and nearly 50 percent of total groundwater pumping in the county. The Woodbine Aquifer is primarily used for municipal purposes and accounts for the majority of municipal groundwater use in Fannin County. Lesser amounts of groundwater from the Woodbine Aquifer are also used for livestock and steam-electric purposes. The locations and depths of wells producing from the Woodbine Aquifer in Fannin County from the TWDB database are shown in Figure 3.3-12.

The Woodbine Aquifer is composed of water-bearing sandstone beds interbedded with shales and clay. The aquifer outcrops, or reaches the ground surface, along the Red River and dips south and eastward to depths of over 2,500 feet below land surface with a thickness of about 700 feet (LBG-Guyton, 2003). Wells in or near the outcrop area are less than 500 feet deep, with depths rapidly increasing to a maximum of over 2,500 feet. Most wells are less than 1,800 feet deep in the Woodbine Formation.

Wells completed into this aquifer can yield moderate to large quantities of water. However, water levels in some areas are declining, with some wells showing significant water level declines over time, with some cases of declines of hundreds of feet. The wells with more stable water levels tend to be located in the northern part of Fannin County where the tilted Woodbine Aquifer outcrops, that is, it reaches the ground surface. The Woodbine Aquifer contains mostly fresh water (less than 1,000 mg/L total dissolved solids) within Fannin County, although some areas in and near the outcrop of the Woodbine Aquifer contain groundwater of poorer quality. However, these areas are sporadic and may be associated with areas of the Woodbine Aquifer that are in hydraulic connection with Red River alluvium.

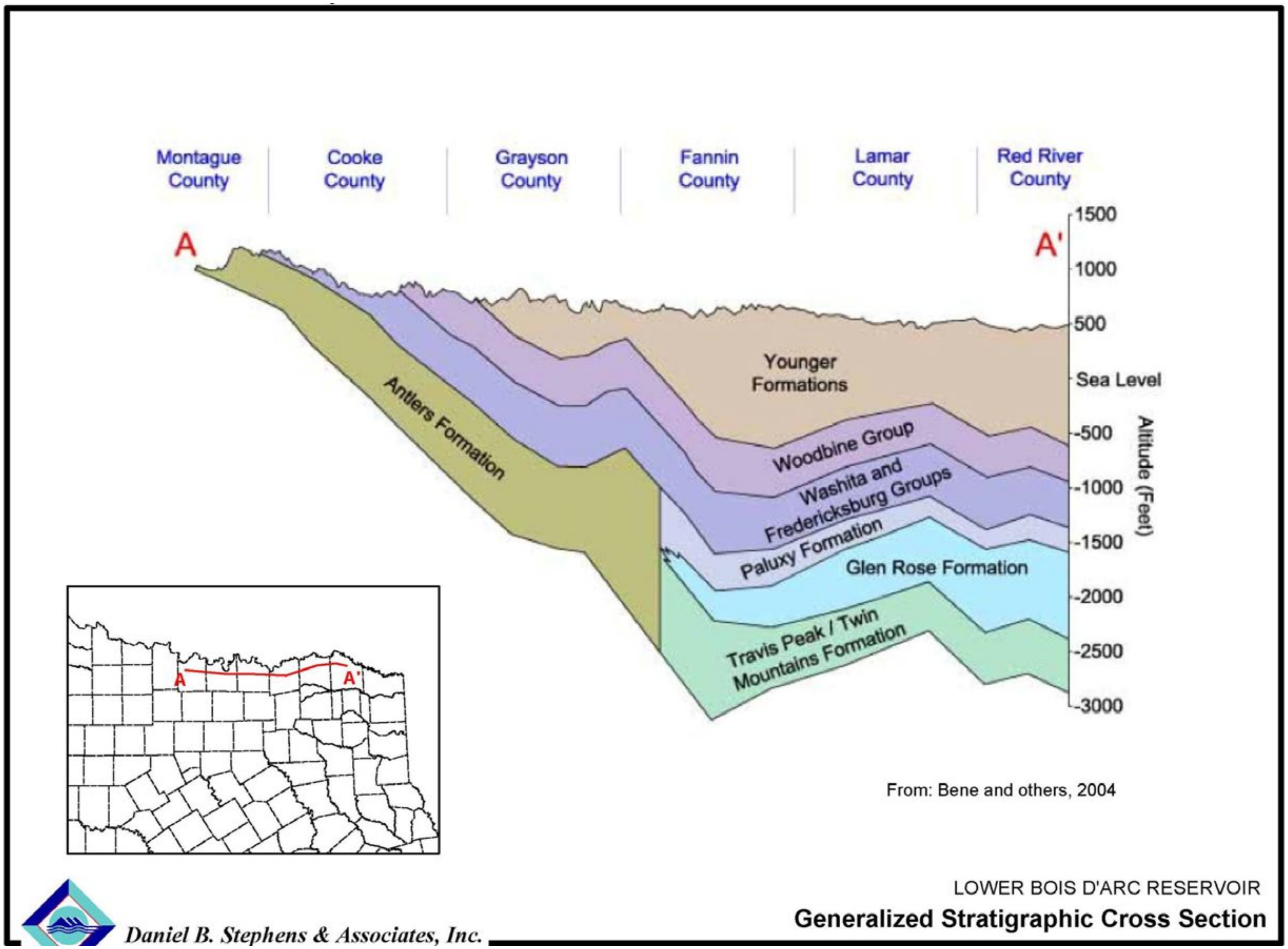


Figure 3.3-11. Generalized Stratigraphic Cross Section West-East across Fannin County and Neighboring Counties

Table 3.3-10. Stratigraphic Units (Rock Layers or Formations) and Their Water-Bearing Characteristics in Fannin County

<table>
<tr><th>Era</th><th>System</th><th>Series</th><th>Group</th><th colspan="2">Stratigraphic Unit/Formation</th><th>Estimated Maximum Thickness</th><th>Strata Description</th><th>Water-Bearing Characteristics[a]</th></tr>
<tr><td rowspan="3">Cenozoic</td><td rowspan="2">Quaternary</td><td>Recent</td><td></td><td colspan="2">Alluvium</td><td rowspan="2">100</td><td rowspan="2">Sand, silt, clay, and gravel</td><td rowspan="2">Yields small to large quantities of water to wells</td></tr>
<tr><td>Pleistocene</td><td></td><td colspan="2">Fluviatile terrace deposits</td></tr>
<tr><td>Tertiary</td><td colspan="5">Undifferentiated</td><td></td><td></td></tr>
<tr><td rowspan="15">Mesozoic</td><td rowspan="15">Cretaceous</td><td rowspan="6">Gulf</td><td rowspan="2">Navarro</td><td colspan="2">Kemp Clay/Corsicana Marl</td><td rowspan="2">800</td><td>Fossiliferous clay and hard limy marl</td><td>Not known to yield water to wells.</td></tr>
<tr><td colspan="2">Nacatoch Sand</td><td>Fine sand and marl, fossiliferous</td><td>Yields small quantities of water near the outcrop.</td></tr>
<tr><td>Taylor</td><td colspan="2">Marlbrook Marl/Pecan Gap Chalk/Wolf City/Ozan</td><td>1,500</td><td>Clay, marl, mudstone and chalk</td><td>Yields small quantities of water to shallow wells.</td></tr>
<tr><td>Austin</td><td colspan="2">Gober Chalk/Brownstone Marl/Blossom Sand/Bonham Formation</td><td>700</td><td>Chalk, limestone and marl; fine to medium sand, fossiliferous</td><td>Yields small to moderate quantities of water to wells; very limited as an aquifer.</td></tr>
<tr><td>Eagle Ford</td><td colspan="2">Undifferentiated</td><td>650</td><td>Shale with thin beds of sandstone and limestone</td><td>Yields small quantities of water to shallow wells.</td></tr>
<tr><td>Woodbine</td><td colspan="2">Undifferentiated</td><td>700</td><td>Medium to coarse iron sand, sandstone, clay and some lignite</td><td>Yields moderate to large quantities of water to municipal, industrial and irrigation wells.</td></tr>
<tr><td rowspan="9">Comanche</td><td rowspan="4">Washita</td><td colspan="2">Grayson Marl</td><td rowspan="4">1,000</td><td rowspan="4">Fossiliferous limestone, marl and clay; some sand near top</td><td rowspan="4">Yields small quantities of water to shallow wells.</td></tr>
<tr><td colspan="2">Mainstreet/Pawpaw/ Weno/Denton</td></tr>
<tr><td colspan="2">Fort Worth/Duck Creek</td></tr>
<tr><td colspan="2">Kiamichi</td></tr>
<tr><td rowspan="2">Fredericksburg</td><td colspan="2">Goodland</td><td rowspan="2">250</td><td>Cherty limestone; marly limestone</td><td>Yields small to moderate quantities of water to wells.</td></tr>
<tr><td colspan="2">Walnut Clay</td><td>Clay, marl, shale and shell agglomerates</td><td>Not known to yield water to wells.</td></tr>
<tr><td rowspan="3">Trinity</td><td rowspan="3">Antlers</td><td>Paluxy</td><td>400</td><td>Fine sand, sandy shale and shale</td><td>Yields small to moderate quantities of water to wells.</td></tr>
<tr><td>Glen Rose</td><td>1,500</td><td>Limestone, marl, shale and anyhdrite</td><td>Yields small quantities of water in localized areas.</td></tr>
<tr><td>Twin Mountains</td><td>1,000</td><td>Fine to coarse sand, shale and clay; basal gravel and conglomerate</td><td>Yields moderate to large quantities of water to wells.</td></tr>
<tr><td>Paleozoic</td><td></td><td colspan="5">Paleozoic Rocks Undifferentiated</td><td></td><td></td></tr>
</table>

[a] Yield, in gallons per minute (gpm): small, less than 100 gpm; moderate, 100-1,000 gpm; large, more than 1,000 gpm

Sources: Bené et al., 2004; Nordstrom, 1982

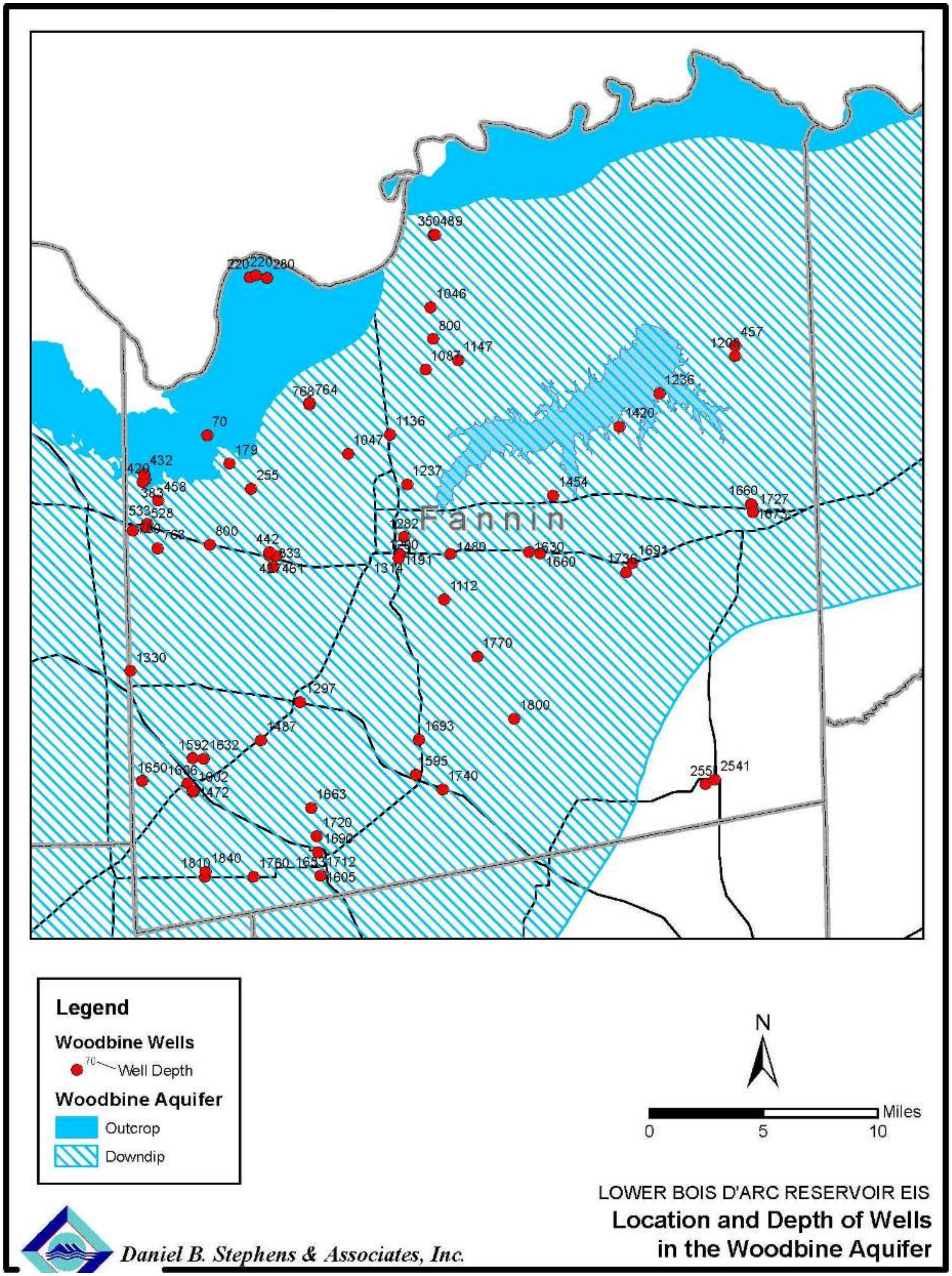


Figure 3.3-12. Location and Depths of Wells in the Woodbine Aquifer in Fannin County, Texas

Trinity Aquifer

The Trinity Aquifer is an aquifer system composed of several individual aquifers within the Cretaceous-age Trinity Group. The Trinity Aquifer is found throughout Fannin County and is located stratigraphically several layers beneath the Woodbine Aquifer (shown in Table 3.3-10). Very little groundwater is produced from the Trinity Aquifer in Fannin County, with only a few wells present in the southeastern corner of the county. These wells are extremely deep (greater than 3,000 feet), can produce several hundred gallons per minute, and are generally used for municipal water supply purposes.

Trinity Group deposits in Fannin County generally include sands, limestones, shales, and clays of the Paluxy Formation. Groundwater flow in the Trinity Aquifer is generally from the outcrop areas in a downdip direction. Because the Trinity Aquifer does not outcrop within Fannin County, all groundwater in the Trinity Aquifer within the county is found under artesian conditions, that is, under pressure which pushes the water upward. Due to the limited number of wells in the Trinity Aquifer in Fannin County, it is not possible to delineate groundwater flow directions. In general, the flow will be in a downdip direction, toward the east-southeast. Water level measurements providing data on the Trinity Aquifer are also scarce, although hydrographs of Trinity Aquifer wells within Fannin County indicate that water levels in the Paluxy Formation of the Trinity Aquifer are declining by 3 to 4 feet per year.

Because of the limited number of wells producing from the Trinity Aquifer in Fannin County, it is difficult to fully define the water quality within this aquifer. The available data indicate the Trinity Aquifer has very consistent water quality results, with total dissolved solids ranging between 850 and 900 mg/L. However, based on water quality analyses from adjacent counties (LBG-Guyton, 2003), there is likely to be some slightly saline water present in the Trinity Aquifer in Fannin County.

3.4 BIOLOGICAL RESOURCES

This section provides a discussion of the existing conditions of the biological resources for Alternatives 1 and 2. The biological resources that have been identified that may be affected by Alternatives 1 and 2 include waters of the United States, including wetlands; upland habitat; aquatic biota; wildlife; threatened and endangered species; and invasive wildlife and plant species.

The project components of Alternative 1 and 2 are defined at the beginning of Chapter 3. The evaluation of the biological resources has been conducted with the understanding that the reservoir footprint of Alternative 2 is fully situated inside the reservoir footprint of Alternative 1. The footprint for the associated project components including the dam, raw water pipeline, WTP, and TSR is the same for both Alternatives 1 and 2. A broad description of the existing conditions is provided in some instances for the Bois d'Arc Creek watershed for resources such as tree cover or streams.

The assessment of the affected environment is based on information reported in the Preliminary and Approved Jurisdictional Determinations (Appendices H and I), Habitat Evaluation Procedure (HEP) Report for the Proposed Lower Bois d'Arc Creek Reservoir Site (Appendix J), Application of the East Texas Hydrogeomorphic Approach (HGM) to the LBCR Project (Appendix K), Rapid Geomorphic Assessments (RGAs) of Bois d'Arc Creek (Appendix L), Instream Flow Study (Appendix M), Environmental Report Supporting an Application for a 404 Permit for Lower Bois d'Arc Creek Reservoir (Appendix Q), and supporting publications and documents cited in Chapter 6, References Cited, of this Revised DEIS.

3.4.1 Methods

It should be noted that data collection related to biological resources was inhibited to an extent by land access issues, that is, lack of permission for access to all private properties, especially within the reservoir footprint. This necessitated extrapolation of findings from sites to which access was gained and data obtained to other sites which were not actually visited or observed by biologists.

Wetland Delineation

Wetlands and surface waters in the proposed LBCR reservoir site for Alternatives 1 and 2 (i.e., the area in which existing or baseline habitats would be altered by construction activities, reservoir clearing, and impoundment of water) were identified through a field delineation using the *1987 Corps of Engineers Wetland Delineation Manual*. Section 404 of the Clean Water Act (CWA) authorizes the USACE to review and issue regulatory permits for activities that may discharge dredged or fill material into waters of the United States, which includes wetlands. The *1987 Corps of Engineers Wetland Delineation Manual* was written to provide technical guidance on how to determine wetlands and waters of the United States that are under USACE jurisdiction pursuant to Section 404 of the CWA. Objectives of the manual are to provide technical guidelines and methods for implementing the guidelines. These technical guidelines for wetlands do not constitute a classification system, but provide a basis for determining whether a given area is a wetland under Section 404 (USACE, 1987).

Habitat Evaluation Procedure

The Habitat Evaluation Procedure (HEP) was conducted to quantify habitat value of the proposed LBCR reservoir site for Alternatives 1 and 2 (i.e., the area in which existing or baseline habitats would be altered by construction activities, reservoir clearing, and impoundment of water). The HEP analysis was conducted by multiple interagency teams that included personnel from USFWS, USACE, EPA, USFS, TPWD, TWDB, TCEQ, NTMWD, and Freese and Nichols, Inc. This evaluation was made to determine baseline conditions of the nine habitat types identified. HEP was also performed on the proposed Riverby Ranch mitigation site to quantify existing habitat values on that site. In this Revised DEIS, HEP was used to determine compensatory mitigation requirements for emergent and shrub wetlands. A detailed description of the HEP analysis is provided in Appendix J.

HEP was developed by the USFWS in 1974 to provide a habitat-based evaluation methodology for use as an analytical tool in impact assessments and project planning. HEP is a species-habitat analysis of the ecological value of a study area. Its approach is to quantify the value of habitat available in a geographic area to a selected set of wildlife species (evaluation species). The HEP analysis describes wildlife habitat values at baseline and future conditions to allow for comparison of different areas. Providing quantitative values for comparisons means this analytical approach may be used in planning applications such as the assessment of current and future wildlife habitat, trade-off analyses or compensation analyses. Two general types of wildlife habitat comparison can be made using HEP:

1. The relative value of wildlife habitats at different locations at the same point in time; and
2. The relative quality of wildlife habitats at the same locations at future points in time.

To quantify habitat quality, sixteen evaluation species (American kestrel, barred owl, brown thrasher, Carolina chickadee, downy woodpecker, eastern cottontail, eastern meadowlark, eastern turkey, field sparrow, fox squirrel, green heron, raccoon, racer, scissor tailed flycatcher, swamp rabbit, and the wood duck), were selected by the HEP team based on their ecological significance and the availability of applicable Habitat Suitability Index (HSI) models. The HSI scale ranges from 0.0 to 1.0, with 0.0 being unsuitable habitat and 1.0 being optimal habitat for an evaluation species. The HSI value obtained from this comparison becomes an index of carrying capacity (the population size or density a habitat of a given quality can support) for selected evaluation species.

Hydrogeomorphic Approach (HGM)

Developed to be used with the Clean Water Act Section 404 Regulatory Program, the HGM approach derives functional indices as well as the protocols to apply these indices to the assessment of wetland functions at specific sites. The HGM tool can be applied to analyze project alternatives, minimize impacts, assess unavoidable impacts, determine mitigation requirements, and monitor the success of compensatory mitigation (Camp et al., 2016).

The HGM approach includes four parts: (a) the HGM classification, (b) reference wetlands, (c) assessment variables and assessment models from which functional indices are derived, and (d) assessment protocols. HGM is conducted in two phases (Williams *et al.*, 2010). In the first, an interdisciplinary assessment team of experts carries out the development phase of the HGM approach. In the second phase, the assessment variables, models, and protocols are applied to assess wetland functions at the site(s) of interest.

In 2011, the Office of Wetlands, Oceans, and Watersheds at EPA in Dallas contracted with the Waters of East Texas Center, Stephen F. Austin State University, Arthur Temple College of Forestry and Agriculture (SFASU) to conduct field testing in Fannin County of the methods outlined in the *Regional Guidebook for Applying the Hydrogeomorphic Approach to the Functional Assessment of Forested Wetlands in Alluvial Valleys of East Texas* (Williams et al., 2010), referred to as the East Texas Guidebook. The East Texas Guidebook was originally prepared to support forested wetland functional assessment in the modern floodplains of riverine systems in the East Texas Pineywoods ecoregion. The objective of the 2011 study request by EPA was to evaluate the methods and models in the guidebook for use in assessing forested wetland functions for the proposed LBCR of Alternatives 1 and 2.

The 2011 assessment team sampled forested wetlands associated with riverine geomorphic sites in Fannin County that were believed to approach the highest functional condition to measure the wetland variables identified in the East Texas Guidebook. Property access limited specific sample locations. The variables were used in models to calculate functional capacity indices (FCI). The USACE Tulsa District Regulatory Office contacted SFASU during the summer of 2015 to discuss the additional work that would be necessary to modify variable metrics and models in the East Texas HGM FCI spreadsheet calculator for use in the evaluation of the proposed LBCR site for Alternatives 1 and 2. In 2016, an interagency team conducted HGM at both the proposed reservoir site and the proposed Riverby Ranch mitigation site.

In this Revised DEIS, HGM was used to determine compensatory mitigation requirements for forested wetlands. A detailed description of the HGM analysis is provided in Appendix K.

3.4.2 Habitat

Wetlands

Wetlands are habitats that represent a transition zone between dry upland and wet areas. The USACE defines wetlands as areas that are inundated or saturated by surface or groundwater at a frequency and duration that will support vegetation and soil characteristics that will thrive in saturated conditions (USACE, 1987). Wetlands are identified and delineated using the methodologies and procedures identified in the 1987 Corps of Engineers *Wetlands Delineation Manual* (USACE, 1987). The manual uses three factors, vegetation, hydric soil, and hydrology, to determine if an area is a wetland. Hydrology largely determines how soils develop and the plant and animal communities that live in and on a given soil type. Soils exposed to prolonged saturation or inundation develop particular physical and chemical properties and become hydric or wetland soils.

Wetlands may support both terrestrial and aquatic species. They also support hydrophytes, specialized plants that have adapted to thrive under the prolonged presence of water. Wetlands include habitats such as, but not limited to, marshes (emergent wetlands), swamps (forested wetlands), bogs, muskegs, vernal pools and other habitat types. "Jurisdictional wetlands" are those wetlands that are considered waters of the United States, as defined in 33 CFR 328.3, and therefore are regulated by the USACE under Clean Water Act Section 404. Determining if an area is a wetland and determining if that wetland is also jurisdictional are two separate steps. The first task is to determine if an area is a wetland. After determining whether an area is a wetland, a jurisdictional determination is made.

The vegetation communities and plant species in eastern Texas are highly diverse; the bottomland communities and their associated wetlands are among the most biologically productive and diverse ecosystems in North America (USFWS, 1984). A desktop analysis was conducted to identify land cover types that occur within the footprint of the proposed reservoir under Alternative 1, as shown in Figure 3.4-1. Upland land cover types are discussed in Section 3.4.2.3.

A map identifying the boundaries of jurisdictional wetlands and water bodies within the project area is presented in Figure 3.4-2. A formal wetland delineation for the entire reservoir project area was not conducted, although some data collection occurred during field efforts associated with the instream flow study and field applications of functional assessment tools. Wetland land cover types in the proposed reservoir footprint were estimated to include 4,602 acres of forested wetlands, 1,223 acres of emergent wetlands, and 49 acres of scrub shrub wetlands. Water bodies or waters of the United States were initially identified and delineated in 2007 by a Preliminary Jurisdictional Determination (PJD) and then verified in 2015 when an Approved JD (AJD) was conducted by the USACE. Water bodies present within the project area consist of 78 acres of open water and approximately 651,140 linear feet (219 acres) of streams later classified as 286,139 linear feet (120 acres) of existing intermittent streams and 365,002 linear feet (99 acres) of intermittent/ephemeral streams.

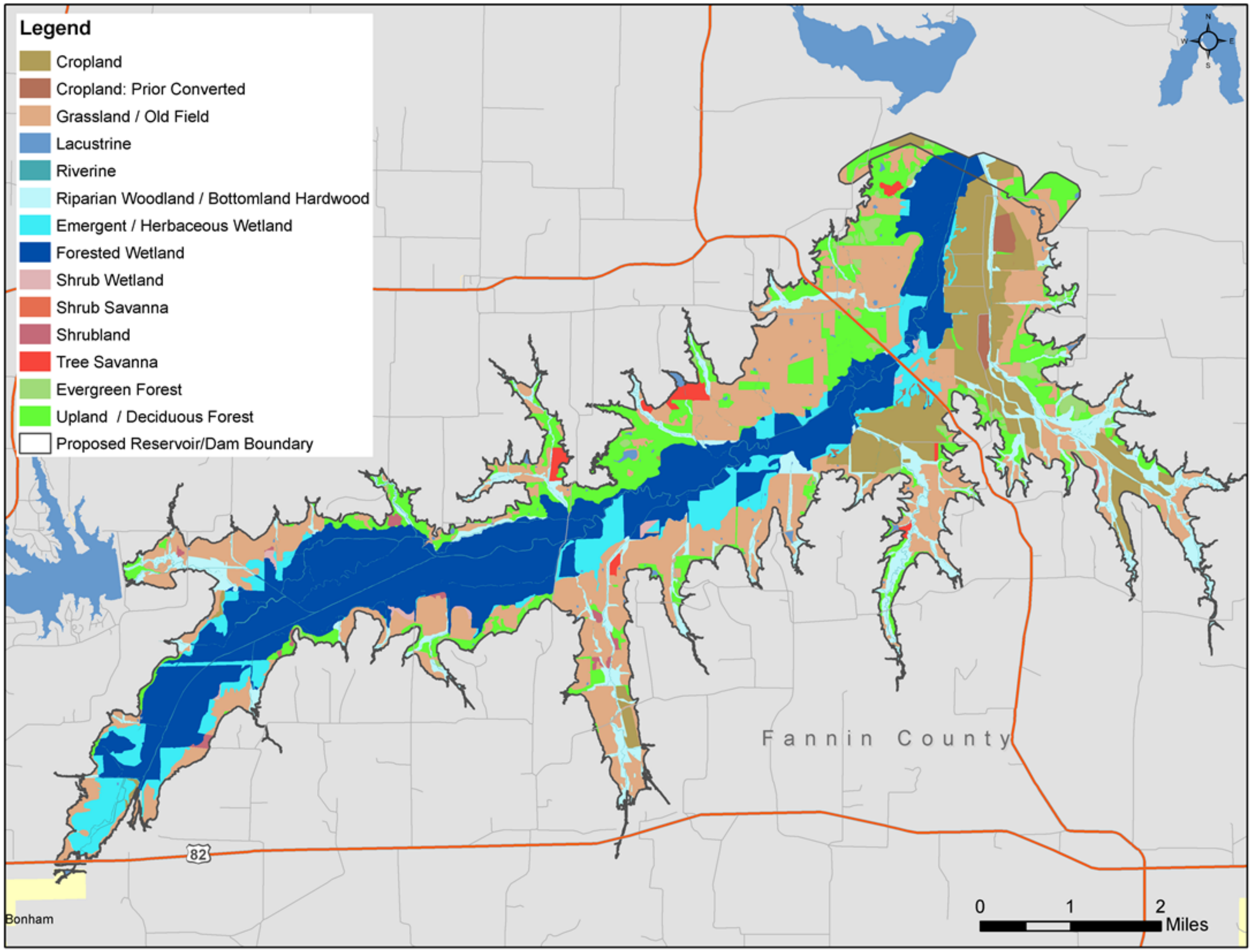


Figure 3.4-1. Existing Land Cover Types within the Reservoir Footprint for Alternative 1

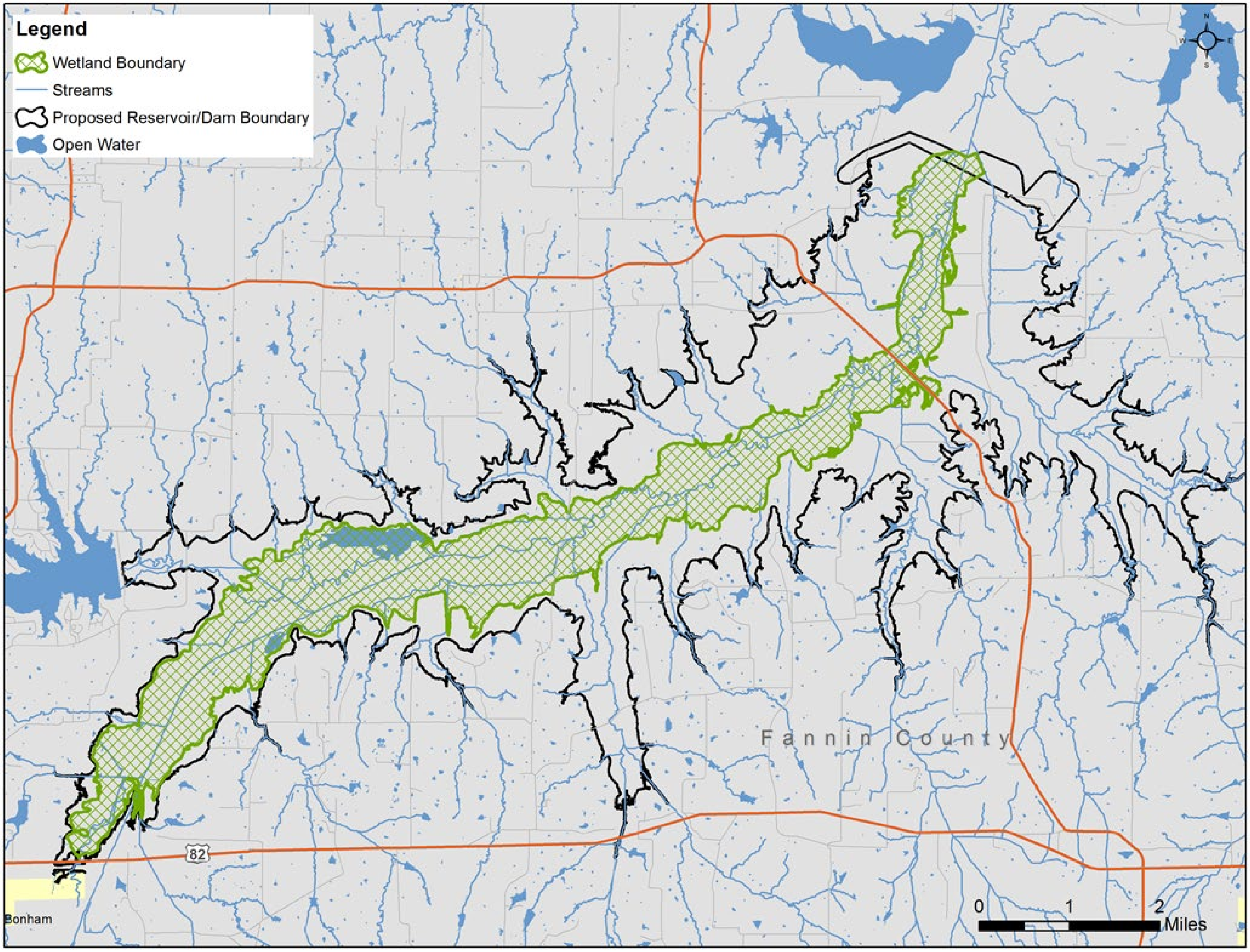


Figure 3.4-2. Existing Jurisdictional Wetlands and Waters within the Reservoir Footprint for Alternative 1

The primary stream within the project area is Bois d'Arc Creek; all other streams on the site are either direct tributaries of Bois d'Arc Creek or tributaries of tributaries to Bois d'Arc Creek. Bois d'Arc Creek flows in a generally southwest to northeast direction to its confluence with the Red River at the northern boundary of Fannin County which is also the northern state boundary. Approximately 62 percent of the main stem of Bois d'Arc Creek within the LBCR footprint has been channelized (Kiel, 2016a). The creek has been characterized as flashy, showing rapid response to rainfall events with extended periods of little or no flow. It experiences periodic flooding. Bar deposits of sand and gravel can be found dispersed along the creek. The highly channelized and straightened nature of Bois d'Arc Creek (Figure 3.4-3) plays an important role in determining the current behavior and geomorphological processes that prevail in the stream, and also contributes to considerable erosion of its bed and banks, limited habitat and biotic diversity in channelized sections, and minimal lateral migration. Detailed information regarding hydrology is discussed in Section 3.3.

Figure 3.4-3 Channelized Portion of Bois d'Arc Creek

In the Revised DEIS, a desktop assessment of the affected environment for wetlands and waters was also conducted for the proposed smaller LBCR (Alternative 2). The footprint of the proposed reservoir project area for Alternative 2 in certain areas is the same as the footprint of the proposed project area of Alternative 1, and in other areas is smaller and situated within the footprint of the larger proposed project area of Alternative 1. Therefore, the assessment and descriptions for wetlands and waters of Alternative 1 encompass the footprint of the reservoir project area for the smaller LBCR. A map, also generated by a desktop exercise, of the vegetation cover types for Alternative 2 is shown in Figure 3.4-4. Jurisdictional wetlands and waters identified under this assessment for Alternative 2 are displayed in Figure 3.4-5.

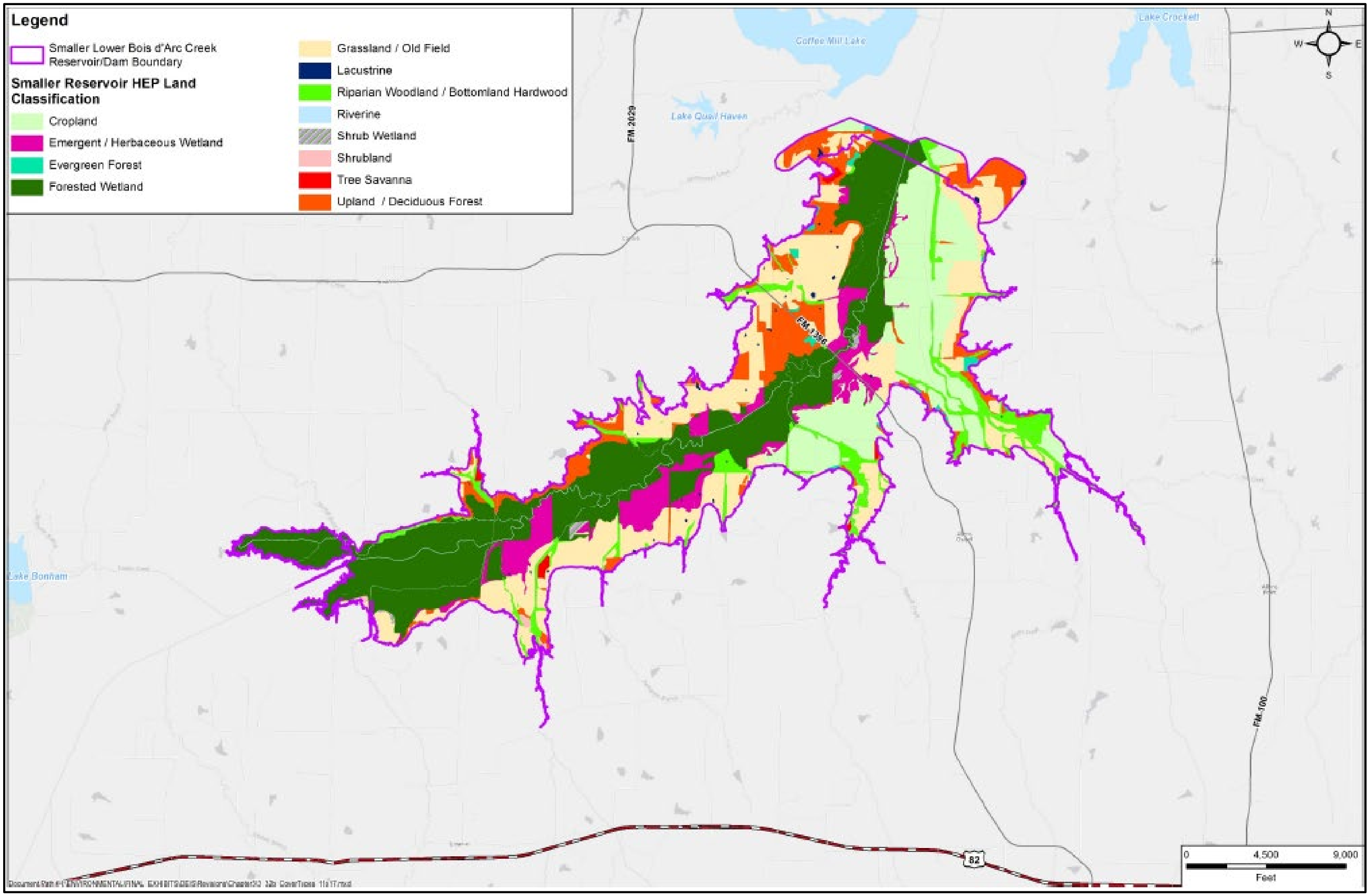


Figure 3.4-4. Existing Land Cover Types within the Footprint of the Smaller Lower Bois d'Arc Creek Reservoir (Alternative 2)

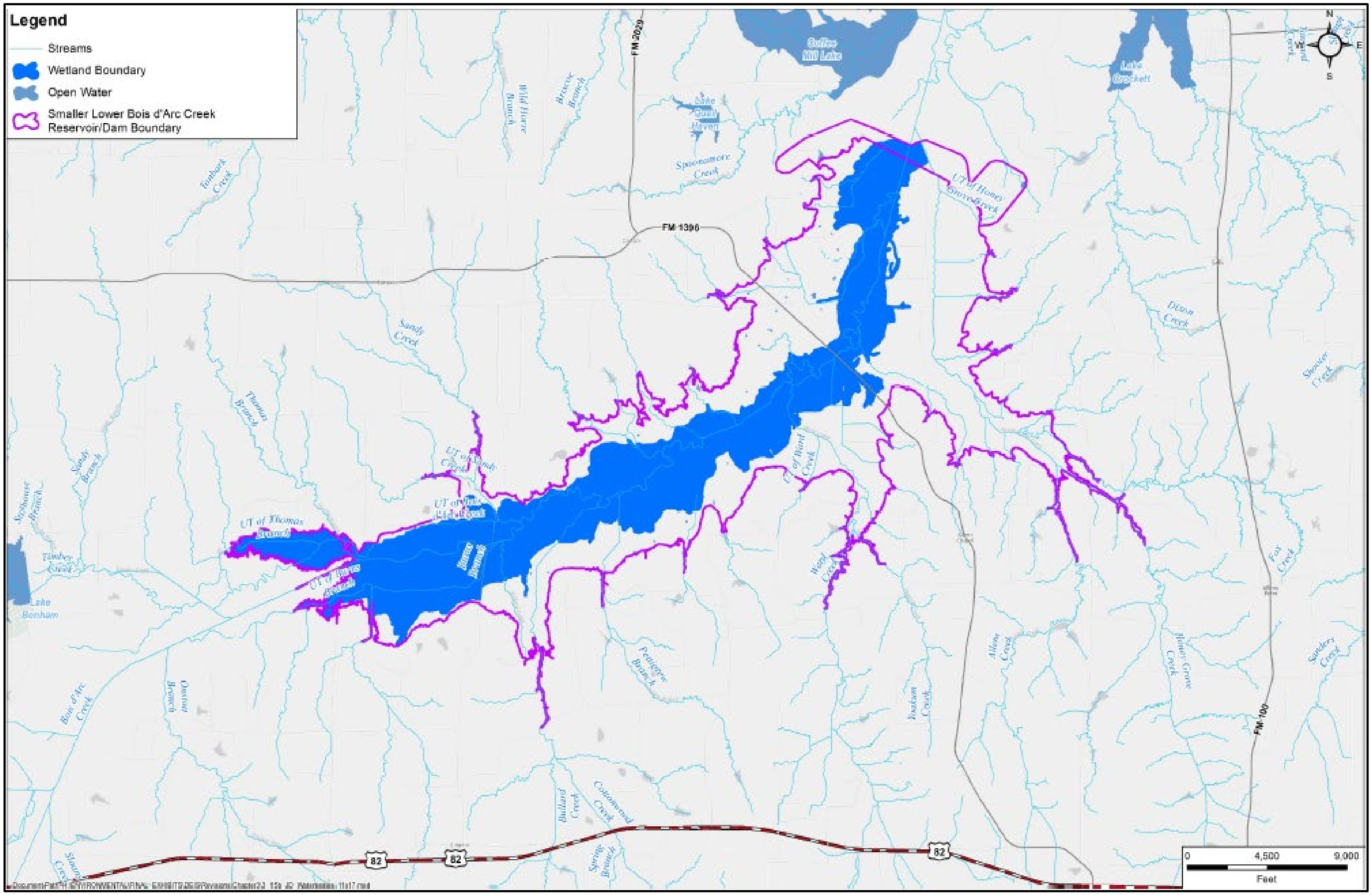


Figure 3.4-5. Existing Jurisdictional Wetlands and Waters within the Footprint of the Smaller Lower Bois d'Arc Creek Reservoir (Alternative 2)

For both Alternatives 1 and 2, the areas in which the proposed raw water pipeline, WTP, and TSR would be constructed have no wetlands present, and all of these components have been sited in uplands or existing right-of-way (ROW). Vegetative cover was not assessed for the pipeline to be constructed from Lake Texoma to the balancing reservoir (for Alternative 2 only) since it is being placed within an existing ROW. Waters (in the form of streams) that occur within the overall proposed project area are discussed in Section 3.3.

Forested Wetlands

The forested wetlands 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 riparian woodland / bottomland hardwood cover type. The forested wetlands in the proposed reservoir footprint are predominantly deciduous forests and are associated with the floodplains of Bois d'Arc Creek and Honey Grove Creek. The condition of the forest floor in these areas varies from standing water to dry, cracking mud. Average tree canopy cover equals approximately 68 percent, while the shrub cover equals approximately 19 percent. There are approximately 4,602 acres of forested wetlands in the proposed footprint of Alternative 1.

The forested wetlands, also known as bottomlands, of the southeastern United States, including Texas, are increasingly subjected to various development pressures which have resulted in high rates of conversion of stream bottom habitats. As a result, in 1984 the USFWS published the Texas Bottomland Hardwood Preservation Program Category 3 (U.S. Fish and Wildlife Service, 1985) which identified 62 forested bottomland areas proposed for conservation consideration, and further placed the sites into six priority categories. Bois d' Arc Creek is categorized as Priority 4, which is defined as moderate quality bottomlands with minor waterfowl benefits. The USFWS Preservation Program recognizes the forested region of eastern Texas as having value for wintering mallards, wintering and breeding wood ducks and other species; it also recognizes that the area has played a key role in sustaining continental waterfowl populations (USFWS, 1984).

Dominant trees include black willow (*Salix nigra*), boxelder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), sugarberry (*Celtis laevigata*), and cedar elm (*Ulmus crassifolia*). Average diameter at breast breast height (dbh) of overstory trees is approximately nine inches and basal area in the forest averages 97 square feet per acre. Dominant shrubs are often small trees of the species listed above, as well as honey locust (*Gleditsia triacanthos*), poison ivy (*Toxicodendron radicans*), coralberry *(Symphoricarpos* orbiculatus), buttonbush *(Cephalanthus occidentalis),* and Virginia creeper (*Parthenocissus quinquefolia*). Common herbaceous plants in the bottomland hardwood forest include baccharis (*Baccharis* spp.), Cherokee sedge (*Carex cherokeensis*), ragweed (*Ambrosia* spp.), and Virginia wildrye (*Elymus virginicus*).

The tree cover observed both in the LBCR footprint as well as in the Bois d'Arc Creek watershed is commonly limited to one to three dominant tree species including green ash, sugarberry, and cedar elm. Green ash, which is a pioneer species that readily invades cutover sites in the project area, is the most prevalent. This is indicative that the wetland forest is immature within areas that have experienced logging activities that have been ongoing for decades.

All of the forested wetlands within the footprint of the proposed reservoir are designated under HGM as sub-class low-gradient riverine. Riverine wetlands occur within the 5-year floodplain and the riparian corridor associated with stream channels. Their primary water source is from overbank or backwater flow from the channel. Other water sources for riverine wetlands include interflow, overland flow from adjacent uplands, tributary inflow, and direct precipitation. Low-gradient riverine wetlands are found within the floodplains of rivers. These floodplains can be wide even along relatively narrow channels, a feature that is common in modern coastal plain river systems. Typically, such systems have large, distinctive geomorphic features and are often subjected to both overbank and backwater flooding. Their typical hydrogeomorphic setting includes point bars, backswamps, and natural levee deposits associated with meandering streams within the 5-year floodplain (Williams et al., 2010). All of the forested wetlands are contiguous and are located within the 5-year floodplain of Bois d'Arc Creek, as shown in Figure 3.4-6 (Votaw, 2016). The forested wetlands are strongly associated with the Tinn Clay, 0-1 percent slopes, frequently flooded and Tinn Clay, 0-1 percent slopes, occasionally flooded soil map units.

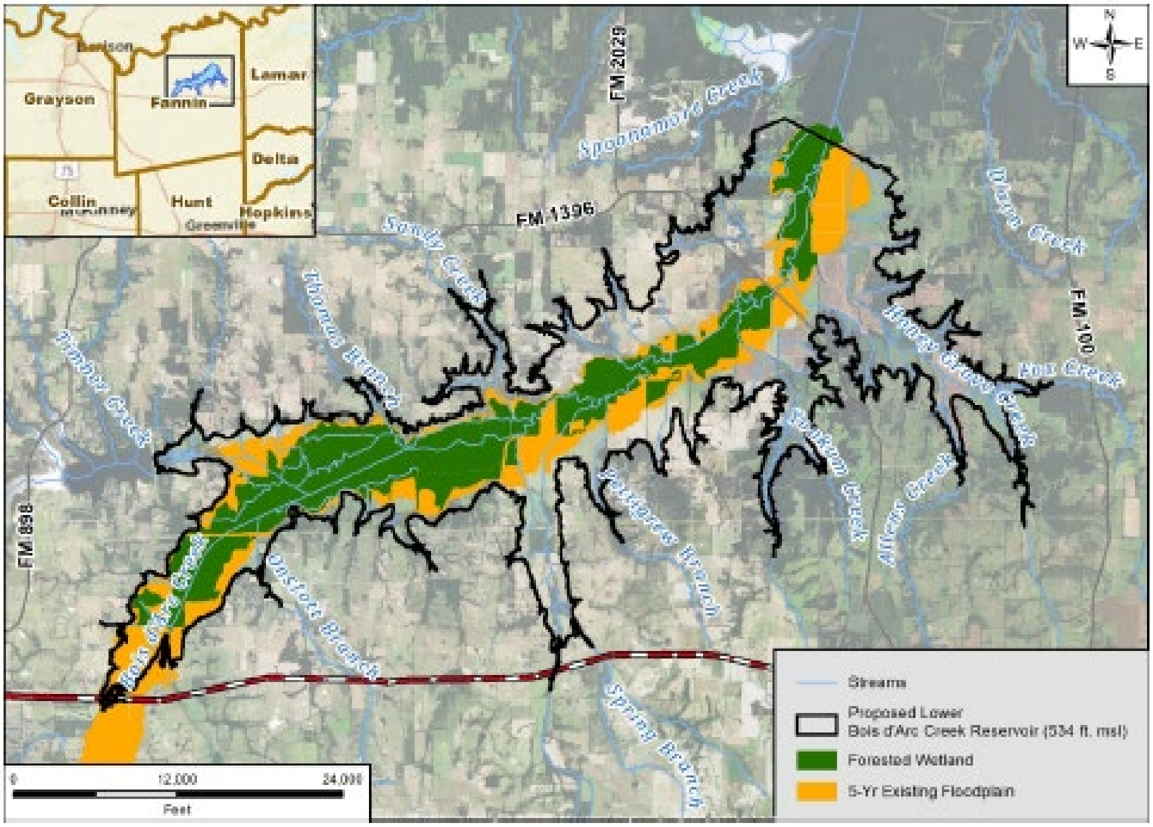


Figure 3.4-6. Forested Wetlands Located Within the 5-year Floodplain of the Project Area

Initially, the United States Fish and Wildlife Service (USFWS) HEP was used as an assessment tool for forested wetlands. The HEP is a species-specific analysis of the ecological value of an area that evaluates the relative quality and value of wildlife habitat. A detailed description of the HEP analysis is presented in section 3.4.1.2 and Appendix J. The HEP determined the forested wetlands in the project area to be low quality (Figure 3.4-7), with a habitat suitability index of 0.25 (on a scale of 0 to 1).

Figure 3.4-7. View Looking Upstream (towards Southeast) of Bullard Creek, an Example of a Sub-class Low Gradient Riverine Forested Wetland

In response to comments on the 2015 DEIS, changes to the forested wetlands assessment methodology were made. In collaboration with the cooperating agencies EPA, USFWS, and TPWD, the HEP assessment tool for forested wetlands was changed to the hydrogeomorphic (HGM) approach. HGM is a model specifically designed to measure the functions of Forested Wetlands. It cannot be used to assess emergent or scrub shrub wetland functions. At the time the LBCR Section 404 permit application was submitted in 2008, there was no vetted HGM model available in the Tulsa District to measure such functions; therefore HEP was originally used to assess Forested Wetlands. In 2016, HGM was introduced and USACE and the cooperating agencies participated in a collaborative reassessment of the forested wetlands using the Modified East Texas HGM. HEP reports quality units as habitat units (HUs) while the HGM reports functional capacity units (FCUs).

FCUs are derived by multiplying the area of forested wetlands by the functional capacity index (FCI) value. The FCI value is an indication of the ability of a given wetland to perform a specific function relative to the ability of reference standard wetlands to perform the same function. FCI values range from 0.0 to 1.0; wetlands with an FCI of 1.0 perform the assessed function at a level comparable to reference standard wetlands. A lower FCI indicates that the wetland is performing a function at a level below reference standard wetlands. The FCI value for each function was multiplied by the acreage of forested wetlands in the proposed reservoir area, 4,602 acres, to determine the functional capacity units (FCUs) for the function. The six wetland functions evaluated, their FCI value as determined by the HGM approach, and the resulting functional capacity units for each function are summarized in Table 3.4-1. A detailed description of the HGM analysis is presented in section 3.4.1.3 and Appendix K.

Table 3.4-1 shows relatively high FCI values for the six wetland functions, indicating that the forested wetlands within the project area are functioning close to the reference standard community. "Reference standard wetlands" are high-quality wetlands and are given an FCI of 1.0, the highest score possible; reference wetlands perform functions at a level characteristic of the least altered wetland sites in the least modified landscapes (Williams et al., 2010). The functional capacities of the downstream wetlands are similar to the functional capacities within the proposed reservoir footprint.

Table 3.4-1. Forested Wetlands Functional Capacity Index Values and Functional Capacity Units

Wetland Function	FCI	Functional Capacity Units in Acres (hectares)
Detain Floodwater	0.92	4,233.84 (1,713.04)
Detain Precipitation	0.78	3,589.56 (1.452.36)
Cycle Nutrients	0.85	3,911.70 (1,582.70)
Export Organic Carbon	0.87	4,003.74 (1,619.94)
Maintain Plant Communities	0.90	4,141.80 (1,675.80)
Provide Habitat for Fish and Wildlife	0.86	3,957.72 (1,601.32)

Emergent Wetlands

Emergent wetlands are defined as areas with a total vegetation cover of greater than 30 percent that are dominated by hydrophytic plants growing on or below the water surface (USFWS, 1980c; Cowardin et al., 1979). An example of an emergent wetland is pictured in Figure 3.4-8. Emergent wetlands in the project area are dominated by an herbaceous layer made up of wetland obligates (species that are found only in wetlands) such as rushes (*Juncaceae* spp.), sedges (*Cyperaceae* spp.), smartweed (*Plygonum* spp.), and redstem (*Ammannia* spp.). The shrub layer is primarily made up of black willow, green ash, baccharis, swampprivet (*Forestiera* spp.), buttonbush (*Cephalanthus occidentalis*), honey locust, cocklebur (*Xanthium strumarium*), and desert false indigo (*Amorpha fruticosa*). The herbaceous canopy includes numerous grass species, such as barnyard grass (*Echinochloa crus-galli*), crowngrass (*Paspalem* spp.), and eastern gammagrass (*Tripsacum dactyloides*). Other plants found in the herbaceous wetlands include rushes, blue sedge (*Carex glaucodea*), spikerush (*Eleocharis* spp.), flatsedge (*Cyperus* spp.), smartweed, sumpweed (*Iva annua*), frog fruit (*Phyla* spp.), water primrose (*Ludwigia* spp.), balloon vine (*Cardiospermum halicacabum*), dock (*Rumex* spp.), and buttercup (*Ranunculus* spp.).

Figure 3.4-8. Example of an Emergent Wetland

A HEP analysis was conducted in 2007 for the proposed reservoir site and in 2013 for other project component areas including the raw water pipeline, WTP and TSR sites. A brief description of the HEP analysis is provided in Section 3.4.1.2 and a more detailed description is provided in Appendix J. Approximately 1,223 acres of emergent wetlands were identified within the Alternative 1 (full-sized) reservoir footprint in 2007. During the HEP field data collection, 11 emergent wetland habitat variables were assessed at six random sites within these 1,223 acres of emergent wetlands. The total acreage of existing emergent wetlands (1,223 acres) was multiplied by the average habitat quality, called the Habitat Suitability Index (HSI), which had a value of 0.42 to obtain a Baseline Habitat Unit (HU). The HEP determined an HU of 514 for emergent wetlands within the Alternative 1 reservoir footprint. This value is an estimate of the aggregate value of emergent wetlands present on site. This is the value that serves as the basis for determining the amount of compensatory mitigation.

Scrub Shrub Wetlands

Scrub shrub wetlands are 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). Scrub shrub wetlands in the project area (Figure 3.4-9) can be considered wetlands in successional transition between herbaceous wetlands and bottomland hardwood forests. The scrub shrub layer is dominated by small trees such as green ash, sugarberry, and cedar elm, as well as shrub species such as honey locust and baccharis. Scrub shrub canopy cover in the project area averages approximately 48 percent. Dominant herbaceous plants include sedge, ragweed, ironweed (*Vernonia* spp.), goldenrod (*Solidago* spp.), evening primrose (*Oenothera speciosa*), round-leaf groundsel (*Packera obouta*), trumpet vine (*Campsis radicans*), and wild pea (*Lathyrus* spp.). Herbaceous canopy cover averages approximately 66 percent.

Approximately 49 acres of scrub shrub wetlands were identified within the Alternative 1 reservoir footprint. Applying HEP in the same way as described above for emergent wetlands, an average HSI value of 0.46 was obtained for these scrub shrub wetlands and thus it was determined that 23 HUs exist within this community. This value is an estimate of the aggregate value of scrub shrub wetlands present on site and serves as the basis for determining the amount of compensatory mitigation that would be required.

Figure 3.4-9. Scrub Shrub Habitat within the Reservoir Project Area

Streams

Bois d' Arc Creek is a warm water precipitation dependent stream characterized by a high degree of artificial channelization. Channelized stream reaches were identified through an assessment using a comparison of a 1915 topographic map to contemporary aerial photography. The effects of artificial channelization are exacerbated by local geology, which is characterized by cohesive highly erodible soils. Increased overland sheet flow (associated with watershed agricultural land use) and large flood pulse occurrences caused from rainfall events have downcut stream banks approximately 20 to 30 feet throughout the majority of the mainstem channel. These changes to channel morphology have reduced channel bed and bank topography, thus leading to an altered aquatic system with reduced instream habitat variability.

The Instream Flow Study included in Appendix M is a compilation of multiple studies that includes hydrology, geomorphology, biology, and water quality. The biological component of the instream flow study reflects the integration of the hydrology, hydraulics, geomorphology and water quality aspects of the stream (Bovee et al., 1998; Annear et al., 2002; TWDB, 2008). These components directly impact aquatic habitats, biological migration, reproduction, and aquatic life viability. Understanding these relationships provides a mechanism to create and maintain a stable ecological environment.

To characterize the baseline conditions of a stream, the biological component of an instream flow study includes determining relationships among aquatic communities, life histories, and habitats (TIFP, 2008). Flow regimes affect the quality and quantity of available habitat (Bunn and Arthington, 2002). Flow regimes also manipulate the geomorphic structure of a channel and affect water quality conditions in streams, in turn influencing the biological processes. Habitat conditions are generally characterized in terms of water velocity, depth, substrate composition, and instream cover. The aquatic habitats in Bois d'Arc Creek are subject to displacement during high flow events. During periods with low flows, the habitats are generally limited to perennial pools, which limits both run and riffle habitats. The aquatic life must be adaptable to changes in flow, which can limit biotic diversity.

A stream order designation is a measure of the relative size of streams. The smallest tributaries are designated as first-order streams, while the largest river in the world, the Amazon, is designated as a twelfth-order waterway. The order of a stream can be used to understand the sediment potential in a stream segment and to determine what types of aquatic life might be present in the waterway. Bois d'Arc Creek is classified as a 3rd to 4th order stream for the sampling reaches of the instream flow study.

Existing Stream Classification

Seventeen named streams/creeks and 15 associated tributaries that support aquatic biota exist within the project area. All of the streams/creeks are intermittent or intermittent/ephemeral. Figure 3.4-10 shows an example of an intermittent/ephemeral stream. A detailed discussion of these streams may be found in Section 3.3.

Figure 3.4-10. Downstream View (East) of an Unnamed Ephemeral Tributary of Loring Creek, an Example of an Intermittent/Ephemeral Creek

Upland Habitats

Upland habitat occurs in areas of land lying above the level where water flows or where flooding occurs, at a higher elevation than the alluvial plain or stream terrace. This section discusses regional upland habitat, as well as the various upland community types that occur in the project area.

Regional Vegetation

The proposed project area is located in the Blackland Prairie and the Northern Post Oak Savannah Level IV Ecological regions (see Figure 3.4-11) (Griffith et al., 2004). These regions extend from approximately the Red River of Oklahoma south to San Antonio, Texas, east to the East Texas Pineywoods and west to the Eastern Cross Timbers.

The Backland Prairie represents the southernmost extension of the North American tallgrass prairies and is dominated by a diverse assortment of perennial and annual grasses and forbs. Historically, vegetation in the northern portion of this ecoregion consisted of little bluestem (*Schizachyrium scoparium*), yellow Indiangrass (*Sorghastrum nutans*), and tall dropseed (*Sporobolus asper* var. *asper*). Dominant grasses included eastern gamagrass (*Tripsacum didactylus*), switchgrass (*Panicum virgatum*), Silveanus dropseed (*S. silveanus*), Mead's sedge (*Carex meadii*), and long-spike tridens (*Tridens strictus*). Common forbs included asters (*Aster* spp.), prairie bluet (*Hedyotis nigricans*), prairie clovers (*Dalea* spp.), and black-eyed susan (*Rudbeckia hirta*) (Griffith et al., 2004). While prairie grasslands were the dominant vegetation cover in this ecoregion, forests were located primarily along stream courses and some upland areas (USGS, 2011e). Bur oak (*Quercus macrocarpa*), Shumard oak (*Q. shumardii*), sugar hackberry (*Celtis laevigata*), elm (*Ulmus* spp.), ash (*Fraxinus* spp.), eastern cottowood (*Populus deltoides*), and pecan (*Carya illinoensis*) once dominated these forests (Griffith et al., 2004).

By the 1800s most of this area was converted to farmland, which remains the dominant land cover today. Forests, grassland/shrubland, and developing land are also leading land covers found in this ecoregion. Minor land covers include wetlands, water, and mining. Forests within the region are primarily located in stream drainages or in areas where mesquite and juniper shrubland was allowed to grow into tree height woodlands. Grassland/shrublands can be found in 1) areas where less intense grazing occurs, 2) land where wood vegetation was allowed to grow on pasture land, and 3) on idle Conservation Reserve Program (CRP) farmland.

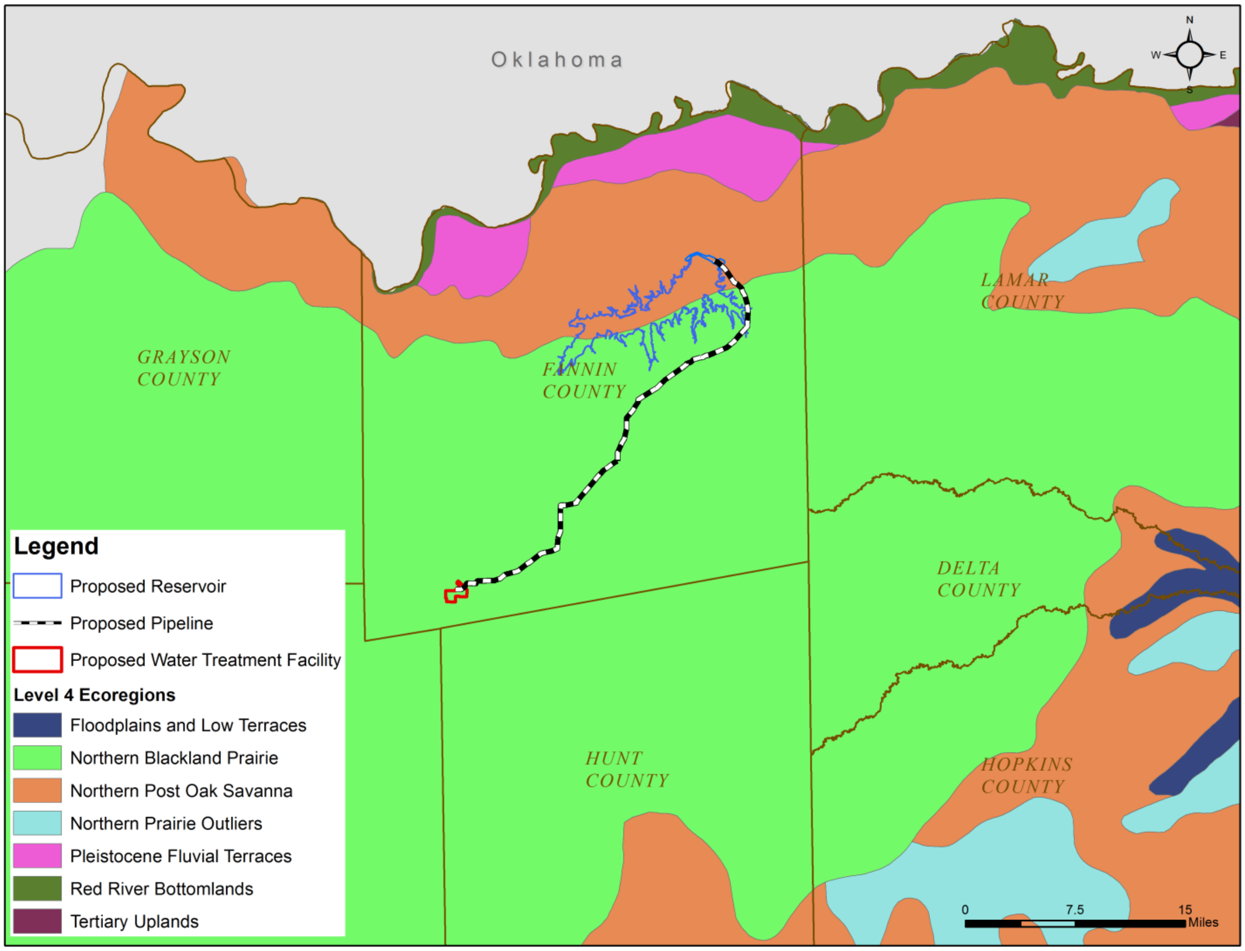


Figure 3.4-11. Ecoregion Types of Fannin and Surrounding Counties, Texas

The Northern Post Oak Savannah Ecoregion is found within the East Central Texas Plains and is characterized by native bunch grasses and forbs with scattered clumps of trees, primarily post oak (Griffith et al., 2004). Today improved pastures, rangelands, and croplands make up the majority of this Ecoregion. Historically, fires and burns in the northern part of the East Central Texas Plains maintained grassy openings, but with the absence of fires, woody plants have taken over many of these grassy openings. Mixed native and introduced grasses and forbs on grassland sites or mixed herbaceous communities have resulted from the recent clearing of woody vegetation.

Forested areas in this ecoregion are limited to hardwood bottomlands along major rivers and creeks, or in areas protected from fire (Freese and Nichols, 2008a). These forests are dominated by post oak (*Q. stellata*), blackjack oak (*Q. marilandica*), eastern red cedar (*Juniperus virginiana*), and black hickory (*Carya texana*). Unlike the Northern Blackland Prairies, prairies found in this ecoregion contain little bluestem and other grasses and forbs (Griffith et al., 2004).

Federally protected land near the proposed project site of Alternatives 1 and 2 includes the Caddo National Grasslands. The proclamation boundaries of the Grasslands cover 17,785 acres and contain three lakes. The Caddo National Grasslands is comprised of two units, the Bois d'Arc Unit and the Ladonia Unit (Freese and Nichols, 2008a). The Bois d'Arc Unit is located adjacent to the north end of the proposed LBCR.

The types and quantities of habitat within the proposed reservoir site of Alternatives 1 and 2 were identified during the summer of 2007. Table 3.4-2 provides a breakdown of vegetation cover types within the reservoir site. The distribution and location of each vegetation cover type are shown in Figures 3.4-1 and 3.4-4.

Table 3.4-2. Upland Habitat Types within Proposed LBCR Site of Alternatives 1 and 2

Habitat Type	Acreage	Percent[a]
Evergreen Forest	228	1
Upland/Deciduous Forest	2,216	13
Riparian Woodland/ Bottomland Hardwood	1,728	10
Shrubland	63	0
Grassland/ Old Field	4,761	28
Cropland	1,757	10
Tree Savanna	132	1
Shrub Savanna	4	0
All wetland and aquatic habitats	6,179	37
Grand Total	**17,068**	**100**

[a] Percentage of entire reservoir footprint of Alternative 1, including dam.

Upland Deciduous Forest

On average, upland deciduous forests in the project area are composed of 90 percent deciduous trees, with overstory trees having an average height of 43 feet. The upland forest cover type makes up approximately 2,216 acres of the proposed Lower Bois d'Arc Creek Reservoir site (both alternatives) (Figure 3.4-12).

Figure 3.4-12. Upland Deciduous Forest at the LBCR Site

Dominant tree species include post oak, water oak (*Q. nigra*), southern red oak (*Q. falcata*), Shumard's oak (*Q. shumardii*), cedar elm (*Ulmus crassifolia*), sugarberry, bois d'Arc (*Maclura pomifera*), green ash (*Fraxinus pennsylvanica*), and eastern red cedar. Tree canopy closure averages approximately 68 percent.

Common shrub and vine species include coralberry (*Symphoricarpos orbiculatus*), greenbrier (*Smilax* spp.), honey locust, poison ivy, Virginia creeper (*Parthenocissus quinquefolia*), and dogwood (*Cornus drummondii*). Shrub canopy closure in the typical upland forest averages about 33 percent. Dominant herbs include sedges, flatsedge (*Cyperus* spp.), panicgrass (*Dichanthelium* spp.), corn salad (*Valerianella* sp.), Virginia wildrye (*Elymus virginicus*), ironweed (*Vernonia* spp.) (Figure 3.4-13), Venus' looking-glass (*Triodanis* sp.), and wild onion (*Allium ascalonicum*). Average herbaceous canopy cover equals approximately 38 percent of the proposed LBCR site (both alternatives).

Figure 3.4-13. Ironweed

Evergreen Forest

Evergreen forests in the project area have a tree canopy with very few deciduous trees and with little understory. The evergreen forest cover type makes up approximately 228 acres of the proposed Lower Bois d'Arc Creek Reservoir site (both alternatives) (Figure 3.4-14).

Figure 3.4-14. Upland Juniper Woods at LBCR Site, an example of Evergreen Forest

These forests are dominated by the evergreen eastern red cedar mixed with deciduous tree species including southern red oak, post oak, and blackjack oak. Average tree canopy closure equals approximately 70 percent, with evergreens comprising 98 percent of the tree canopy on average. Shrub and herbaceous cover is sparse in these areas, averaging about 5 and 8 percent, respectively. Shrub and vine species occurring in these forests include coralberry, greenbrier, gum bumelia (*Sideroxylon* (syn. *Bumelia*) l*anuginosum*), and possumhaw holly (*Ilex decidua*). Herbaceous species include Cherokee sedge (*Carex cherokeensis*), panicgrass, Johnsongrass (*Sorghum halepense*), and king ranch bluestem (*Bothriochloaischaemum* var. *songarcia*).

Shrubland

Shrublands occupy 63 acres in the project area and represent a midpoint in the successional transition from upland old fields to forests, with a shrub layer dominated by tree species such as green ash, bois d'Arc, and eastern red cedar. Shrub canopy cover averages approximately 44 percent, while tree canopy cover averages approximately three percent. The diverse herbaceous layer is dominated by Cherokee sedge, goldenrods (*Solidago* spp.), Johnsongrass, silver bluestem (*Bothriochloa laguroides*), wild pea (*Lathyrus* spp.), and snow-on-the-prairie (*Euphorbia bicolor*). The herbaceous cover is high, averaging approximately 89 percent.

Grassland/Old Field

The grassland/old fields (Figure 3.4-15) in the project area are generally 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. There are 4,761 acres of grassland/oldfield within the reservoir footprint.

Dominant grass species include tall fescue (*Lolium arundinaceium*), perennial rye (*L. perenne*), bahiagrass (*Paspalum notatum*), Bermudagrass (*Cynodon dactylon*), Texas wintergrass (*Nassella leucotricha*), and dallisgrass (*Paspalum dilatatum*). Common forbs include western ragweed (*Ambrosia psilostachya*), ironweed, dock (*Rumex* spp.), vetch (*Vicia* spp.), and wild pea. Herbaceous canopy cover averages approximately 87 percent, while the herbaceous canopy height in spring averages about 13 inches.

Figure 3.4-15. Grassland/Old Field Within the Proposed Reservoir Footprint

Cropland

The croplands in the project area, 1,757 acres, are primarily planted with oats (*Avena sativa*), soybeans (*Glycine max*), and hay crops, often alternated with winter wheat (*Triticum aestivum*) cover. Trees and shrubs are excluded from these areas but are often present in adjacent fencerows. Fallow fields are dominated by Johnsongrass, but also often include panicgrass, knotroot (*Stachys affinis*), bristlegrass (*Setaria paviflora*), tall fescue, and Bermudagrass (Figure 3.4-16). Forbs are also common in the herbaceous layer, including docks, pigweed (*Amaranthus* spp.), spurges (*Euphorbia* spp.), morning glory (*Ipomoea* spp.), and black-eyed Susan. This herbaceous cover stands at an average of 22 inches in the spring, with an average canopy cover of approximately 47 percent.

Figure 3.4-16. Improved Pasture Within the LBCR Footprint

Tree Savanna

Tree savannas in the reservoir footprint, comprising 132 acres, have sparse tree and shrub canopies and abundant herbaceous cover. Tree canopy cover within this cover type averages 12 percent, consisting primarily of large lone trees. These trees are most often cedar elms, bois d'Arc, or eastern red cedars. Shrub canopy cover is also low in these areas, averaging about nine percent. The shrub and vine species commonly seen in these areas include gum bumelia, coralberry, greenbrier, poison ivy, and southern dewberry (*Rubus trivialis*).

Herbaceous cover in tree savannas within the project area is both diverse and abundant, averaging 89 percent cover. Species frequently occurring in the herbaceous layer include ironweed, western ragweed, sedges, flatsedge, Bermudagrass, panicgrass, king ranch bluestem, Indian plantain (*Arnoglossum* spp.), prairie plantain (*Plantago* spp.), croton (*Croton* spp.), and docks.

The proposed North Water Treatment Plant of Alternatives 1 and 2 that would receive raw water from the LBCR is located within a previously disturbed area. This site and the surrounding area are primarily used for livestock grazing and hay production. The site spans 662 acres and is divided by County Road 4965. Vegetation on the proposed site consists mainly of upland herbaceous vegetation with wooded areas along riparian corridors and along fence lines (Alan Plummer Associates, 2010).

Under Alternatives 1 and 2, the proposed project includes 35 miles of new 90-96 inch diameter pipeline. This pipeline would transport untreated (raw) water from the Lower Bois d'Arc Reservoir to the North Water Treatment Plant near the City of Leonard, Fannin County. The proposed pipeline would have a permanent easement width of 50 feet and a temporary construction easement width of 70 feet (for a total temporary width during construction of 120 feet). The pipeline is entirely in Fannin County and vegetational cover types of this area are dominated by agriculture. Most lands within the 120-foot wide limits of the proposed pipeline corridor are either cultivated for crops or managed as improved pasture for livestock (Alan Plummer Associates, 2008). The only trees and shrubs that occur are located in riparian zones at stream crossings or along fence rows.

The entire affected area of the proposed raw water pipeline, WTP, TSR, intake pump station (IPS), electrical substation sites, TSR rail spur, and discharge pipeline/outfall is approximately 875 acres. Included in this acreage are 23 acres of upland deciduous forest, 16 acres of evergreen forest, three acres of shrubland, 500 acres of cropland, 314 acres of grassland/old field, and eight acres of riparian woodland/bottomland hardwood.

Native Prairie Remnant

Native prairie remnant is not listed with other upland habitats in Table 3.4-2, but according to TPWD, a review of new data on the Texas Natural Diversity Database (TXNDD) indicates that a native prairie remnant (Element Occurrence ID 11932) may occur within the footprint of the LBCR. Native prairie habitats are a rare resource in Texas. Although based on the best information available to TPWD regarding rare species or habitats, TXNDD data are not a definitive answer as to the presence, absence or condition of special species, natural communities, or other significant features at the proposed project site of Alternatives 1 and 2, and cannot take the place of on-the-ground surveys (Melinchuk, 2015).

3.4.3 Aquatic Biota

Human presence in the Bois d'Arc Creek watershed has altered aquatic and riparian habitats, and consequently the biota that use or reside in these habitats. The Bois d'Arc Creek has been altered over the past 100 years primarily due to agricultural practices and channelization. Channelization and bank stabilization, non-native species introductions, timber harvesting, and agricultural practices have contributed to changes in aquatic habitats and biota from historical conditions. In 2000 and on more recent site visits, observers noted channelization and losses to the riparian corridor and associated stream bank vegetation indicated by highly exposed root systems (Figure 3.4-17), siltation of the stream, bank caving, and elevated stream water temperatures.

Figure 3.4-17. Bois d'Arc Creek Bank Showing Newly Exposed Roots

The Instream Flow Study included in Appendix M is a compilation of multiple studies that includes hydrology, geomorphology, biology, and water quality. This study's main purpose was to "characterize baseline stream conditions within the proposed reservoir site and downstream, develop predictions of conditions in the reservoir pool, and develop a proposed instream flow regime to maintain a sound ecological environment downstream of the dam". The interagency team that conducted the 2010 Instream Flow Study included participants from USFWS, USACE, USEPA, USFS, TWDB, TPWD, TCEQ, RRA, NTMWD, and FNI.

Four mesohabitats were identified within the Bois d'Arc Creek study area and its tributaries: runs, riffles, structures and areas such as large woody debris and root wads that provide cover for aquatic species, and pools. The frequent change of water flow in Bois d'Arc Creek from low flows (0 to 1 cfs) to high flows (>1,000 cfs) affects both the aquatic habitats and species diversity.

Fish

There is little baseline information on the stream fisheries of Bois d'Arc Creek. Although there have been several collections in the mainstem Red River, with studies in the 1950s conducted throughout the Red River basin (Bonn, 1957), these studies provide a compilation of collected species and do not identify specific tributaries for individual collections. Only one study that documented collection was found to be specific to Bois d'Arc Creek (Red River Authority (RRA), 1999).

Fish species composition was found to be consistent with recorded occurrences for the Red River drainage basin (Thomas et al., 2007), as were index of biotic integrity (IBI) scores (RRA, 1999). IBIs are developed from statistical analysis, based upon a quantitative assessment of changes in the composition of biologic communities that may be collected during field sampling events over time. IBIs are developed to accurately reflect the ecological complexity of a system or identify impacts on the health of a biological system. At least 191 freshwater fish species have the potential to occur in the Red River Basin (Hubbs et al. 2008; Texas A&M, no date). In 1982, approximately 20 fish species were collected by Texas Parks and Wildlife Division (TPWD) in Bois d'Arc Creek (Appendix M); in 1998, 11 species were collected by the RRA in the Red River Basin for their assessment of the eastern Red River Basin (RRA, 1999). Fish in lower Bois d'Arc Creek were also sampled in 2009 (Figure 3.4-18) for the 2010 Instream Flow Study (Appendix M) conducted in support of NTMWD's Water Right permit application.

Figure 3.4-18. Electrofishing and Seine Hauls During Interagency Biological Sampling along Lower Bois d'Arc Creek

Table 3.4-3 lists the historic fish species collected from various lakes and the reservoir project area during the 1982, 1998, and 2010 (Appendix M) studies. The table also identifies fish species occurrences in lacustrine areas, or inland depressions or channels containing standing water (Cowardin, 1979).

Table 3.4-3. Fish Species Documented in Bois d'Arc Creek and Red River Basin, 1982, 1998, and 2010

Common Name	Scientific Name	1982 Study (Bois d'Arc Creek) *	1998 Study (Red River Basin)*	2010 Bois d'Arc Creek Instream Flow Study (number of observations)	Species Occurrence From Local Reservoirs *	Lacustrine Occurrence
American gizzard shad	*Dorosoma cepedianum*			69		
Bigscale lonperch	*Percina macrolepida*			1		
Black crappie	*Pomoxis nigromaculatus*			2		
Blackstripe topminnow	*Fundulus notatus*		*	33		Yes
Blacktail shiner	*Cyprinella venusta*			21		
Blacspot shiner	*Notropis atrocaudalis*			1		
Black bullhead	*Ameiurus melas*			20		
Bluegill	*Lepomis macrochirus*			151	*	
Brook silverside	*Labidesthes sicculus*			7		
Bullhead minnow	*Pimephales vigilax*		*	147		Yes
Central stonewaller	*Campostoma anomalum*			20		
Channel catfish	*Ictalurus punctatus*	*		39	Lake Bonham, Lake Texoma, Coffee Mill Lake, Lake Crockett	Yes
Common carp	*Cyprinus carpio*	*	*	0	Lake Bonham, Lake Texoma, Coffee Mill Lake, Lake Crockett	Yes
Common lonperch	*Percina caprodes*			10		
Carp and minnow hybrids	*Cyprinella hybrid*			3		
Dusky darter	*Percina sciera*			22		
Flathead catfish	*Pylodictis olivaris*			10		
Freckled madtom	*Noturus nocturnus*			9		
Freshwater drum	*Aplodinotus grunniens*			1	Lake Bonham, Lake Texoma, Coffee Mill Lake	Yes
Golden redhorse	*Moxostoma erythrurum*			1		

Common Name	Scientific Name	1982 Study (Bois d'Arc Creek) *	1998 Study (Red River Basin)*	2010 Bois d'Arc Creek Instream Flow Study (number of observations)	Species Occurrence From Local Reservoirs *	Lacustrine Occurrence
Golden shiner	*Notemigonus crysoleucas*	*				Yes
Green sunfish	*Lepomis cyanellus*			154		
Largemouth bass	*Micropterus salmoides*	*	*	37	Lake Bonham, Lake Texoma, Coffee Mill Lake, Lake Crockett	Yes
Longear sunfish	*Lepomis megalotis*		*	421		
Longnose gar	*Lepisosteus osseus*			1		
Orange-spotted sunfish	*Lepomis humilis*			28		
Red shiner	*Cyprinella lutrensis*			1,417		Yes
Redear sunfish	*Lepomis microlophus*			24		
Ribbon shiner	*Lythrurus fumeus*			25		
River carpsucker	*Carpiodes carpio*			4	Lake Texoma	Yes
Sand shiner	*Notropis stramineus*			27		
Slenderhead darter	*Percina phoxocephala*			1		
Smallmouth buffalo	*Ictiobus bubalus*	*		2	Lake Texoma	Yes
Slough darter	*Etheostoma gracile*			2		
Suckermouth minnow	*Phenacobius mirabilis*			26		
Spotted gar	*Lepisosteus oculatus*	*		1	Coffee Mill Lake	Yes
Spotted bass	*Micropterus punctulatus*			3		
Sunfish hybrid	*Lepomis hybrid*	*		18		
Tadpole madtom	*Noturus gyrinus*			2		
Texas shiner	*Notropis amabilis*		*	27		Yes
Threadfin shad	*Dorosoma petenense*			1		
Warmouth	*Lepomis gulosus*		*	12		

Common Name	Scientific Name	1982 Study (Bois d'Arc Creek) *	1998 Study (Red River Basin)*	2010 Bois d'Arc Creek Instream Flow Study (number of observations)	Species Occurrence From Local Reservoirs *	Lacustrine Occurrence
White crappie	*Pomoxis annularis*		*	5	Lake Bonham, Lake Texoma, Coffee Mill Lake, Lake Crockett	Yes
Western mosquitofish	*Gambusia affinis*	*	*	247		Yes
Yellow bullhead	*Ameiurus natalis*			112	Lake Bonham, Lake Crockett	Yes

* Indicates presence

Note: Survey reports from the Statewide Freshwater Fisheries Monitoring and Management Program for Lake Coffee Mill, Lake Crockett, Lake Texoma, and Lake Bonham were reviewed to determine if species have also been documented from local reservoirs; 73 percent of the fish found in Bois d'Arc Creek have also been documented in these reservoirs.

Sources: Appendix L, Appendix M

As referenced in the 2010 Instream Flow Study, data collection occurred from March to July 2009 and researchers collected a total of 3,138 fish, representing 42 species from 11 families at Bois d'Arc Creek (Table 3.4-4).

Table 3.4-4. Fish Species Collected in Bois d'Arc Creek for the 2010 Instream Flow Study

Family	Common Name	Scientific Name	TOTAL	Relative Abundance
Lepisosteidae	Spotted gar	*Lepisosteus oculatus*	1	0.03%
	Longnose gar	*Lepisosteus osseus*	1	0.03%
Clupeidae	American gizzard shad	*Dorosoma cepedianum*	69	2.20%
	Threadfin shad	*Dorosoma petenense*	1	0.03%
Cyprinidae	Central stoneroller	*Campostoma anomalum*	20	0.64%
	Red shiner	*Cyprinella lutrensis*	1,417	45.16%
	Blacktail shiner	*Cyprinella venusta*	21	0.67%
	Hybrid shiner	*Cyprinella hybrid*	3	0.10%
	Ribbon shiner	*Lythrurus fumeus*	25	0.80%
	Blackspot shiner	*Notropis atrocaudalis*	1	0.03%
	Sand shiner	*Notropis stramineus*	27	0.86%
	Suckermouth minnow	*Phenacobius mirabilis*	26	0.83%
	Bullhead minnow	*Pimephales vigilax*	147	4.68%
Catostomidae	River carpsucker	*Carpiodes carpio*	4	0.13%
	Smallmouth buffalo	*Ictiobus bubalus*	2	0.06%
	Golden redhorse	*Moxostoma erythrurum*	1	0.03%
Ictaluridae	Black bullhead	*Ameiurus melas*	20	0.64%
	Yellow bullhead	*Ameiurus natalis*	112	3.57%
	Channel catfish	*Ictalurus punctatus*	39	1.24%
	Tadpole madtom	*Noturus gyrinus*	2	0.06%

Family	Common Name	Scientific Name	TOTAL	Relative Abundance
	Freckled madtom	*Noturus nocturnus*	9	0.29%
	Flathead catfish	*Pylodictis olivaris*	10	0.32%
Atherinopsidae	Brook silverside	*Labidesthes sicculus*	7	0.22%
Fundulidae	Blackstripe topminnow	*Fundulus notatus*	33	1.05%
Poeciliidae	Mosquitofish	*Gambusia affinis*	247	7.87%
Centrarchidae	Green sunfish	*Lepomis cyanellus*	154	4.91%
	Warmouth	*Lepomis gulosus*	12	0.38%
	Orangespotted sunfish	*Lepomis humilis*	28	0.89%
	Bluegill	*Lepomis macrochirus*	151	4.81%
	Longear sunfish	*Lepomis megalotis*	421	13.42%
	Redear sunfish	*Lepomis microlophus*	24	0.76%
	Hybrid sunfish	*Lepomis hybrid*	18	0.57%
	Spotted bass	*Micropterus punctulatus*	3	0.10%
	Largemouth bass	*Micropterus salmoides*	37	1.18%
	White crappie	*Pomoxis annularis*	5	0.16%
	Black crappie	*Pomoxis nigromaculatus*	2	0.06%
Percidae	Slough darter	*Etheostoma gracile*	3	0.10%
	Common logperch	*Percina caprodes*	10	0.32%
	Bigscale Logperch	*Percina macrolepida*	1	0.03%
	Slenderhead darter	*Percina phoxocephala*	1	0.03%
	Dusky darter	*Percina sciera*	22	0.70%
Sciaenidae	Freshwater drum	*Aplodinotus grunniens*	1	0.03%
		TOTAL NUMBER	**3,138**	
		Number of Species	**42**	

Source: Appendix M

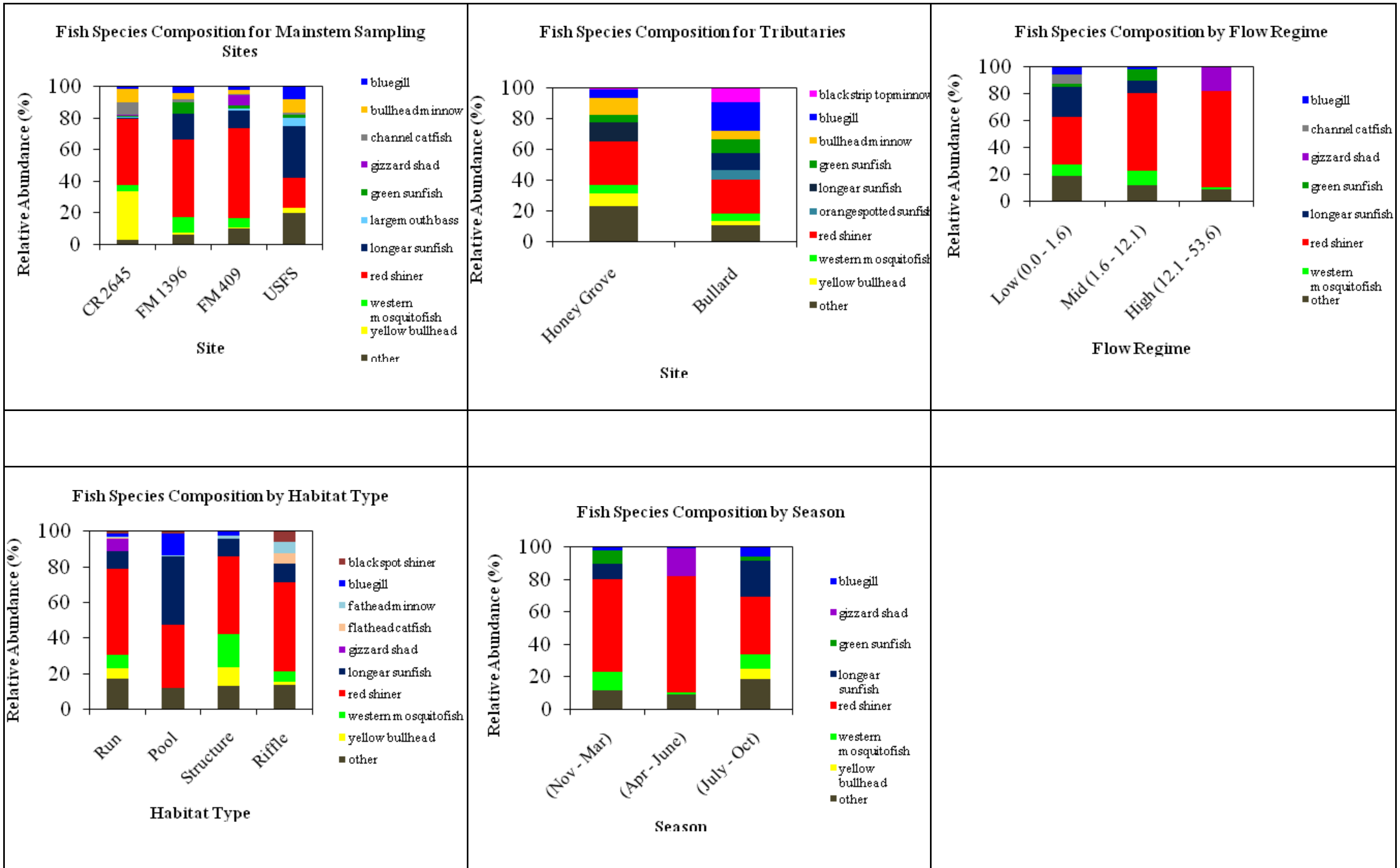
Biological analyses considered both field sampling data from the 2010 Instream Flow Study and previous studies conducted within the watershed and associated ecoregions. The stream fish assemblage collected during the Instream Flow Study was dominated by headwater colonizer species (i.e., smaller-bodied and short-lived fish). A previous study conducted by Linam et al. (2002) collected a total of 47 fish taxa from the Central Texas Plains and the Texas Blackland Prairies ecoregions. Resident species in streams similar to Bois d'Arc Creek are generally adapted to extreme environmental variation (Rahel and Hubert, 1991) and illustrate rapid post-disturbance recolonization (Schlosser, 1987). Prairie streams such as Bois d'Arc Creek have been described as lacking spatial heterogeneity in aquatic habitat and substrata (Osting et al., 2004) and are dominated by pools and backwater areas with silty-clay substrate. There is generally little cobble or gravel substrate in Bois d'Arc Creek, and subsequently no true riffle habitat (as defined according to standard methods; Arend, 1999). Aquatic systems with these characteristics are often dominated by generalist fish taxa (Poff and Allan, 1995), and recent studies conducted in neighboring watersheds have found that assemblage structure was not strongly linked to physical habitat measurements (Gelwick and Li, 2002; Osting et al., 2004).

The most abundant families noted in the 2010 Instream Flow Study were Cyprinidae (59% in percent total relative abundance), followed by Centrarchidae (20%), Poeciliidae (8%), Ictaluridae (6%), and Clupeidae (3%). The remaining 3% of species assemblage included members of the families Percidae, Fundulidae, Catostomidae, Atherinopsidae, Lepisosteidae, and Sciaenidae. The relative abundance from all sampling events is shown in Appendix B of the Supplemental Instream Flow Study (Appendix M).

Species relative abundance across site, mesohabitat, flow, and season exhibited dominance of generalist species able to survive in both riverine and lacustrine habitats species (Figure 3.4-20 and Appendix M). Seventy-eight percent of the fish collected during the May 2009 sampling event for the instream flow study (Appendix M) were two generalist species: red shiner and longear sunfish (listed in Table 3.4-3 and shown in Figure 3.4-19). The 2010 Instream Flow Study exhibited similar results: 81percent of the species collected were generalist species, with red shiner (50 percent total relative abundance) and longear sunfish (13.7 percent) being the most abundant of the generalist species. Only a few of the species collected are characteristically found only in flowing water or are considered fluvial specialists (cential stoneroller, ribbon shiner, blackspot shiner, sand shiner, suckermouth minnow, freckled madtom, slough darter, and dusky darter). Species composition for tributary sites was similar to the mainstem sites, although abundance scores were more evenly distributed across species.

Figure 3.4-19. Longear Sunfish (*Lepomis megalotis*)

Across flow regimes, relative abundance of longear sunfish, bluegill, green sunfish, and western mosquitofish declined at higher flows, while red shiner abundance increased. There was no distinguishable seasonal pattern, except that red shiner was particularly abundant in the summer. Gizzard shad were only collected during the spring sampling event, which may have been associated with migratory spawning behavior. There was no apparent pattern across mesohabitat, except that Centrarchid (sunfish) species were more abundant in pool habitats. Detailed species accounts are presented in Appendix M.



Note: "Other" includes those species with a relative abundance less than 5 percent.

Figure 3.4-20. Relative Abundance of Fish Taxa by Sample Site, Location, Flow Regime, Mesohabitat, and Season (Appendix M)

Fish Trophic Structure

There was no clear pattern of trophic structure across sites, though there were some apparent patterns across flow, mesohabitat, and season. More top-level predators (i.e., sunfish) were collected from pools, particularly in the low flow summer sampling event. Generalist species with opportunistic feeding strategies such as red shiner and sunfish species (particularly longear) mostly forage in the form of benthic grazing or water surface predation. These feeding strategies are a response to Bois d'Arc Creek's turbid waters and general lack of favorable microhabitat. Sunfish species are likely thrive under these conditions compared to fluvial specialists. The only other apparent pattern was that more filter feeders-planktivores-were collected during the spring high flow sampling event, which is likely a result of increased primary productivity and increased movement associated with spawning.

Fish Reproduction

Literature review of reproductive strategies for collected fishes revealed that most of the species collected are largely opportunistic, dominated by speleophilic and polyphilic spawners. Speleophils (i.e., crevice spawners) will deposit eggs in submerged structures, but have no specific structural requirements. Polyphilic species deposit eggs directly onto stream bed substrates, and generally lack a specific substrate preference. Similar to structural patterns found with functional feeding groups, sunfish species (largely polyphils) dominated pool habitats and were particularly abundant during the low flow summer sampling event. Speleophils dominated reproductive strategy across all categories, as the pervasive red shiner is a speolophilic spawner.

Physical habitat requirements and reproductive timing for fish taxa observed in Bois d'Arc Creek were identified from published literature. Fluvial specialist species, particularly members of the families Cyprinidae and Percidae, require specific current velocities, depths, or specific substrates for reproduction. Literature review identified typically shallow depth (i.e., < 3 feet), swifter current velocities (i.e., > 1 feet/sec), and gravel or cobble substrate preference for these fluvial specialist species. However, the reproductive cues of fishes of Bois d'Arc Creek appear to be largely temperature dependent. Dominant species (as determined by the relative abundance analyses) spawn from February to October with the largest proportion in the months of May and June. Detailed information on these species may be found in the 2010 Instream Flow Study (Appendix M). After mid-June, Bois d'Arc Creek experiences little to no flow, indicating unfavorable spawning conditions for fluvial specialists that require flowing water for spawning. However, the generalist species (or those that do not require flowing water for spawning) may find suitable spawning habitat in persistent pools along Bois d'Arc Creek channel.

Biological Integrity

Biotic, or biological, integrity is defined as the ability of an aquatic ecosystem to support and maintain a balanced, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region. The biological integrity score of two study areas of Bois d'Arc Creek were determined with the use of Rapid Bioassessment Protocols. These protocols are a compilation of methods employed by various state water resource agencies. They were designed to be used as a screening tool to determine if a stream is supporting or not supporting a designated aquatic life use. The protocols can be used to: 1) characterize the existence and severity of impairment to a water resource, 2) help identify sources and causes of impairment, 3) evaluate the effectiveness of control actions and restoration activities, 4) support use attainability studies and cumulative impact assessments, and 5) characterize regional biotic attributes of reference conditions (USEPA, 2012a).

The Red River Authority conducted *An Assessment of the Biological Integrity of the Eastern Red River Basin in Texas* in 1998 (RRA, 1999) and the Instream Flow Study (Appendix M) conducted a regionalized Index of Biotic Integrity (IBI) (TPWD, 2002) analysis. The regionalized IBI is a measure of fish communities that includes components of species composition, trophic composition, and abundance and condition (Linam et al., 2002). It is typically used as a water quality indicator, with higher scores indicating better water quality. Scores in the 2010 Instream Flow Study were higher than the intermediate designation reported in the 1999 RRA study. The 2010 Instream Flow Study IBI scores for fish community structure were intermediate to high (mean: 43.83) and increased longitudinally within the mainstem of Bois d'Arc Creek as shown in Figure 3.4-21. Mainstem site scores ranged from 33 (limited) to 49 (high), and tributary scores were also in the high range (i.e., 46 and 43, Honey Grove and Bullard Creek, respectively). These scores indicate that the ability of the habitat to support the expected full range of native aquatic life varies within the Bois d'Arc Creek system from marginal to reasonably good. Given the degraded condition of the creek, as a result of channelization and the unnatural (largely agricultural) surrounding landscape, the biotic integrity of the aquatic system is surprisingly high.

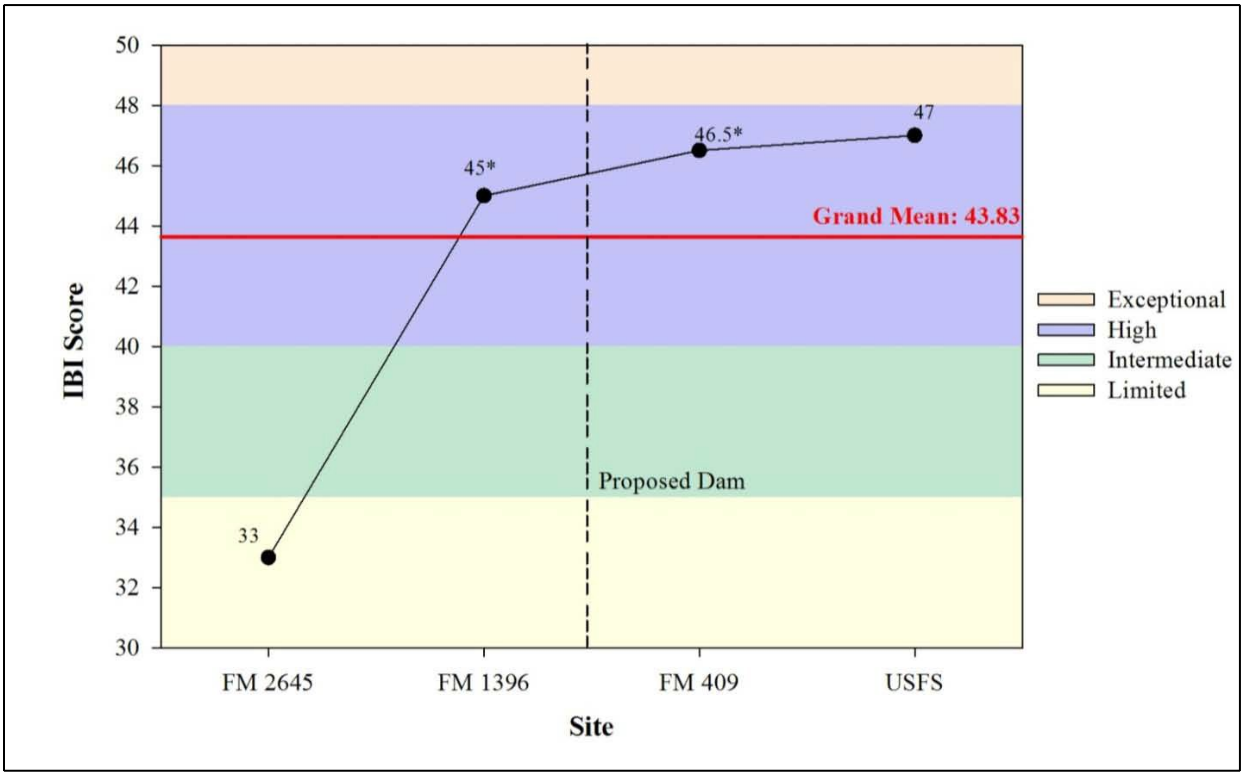


Figure 3.4-21. Fish Index of Biological Integrity, 2010 Bois d'Arc Instream Flow Study (Upstream to Downstream) (Appendix M)

*Indicates averages IBI from multiple collections (i.e., FM 1396: 49, 41; FM 409: 45, 48)

Benthic Macroinvertebrates

Benthic macroinvertebrates are animals without backbones that are visible without a microscope and that live on or in the bottom or substrate of water bodies. They are valuable to aquatic ecosystems and provide various functions including serving as secondary consumers in numerous food chains (Healy, 1984) and serving as recyclers of organic matter (Merritt et al., 1984). They are also important food sources for many species of fish. The macroinvertebrate community of streams, rivers, and lakes typically includes some or all of the following: insects, flatworms, crustaceans, and mollusks.

During the 2010 Instream Flow Study (Appendix M) a total of 2,621 aquatic and terrestrial insects, including 103 identified genus and 46 taxonomic families, were collected from March to July 2009. The relative abundance of functional feeding groups was calculated to evaluate macroinvertebrate trophic structure. Results indicated that collector-gatherers, predators, and scrapers dominate Bois d'Arc Creek representing greater than 80% of the macroinvertebrate population, with few filter-feeding or shredder species. Collector-gatherers filter fine particulate organic matter and a high percentage (greater than 36%) indicates degradation (TCEQ, 2007), while a low to moderate percentage (4% to 15%) of predators, which feed on other consumers, reflect a balanced trophic structure. The trophic structure in Bois d'Arc Creek suggests an abundance of coarse particulate organic matter such as leaf litter and a healthy prey population. There was no apparent longitudinal pattern in benthic macroinvertebrate trophic structure across mainstem sampling stations as shown in Figure 3.4-22.

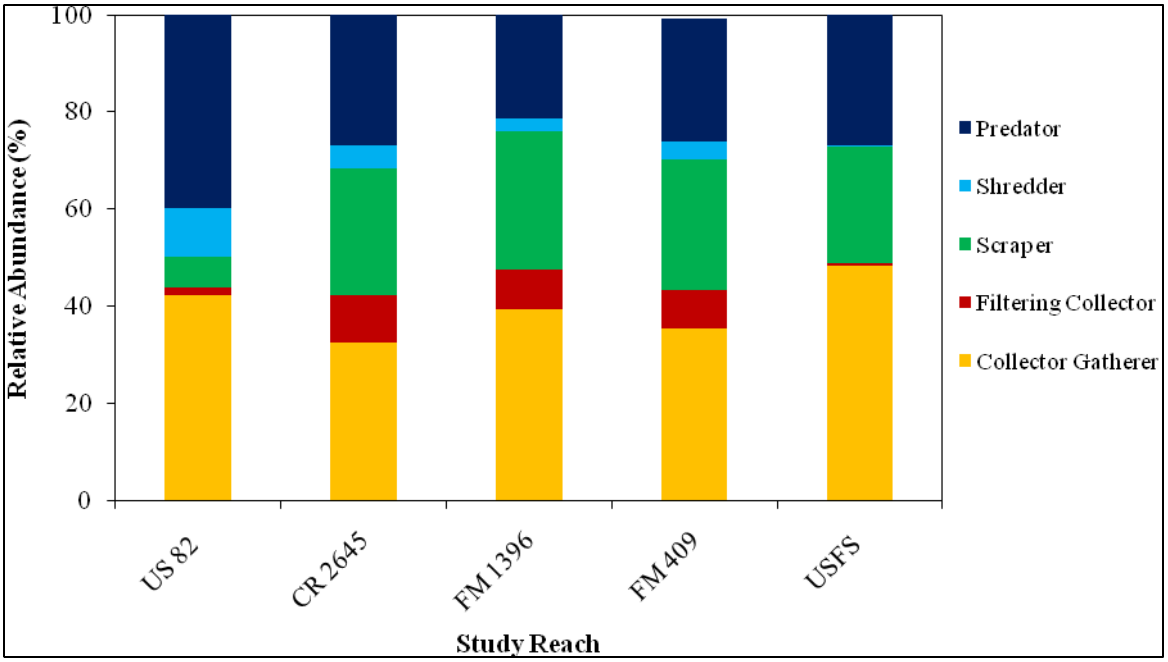


Figure 3.4-22. Bois d'Arc Creek Benthic Macroinvertebrate Trophic Structure (Appendix M)

During the 2010 Instream Flow Study, benthic macroinvertebrates were sampled using TCEQ 2007 SWQM Rapid Bioassessment Protocol (Texas RBA). Rapid bioassessments provide a standardized method for sampling and data analysis that can be used to provide a numerical value for the quality of a stream. The numerical scores determined from the Texas RBA are used to describe Aquatic Life Use categories for a stream (>36 is Exceptional, 29-36 is High, 22-29 is Intermediate, and <22 is Limited). As shown on Figure 3.4-23, the overall biological integrity of Bois d'Arc Creek's macroinvertebrate community was at the higher end of the intermediate range (mean: 28.9) and the scores decrease from upstream to downstream. Mainstem sampling site scores ranged from 22 (intermediate) to 37 (high). These results are consistent with previous studies (RRA, 1999; Hamilton, 2009). Tributaries of Bois d'Arc Creek had lower scores than mainstem sites; Bullard and Honey Grove creeks had scores of 25 and 28, respectively, in the intermediate range.

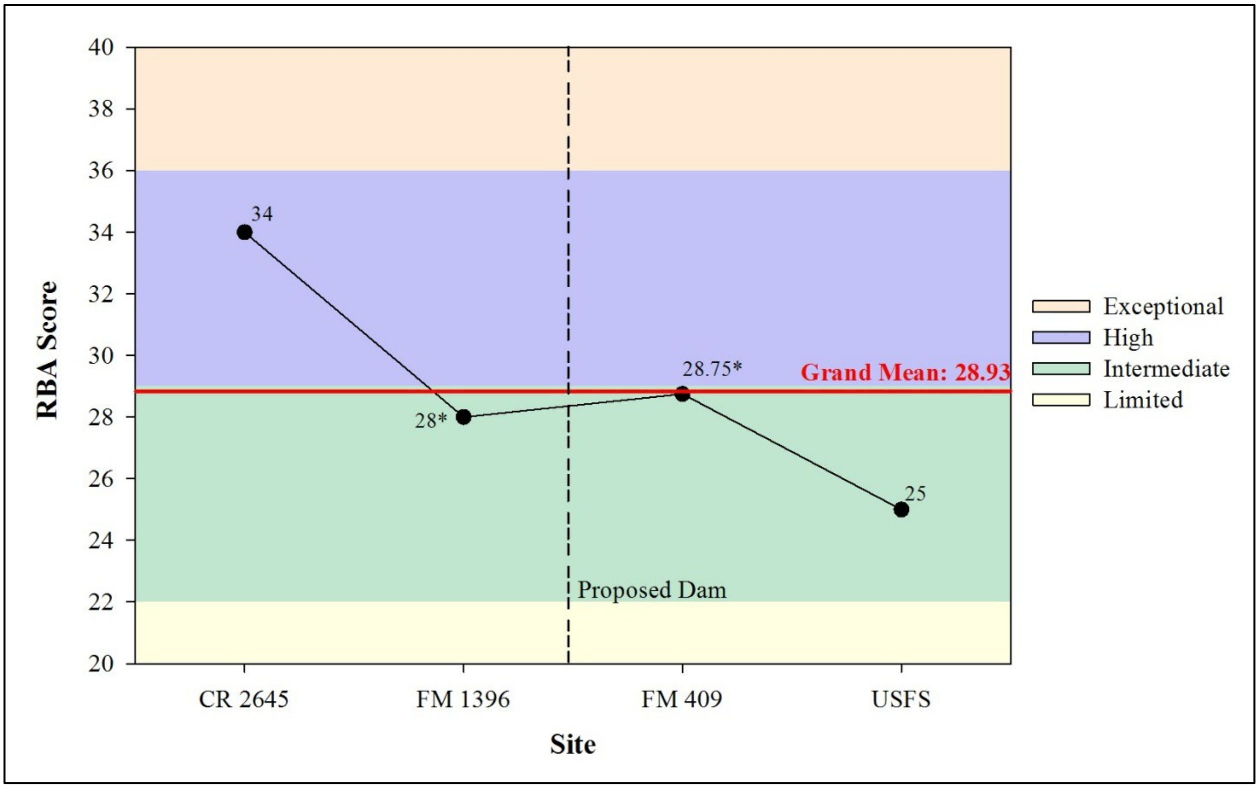


Figure 3.4-23. Biological Integrity of Bois d'Arc Creek's Macroinvertebrate Community According to Rapid Bioassessment, Upstream to Downstream (Appendix M)

*Indicates average metric score from multiple collections (i.e., CR 2645: 31, 37; FM 1396: 31, 22, 31, 29; FM 409: 25, 31, 28, and 31).

Unionid mussels (the largest taxonomic family of freshwater mussels) are important indicators of water quality and stream health and play an important role in freshwater ecosystems. Freshwater mussels mediate the transfer of nutrients between the water column and stream bottom and are a food source for some fishes, mammals and birds. Mussels are very sensitive to changes in the aquatic environment; therefore, declining populations of mussels indicates that a stream's health is deteriorating. Therefore, particular attention is given to the status of mussel species in stream studies. Of the 52 mussel species known to occur in Texas, 15 were listed as state-threatened in 2009 because of declines in their distribution and abundance.

Although efforts were not made to specifically collect mussels from Bois d'Arc Creek, mussels were collected or photographed when they were encountered during other data collection efforts. A total of six species were collected or photographed when they were encountered during the 2010 Instream Flow Study (Appendix M). Figure 3.4-24 shows an example of one of the six species of mussel encountered. The six mussel species that were encountered are listed in Table 3.4-5. No federally listed threatened or endangered mollusk species occur in Fannin County (USFWS, 2015a) and none were identified in Bois d'Arc Creek during the Instream Flow Study (Appendix M).

However, in comments submitted to the USACE in January 2010, following the December 2009 agency scoping meeting for the EIS, TPWD observed that habitat may exist at the site of the proposed LBCR (both alternatives) for four mussel species that had been approved for state threatened status. These included the **Louisiana pigtoe** *(Pleurobema riddellii)*, **sandbank pocketbook** *(Lampsilis satura)*, **Texas**

heelsplitter *(Potamilus amphichaenus)*, and **Texas pigtoe** *(Fusconaia askewi)*. On January 17, 2010 these four species were officially listed as state-threatened (Melinchuk, 2015).

Figure 3.4-24. Live Yellow Sandshell Mussels Collected During Instream Flow Study (Appendix M)

Table 3.4-5. Mussel Species Collected on Bois d'Arc Creek

Common Name	Scientific Name	Habitat
Bleufer	*Potamilus purpuratus*	Streams, rivers, and reservoirs
Fragile Papershell	*Leptodea fragilis*	Streams, rivers and potentially reservoirs
Mapleleaf	*Quadrula*	Large streams, rivers, and lakes
Pink Papershell	*Potamilus ohiensis*	Large rivers and possibly reservoirs
Washboard	*Megalonaias nervosa*	Rivers, lakes, and reservoirs
Yellow Sandshell	*Lampsilis teres*	Streams, rivers, and oxbow lakes

Source: Appendix M

By this time, surveys for the Instream Flow Study (Freese and Nichols, 2010a) had already been completed (from March-July 2009), so that no targeted surveys were conducted specifically for these state-threatened mussels. However, as noted above in Table 3.4-5, six mussel species were documented incidentally during the other data collection activities (e.g., sampling for fish and benthic invertebrates). While none of these six were state-threatened mussels, the incidental collection of six mussel species during other data collection efforts is a good indication that Bois d'Arc Creek in the vicinity of the proposed reservoir of Alternatives 1 and 2 supports mussel habitat (Melinchuk, 2015).

According to TPWD records (TPWD, 2010c), in Texas, the **Louisiana pigtoe** is found in streams and moderate-sized rivers within the Sabine, Neches, and (historically) Trinity River basins, generally in flowing waters on substrates of mud, sand, and gravel. It is not generally known to be found in impoundments. According to TPWD's range map dated 10/14/2010, while this species has not been documented in Fannin County, it has "potential or known presence" in adjacent Hunt and Collin counties to the south and southwest (TPWD, 2010c).

According to TPWD records (TPWD, 2010d), in east Texas (Sulphur River south through San Jacinto River basins and Neches River), the **sandbank pocketbook** is found in small to large rivers on substrates of gravel, gravel-sand, and sand. According to TPWD's range map dated 10/14/2010, while this species has not been detected in Fannin County, it does have "potential or known presence" in adjacent Hunt County to the south (TPWD, 2010d).

According to TPWD records (TPWD, 2010e), in Texas, the **Texas heelsplitter** is found in quiet waters (including reservoirs) in mud or sand, within the Sabine, Neches, and Trinity River basins. According to TPWD's range map dated 10/14/2010, while this species has not been documented in Fannin County, it has "potential or known presence" in adjacent Hunt, Collin, and Grayson counties to the south, southwest, and west (TPWD, 2010e).

According to TPWD records (TPWD, 2010f), in east Texas basins – including the Sabine, Trinity, and San Jacinto – the **Texas pigtoe** occurs in rivers with mixed mud, sand, and fine gravel; it prefers protected areas associated with fallen trees or other structures. According to TPWD's range map dated 1/22/2013, while this species has not been documented in Fannin County, it does have "potential or known presence" in adjacent Hunt County to the south (TPWD, 2010f).

3.4.4 Wildlife

Regional Wildlife

Mammals that are generally distributed throughout the state include but are not limited to the silver-haired bat (*Lasionycteris noctivagans*), eastern red bat (*Lasiurus borealis*), hoary bat (*L. cinereus*), Brazilian free-tailed bat (*Tadarida brasiliensis*), eastern cottontail (*Sylvilagus floridanus*), American beaver (*Castor canadensis*), white-footed mouse (*Peromyscus leucopus*), deer mouse (*P. maniculatus*), coyote (*Canis latrans*), common gray fox (*Urocyon cinereoargenteus*), common raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and white-tailed deer (*Odocoileus virginianus*) (Davis and Schmidly, 1994).

With over 600 species of birds, the state of Texas has the highest avian diversity of any state in the country (TPWD, 2016). Water-related birds include ducks, geese, herons, egrets, bitterns, and rails. Upland bird species found in the Blackland Prairie and Post-oak Savannah Ecoregions include bobwhite quail (*Colinus virginianus*), mourning dove (*Zenaida macroura*), and wild turkey (*Meleagris gallipavo*).

The proposed project (Alternatives 1 and 2) and its connected actions are within the Texan Biotic Province (TPWD, no date-a). Common mammals in this province include the Virginia opossum (*Didelphis virginiana*), eastern mole (*Scalopus aquaticus*), fox squirrel (*Sciurus niger*), Louisiana pocket gopher (*Geomys breviceps*), fulvous harvest mouse (*Reithrodontomys fulvescens*), white-footed mouse, hispid cotton rat (*Sigmodon hispidus*), eastern cottontail, and swamp rabbit (*S. aquaticus*). Mammals common to the grasslands of the Texan Biotic Province include the thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), hispid pocket mouse (*Chaetodipus hispidus*), deer mouse, and black-tailed jackrabbit (*Lepus californicus*).

Amphibian species common to this province include the Hurter's spadefoot (*Scaphiopus hurteri*), Gulf Coast toad (*Bufo valliceps*), Woodhouse's toad (*Bufo woodhousii*), gray treefrog (*Hyla* *versicolor/chrysoscelis*), green treefrog (*Hyla cinerea*), bullfrog (*Rana catesbeiana*), Southern leopard frog (*Rana sphenocephala*), and eastern narrowmouth toad (*Microhylla carolinensis*) (Brazos G, 2006).

Lower Bois d'Arc Creek Site

Wildlife in the Lower Bois d'Arc Creek project area is discussed below by habitat type.

Bottomland Hardwood Forest (Deciduous Forested Wetlands) Habitat

Fauna of the bottomland hardwood forests on the site include white-tailed deer, squirrels, wild turkey, raptors, colonial waterbirds, and other migratory birds. Common birds observed in the area during the HEP field studies include the indigo bunting (*Passerina cyanea*), white-eyed vireo (*Vireo griseus*), yellow-billed cuckoo (*Coccyzus americanus*), American crow (*Corvus brachyrhynchos*), Carolina wren (*Thryothorus ludovicianus*), barred owl (*Strix varia*), egret (Family: Ardeidae), Carolina chickadee (*Poecile carolinensis*), and northern cardinal (*Cardinalis cardinalis*). Evidence of mammalian residents included raccoon tracks, hog tracks, and beaver chew marks on trees. Reptiles such as the ornate box turtle (*Terrapene ornata*) (Figure 3.4-25) and unidentified frogs (Order: Anura) were also found in these forests, as were numerous invertebrate species, including crayfish (Family: Cambaridae) and land snails (Class: Gastropoda) (Freese and Nichols, 2008a).

Figure 3.4-25. Ornate Box Turtle

Upland Woods (Deciduous Forest) Habitat

Bird species observed in upland deciduous forest habitat include northern cardinal, blue-grey gnatcatcher (*Polioptila caerulea*), downy woodpecker (*Picoides pubescens*), yellow-billed cuckoo, great blue heron (*Ardea herodias*), American crow, brown-headed cowbird (*Molothrus ater*), Carolina chickadee, and barred owl. Also observed in these areas are various reptiles such as turtles (Order: Testudines), frogs (Order: Anura), snakes such as racers (*Coluber constrictor*), and mammals including the eastern fox squirrel.

Upland Juniper Woods (Evergreen Forest) Habitat

Bird species observed in evergreen forest habitat of the project area include tufted titmouse (*Baeolophus bicolor*), northern cardinal, painted bunting (*Passerina ciris*), Carolina chickadee, pileated woodpecker (*Dryocopus pileatus*), and American crow.

Emergent / Herbaceous Wetland Habitat

Many species of birds are found in emergent/herbaceous wetlands, including the northern cardinal, American crow, indigo bunting, tufted titmouse, great blue heron, great egret (*Ardea alba*), red-tailed hawk (*Buteo jamaicensis*), and northern harrier (*Circus cyaneus*). Other wildlife observed in this habitat include several mammals, such as raccoon, beaver, feral hog (*Sus scrofa*), and white-tailed deer, and aquatic species including frogs, mosquitofish (*Gambusia affinis*), crayfish, and clams (Class: Bivalvia); and plentiful flying insects such as butterflies (Order: Lepidoptera), bees (Order: Hymenoptera) and dragonflies (Order: Odonata).

Shrub Wetland Habitat

Birds observed in shrub wetland habitat of the project area included northern cardinal, painted bunting, American crow, great egret, solitary warbler (Family: Parulidae), and common yellow throat (*Geothlypis trichas*). Evidence of mammalian residents includes tracks of raccoons and bite marks of beavers. Also observed in the shrub wetlands were the southern leopard frog and crayfish.

Shrubland Habitat

Wildlife observed in shrubland habitat include the northern cardinal, painted bunting, American crow, bluejay (*Cyanocitta cristata*), and white-eyed vireo. The racer snake and garden orbweaver spider (*Argiope aurantia*) were also observed.

Grassland/Oldfield Habitat

Bird species observed in grassland/old field areas include the downy woodpecker, yellow-billed cuckoo, tufted titmouse, Carolina chickadee, northern cardinal, white-eyed vireo, painted bunting, great blue heron, and American crow. Turtle eggs (Order: Testudines) were also observed in this cover type.

Cropland Habitat

Croplands support wildlife populations primarily by providing food sources, and are especially valuable when located adjacent to tree or shrub cover. Bird species observed in the croplands of the project area include the wild turkey, northern cardinal, painted bunting, white-eyed vireo, tufted titmouse, and blue-gray gnatcatcher (*Polioptila caerulea*).

Tree Savanna Habitat

Bird species observed in tree savannas included the Carolina chickadee, yellow-billed cuckoo, painted bunting, white-eyed vireo, northern cardinal, brown-headed cowbird, and downy woodpecker.

3.4.5 Threatened and Endangered Species

This section addresses federal and state listed species found at the proposed dam and reservoir site, pipeline routes, water treatment facility site, and mitigation site of Alternatives 1 and 2.

Federally Listed Species

The Endangered Species Act (ESA) of 1973 and amendments provide for the conservation of threatened and endangered (T&E) species of animals and plants and their habitats. The USFWS technical assistance website and TPWD rare, threatened, and endangered species website were reviewed for information on T&E species in Fannin County (USFWS, 2013; TPWD, 2010b, 2011c, 2014, 2017a). Table 3.4-6 lists the federally-listed species potentially occurring in Fannin County according to the USFWS technical assistance website.

Table 3.4-6. Federally-listed Species Potentially Occurring in Fannin County

Species	Status
Bald Eagle (*Haligeetus leucocephalus*)	Recovery
Interior Least Tern (*Sterna antillarum athalassos*)	Endangered
Black Bear (*Ursus americanus luteolus*)	Threatened/ Similarity of Appearance[a]

[a] S/A = similarity of appearance with the Louisiana black bear (*U. americanus luteolus*).
Source: USFWS, 2013

The bald eagle was formerly listed as federally threatened, but this species has been delisted and is in recovery. The project area contains no nesting and limited foraging habitat for interior least terns, because they require relatively large, bare or mostly bare beaches of sand or gravel, which are lacking at the project site. While potential habitat for black bears does occur within the reservoir footprint, none have ever been documented on-site.

State Listed Species

Table 3.4-7 lists state-listed species potentially occurring in Fannin County according to the TPWD rare, threatened, and endangered species website. The Texas state-threatened blackside darter, blue sucker, creek chubsucker, paddlefish, shovelnose sturgeon, timber/canebrake rattlesnake, Texas horned lizard and alligator snapping turtle may occur locally. These species and their habitats are described below.

Blackside darter (*Percina maculata*)

The blackside darter (Figure 3.4-26) is a state threatened species of Fannin County that reaches 4.3 inches in length. The darter has large black rectangular blotches on its sides and a less conical snout, not extending beyond its upper lip. Within the U.S., the species is wide ranging from the Great Lakes southwards through the Mississippi basin. In Texas, the darter is restricted to the Red River basin in the northeast part of the state. The species is currently stable and although it is one of the most common and widespread darters, it is seldom found in large populations. The habitat of the blackside darter includes small to medium rivers. This species is highly intolerant to certain organic pollutants, such as mine waste. Another threat to the species includes damming of rivers (TSU, no date-a).

Table 3.4-7. TPWD-listed Species Potentially Occurring in Fannin County

Species	State Status
American Peregrine Falcon *(Falco peregrinus anatum)*	T
Arctic Peregrine Falcon *(Falco peregrinus tundrius)*	No state status
Bald Eagle *(Haligeetus leucocephalus)*	T
Eskimo Curlew *(Numenius borealis)*	E
Interior Least Tern *(Sterna antillarum athalassos)*	E
Peregrine Falcon *(Falco peregrinus anatum)*	T
Whooping Crane *(Grus americana)*	E
Wood Stork *(Mycteria americana)*	T
Piping Plover (*Charadrius melodus)*	T
Black Bear *(Ursus americanus)*	T
Red Wolf *(Canius rufus)*	E
Blackside darter *(Percina maculata)*	T

Species	State Status
Blue sucker *(Cycleptus elongatus)*	T
Creek chubsucker *(Erimyzon oblongus)*	T
Paddlefish *(Polyodon spathula)*	T
Shovelnose sturgeon *(Scaphirhynchus platorynchus)*	T
Alligator snapping turtle (*Macrochelys temminckii*)	T
Texas horned lizard *(Phrynosoma cornutum)*	T
Timber/Canebrake rattlesnake *(Crotalus horridus)*	T
American burying beetle *(Nicrophorus americanus)*	No state status

Notes: Species listed in state by TPWD.
E = endangered; T = threatened
Sources: TPWD, 2010b, 2011c, 2014

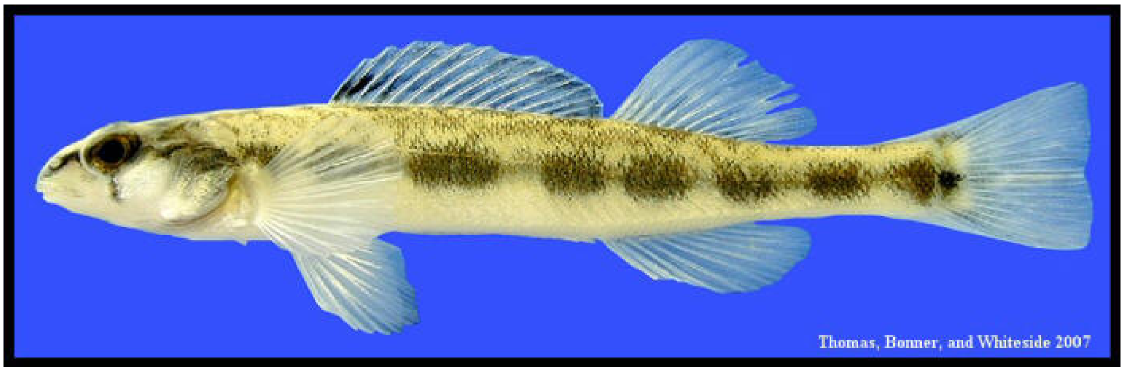


Figure 3.4-26. Blackside Darter

Photo credit: Thomas, Bonner, and Whiteside 2007; *www.txstate.edu*

Blue Sucker (Cycleptus elongatus)

The blue sucker is a state threatened fish species that is olive blue or slate olive on the dorsum and sides of the body. The sucker can reach 32.5 inches in length and has 40-45 relatively large teeth per bone, arranged in a comb-like fashion. It has an elongate body and the eye is closer to the back of the head rather than to the tip of the snout. Throughout its range, it inhabits large, deep rivers and deeper zones of lakes (TSU, no date-b). The blue sucker is found in larger portions of major rivers in Texas, usually in channels and flowing pools with a moderate current. Adults winter in deep pools and move upstream in spring to spawn on riffles (TPWD, 2010b). The species has declined due to impoundments, pollution, and reduced water flows in water systems where it occurs. Threats to the blue sucker include destruction, modification, or curtailment of its habitat or range as well as other natural or manmade factors affecting its continued existence. Dams may contribute to blocking spawning migration and spawning areas, contributing in part to the decline of this species (TSU, no date-b).

Creek Chubsucker (*Erimyzon oblongus*)

The creek chubsucker is a state listed threatened fish with a cylindrical body that can reach 16.5 inches in length. This fish's coloration pattern consists of narrow vertical bars. The upper sides of the fish have a bluish green to brown coloration, the sides of the fish are more yellow or gold, and the underside is white to yellow (TSU, no date-c). The creek chubsucker is found in eastern Texas in the tributaries of the Red, Sabine, Neches, Trinity, and San Jacinto rivers. Its habitat consists of small rivers and creeks of various types and it spawns in river mouths or pools, riffles, lake outlets, and upstream creeks. Preferring headwaters, it is seldom found in impoundments (TPWD, 2010b). Threats to the creek chubsucker include siltation and pollution, including pollution from agricultural runoff (NatureServe, 2010).

Paddlefish (*Polyodon spathula*)

The paddlefish is a state threatened species that can grow up to 87 inches long and typically weighs 10 to 15 pounds, though some have weighed as much as 200 pounds. The paddlefish's body is gray and shark-like with a deeply forked tail, and a long, flat blade-like snout. They eat by swimming with their mouth wide open, ingesting plankton. Paddlefish like to live in slow moving water of large rivers or reservoirs. The paddlefish's native range in Texas includes the Red River's tributaries, Sulphur River, Big Cypress Bayou, Sabine River, Neches River, Angelina River, Trinity River, and the San Jacinto River. Threats to the paddlefish include construction of dams and reservoirs. Paddlefish need large amounts of flowing water to reproduce. Dams and reservoirs decrease water flow and interrupt spawning. The eggs of paddlefish are also threatened by poaching and are used for caviar (TPWD, 2009).

Shovelnose sturgeon (*Scaphirhynchus platorynchus*)

The shovelnose sturgeon is a state listed threatened species that can reach 42.5 inches in length. The top and sides of the fish are light brown in color and the underside is white. The sturgeon is flat with a shovel-shaped snout. The fish is threatened by damming of rivers within its range resulting in flow alteration and habitat fragmentation (TSU, no date-d). Habitat in Texas includes open, flowing channels with bottoms of sand or gravel. The shovelnose sturgeon spawns over gravel or rocks in an area with a fast current. It is found in parts of the Red River and as a rare occurrence in the Rio Grande (TPWD, 2010b).

Timber/Canebrake Rattlesnake (*Crotalus horridus*)

The timber/canebrake rattlesnake is a state threatened species in Fannin County (TPWD, 2010b). The snake has a horny rattle or button on the end of its tail, and numerous small scales on the top of its head. The head is broader than the neck and the color pattern varies geographically. Most have dark crossbands with a yellow, black, or gray background color. The snake grows to approximately 60 inches long. In the South, the snake's habitat includes hardwood forests found in many river bottoms, swampy areas and floodplains, wet pine flatwoods, river bottoms and hydric hammocks, and hardwood forests and cane fields of alluvial plain and hill country. Threats to the snake include habitat destruction, particularly from housing developments, market hunting, snake hunting, shading over, logging, and road mortality (NatureServe, 2010).

Texas Horned Lizard (*Phrynosoma cornutum*)

The state-threatened Texas horned lizard or "horny toad" is a flat-bodied, brownish lizard with two rows of fringed scales on either side of its body. Its head has numerous prominent horns, with two central head spines substantially longer than all the others. It is the only horned lizard with dark brown stripes radiating downward from the eyes and across the top of the head. The Texas horned lizard prefers arid and semiarid habitats in open areas with sparse plant cover. Because it digs to hibernate, nest and insulate itself, it is commonly are found in loamy soils or loose sands. This species ranges from the south-central U.S. to northern Mexico, throughout much of Texas, Oklahoma, Kansas and New Mexico (TPWD, no date-b).

Alligator Snapping Turtle (*Macrochelys temminckii*)

The state-threatened alligator snapping turtle is found in perennial water bodies and the deep water of rivers, canals, lakes, and oxbows. It also occurs in swamps, bayous, and ponds near deep running water. Usually, it is found in water with a mud bottom and abundant aquatic vegetation. Sometimes it enters brackish coastal waters. It may migrate several miles along rivers and is active from March to October. It breeds from April to October. Its known range includes Fannin County (TPWD, 2005).

3.4.6 Invasive Species

Invasive species of both plants and animals are an enormous problem in Texas and throughout the United States. According to the U.S. Department of the Interior (DOI, no date), invasive species are one of most significant – and growing – threats faced by ecosystems, human and animal health, infrastructure, the economy, and cultural resources in the U.S.

Invasive Wildlife Species

Invasive animal species are generally considered harmful to native species and ecosystems because they displace, prey upon, infect, parasitize, or outcompete native fauna, thus compromising indigenous biodiversity. They may also be costly or harmful to human interests, such as by increasing maintenance or management costs. They are typically non-native, that is, they usually originate in other continents and are brought inadvertently or deliberately by human activity to given geographic areas in the U.S. However, some invasives originate in other parts of North America and increase their ranges or jump into new regions, often facilitated by human actions that have modified terrestrial and aquatic environments and habitats.

Invasive wildlife species that might be found within the LBCR footprint include the following:

- Asian clam (*Corbicula fluminea*). Originating in Eurasia, it is currently found across much of the country. In Texas, it has been documented in the Red River drainage and other locations. The threat is poses to native ecosystems is uncertain, but it is known to have economic impacts as a biofouler of many electrical and nuclear power plants across the country, clogging raw water service pipes (TexasInvasives, 2011a).
- Eurasian Collared Dove (*Streptopelia decaocto*). Originally native to the Bay of Bengal region of Asia, it is now found throughout most of the U.S., including northern Texas. This species is extremely successful at colonizing new ranges, and some scientists believe it to be outcompeting native North American doves, although this has yet to be conclusively demonstrated (TexasInvasives, 2011e).
- European Starling (*Sturnis vulgaris*). Originating in Europe, the starling is now widespread across the United States. It tends to displace cavity-nesting native birds, including the bluebird, purple martin, tree swallow, tufted titmouse, and woodpeckers. Starlings frequently commandeer the nests of native birds, expelling the occupants, and their eggs or nestlings (TexasInvasives, 2011b).
- Feral hog (*Sus scrofa*). Originating in Europe, they are now found in much of the U.S., including Texas and the project area. Feral hogs can have detectable adverse effects on native fauna and flora as well as domestic crops and livestock. Their rooting habits may cause extensive disturbance of vegetation and soils, sometimes resulting in a shift in plant succession. They also tend to outcompete, and thereby reduce the populations of, several species of native wildlife (TexasInvasives, 2012).
- Nutria (*Myocastor coypus*). Originally found in South America, this large, dark-colored, semiaquatic rodent was imported into North America by fur ranchers. They can adapt to diverse conditions and habitats and persist in areas once thought to be unsuitable. Nutria damage sugar cane and rice crops as well as water management facilities like levees (TexasInvasives, 2011c).

In addition, the non-native, invasive zebra mussel (*Dreissena polymorpha)*, originally from Russia and Eurasia, while not documented in Bois d'Arc Creek yet, has been rapidly expanding its range in North America over the past couple of decades and may arrive shortly. In North Texas, it has already infested Lake Texoma and Lake Ray Roberts and has been documented in Lake Lavon, Lake Ray Hubbard, the

Red River below Lake Texoma, the Elm Fork of the Trinity River below Lake Ray Roberts, and Sister Grove Creek. Zebra mussels can cause marked decreases in populations of fish, birds and native mussels. In addition, they can disrupt water supply system by colonizing the insides of pipelines and restricting water flow (TexasInvasives.org, 2011d).

Invasive Plant Species

Aquatic and terrestrial plant species not native to Texas may compete with native plants for nutrients and habitat. Executive Order 13112–Invasive Species directs federal agencies to make efforts to prevent the introduction and spread of invasive plant species, detect and monitor invasive species, and provide for the restoration of native species. Texas Parks and Wildlife Department (TPWD) Code §66.0007 and Texas Department of Agriculture (TDA) Code §71.152 prohibit a person from selling, distributing, or importing into Texas the plants listed under this code.

The Parks and Wildlife Code now also addresses aquatic plants under §66.0071 (Removal of Harmful Aquatic Plants) and in §66.0072 (Exotic Harmful or Potentially Harmful Aquatic Plants). The list of harmful or potentially harmful exotic plants is found in Texas Administrative Code §57.111.

To determine possible invasive plant species within the proposed LBCR area, the Invasive Plant Atlas of the United States (2017), a cooperative interagency effort, was reviewed. This atlas is a collaborative effort between the National Park Service and the University of Georgia Center for Invasive Species and Ecosystem Health; it aims to provide individuals with the identification, early detection, prevention, and management of invasive species (Invasive Plant Atlas, 2017). Species prohibited by TDA and TPWD are identified in Table 3.4-8. While the species listed in Table 3.4-8 have been detected in Fannin County, are non-native, and present a problem somewhere in the United States, they are not known to be problematic in Fannin County at this time.

Table 3.4-8. TDA and TPWD Invasive, Prohibited, and Exotic Species

Common Name	Scientific Name
Upland Species	
Mimosa	*Albizia julibrissin*
Stinking chamomile	*Anthemis cotula*
Thymeleaf sandwort	*Arenaria serpyllifolia*
Giant reed	*Arundo donax*
Field brome	*Bromus arvensis*
Rescuegrass	*Bromus catharticus*
Rye Brome	*Bromus secalinus*
Hare's ear	*Bupleurum rotundifolium*
Smallseed falseflax	*Camelina microcarpa*
Sheperd's-purse	*Capsella bursa-pastoris*
Field bindweed	*Convolvulus arvensis*
Barnyardgrass	*Echinochloa crus-galli*
Korean lespedeza	*Kummerowia stipulacea*
Sericea lespedeza	*Lespedeza cuneata*
Chinese privet	*Ligustrum sinense*
Sweet breath of spring	*Lonicera fragrantissima*
Japanese honeysuckle	*Lonicera japonica*

Common Name	Scientific Name
Black medic	*Medicago lupulina*
Yellow sweet clover	*Melilotus officinalis*
Dallisgrass	*Paspalum dilatatum*
White poplar	*Populus alba*
Mourningbride	*Scabiosa atropurpurea*
Johnsongrass	*Sorghum halepense*
Common chickweed	*Stellaria pallida*
moth mullein	*Verbascum blattaria*
Hairy vetch	*Vicia villosa*
Lilac chastetree	*Vitex agnus-castus*
Aquatic and Wetland Species	
Dotted Duckweed	*Landoltia punctata*
Salvinia	All species in genus *Salvinia*
Floating Waterhyacinth	*Eichhornia crassipes*
Rooted Waterhyacinth	*Eichhornia azurea*
Waterlettuce	*Pistia stratiotes*
Hydrilla	*Hydrilla verticillata*
Lagarosiphon	*Lagarosiphon major*
Eurasian Watermilfoil	*Myriophyllum spicatum*
Alligatorweed	*Alternanthera philoxeroides*
Paperbark (Melaleuca)	*Melaleuca quinquenervia*
Torpedo grass	*Panicum repens*
Water Spinach	*Ipomoea aquatic a*
Ambulia (Asian Marshweed)	*Limnophila sessiflora*
NarrowleafFalse Pickerelweed	*Monochoria hastata*
Heartshaped False Pickerelweed	*Monochoria vagina/is*
Duck-lettuce	*Ottelia alismoides*
Wetland Nightshade	*Solanum tampicense*
Exotic Bur-reed	*Sparganium erectum*
Brazilian Peppertree	*Schinus terebinthifolius*
Purple Loosestrife	*Lythrum salicaria*

Sources: TPWD, 2011a; TPWD, no date-d; TDA, no date

Invasive species are usually destructive, difficult to control or eradicate, and generally cause ecological and economic harm. A noxious weed is any plant designated by a federal, state, or county government as injurious to public health, agriculture, recreation, wildlife, or property. These species may spread by non-intentional means such as by wind, floods, wildlife, and accidental transport on vehicles including recreational watercraft and construction vehicles.

Aquatic invasive plants are defined as introduced plants that have adapted to living in, on, or next to water, and that can grow either submerged or partially submerged in water (USDA, 2011). Emergent, rooted floating, and submerged species such as giant salvinia can grow into thick mats that displace native vegetation, clog waterways, restrict oxygen levels of water, increase sedimentation, and prevent drainage

(TexasInvasives, 2007a). Aquatic plants can travel from one watershed to another by way of boat propellers, bilges, and livewells.

The control of these species is often very difficult once they become established. As described in Chapter 1 of this EIS, TPWD is the state agency responsible for managing fish and wildlife resources in Texas. TPWD has been increasing public awareness and education for these species and provides information on prevention of introduction (TPWD, no date-c).

3.5 AIR QUALITY AND GREENHOUSE GAS EMISSIONS

3.5.1 Air Quality

Because air quality is measured and regulated on a regional level, the air quality analysis in this Revised DEIS utilizes air quality data from the Metropolitan Dallas Fort Worth Intrastate Air Quality Control Region (AQCR 215) (40 CFR 81.39). AQCR 215 encompasses 19 counties and includes those portions of Fannin County where Alternatives 1 and 2 would occur.

U.S. EPA Region 6 and the TCEQ regulate air quality in Texas. The Clean Air Act (CAA) (42 United States Code (USC) 7401-7671q), as amended, gives the EPA the responsibility to establish the primary and secondary National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) that set acceptable concentration levels for seven criteria pollutants: fine particulate matter (PM_{10}), very fine particulate matter ($PM_{2.5}$), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), ozone (O_3), and lead. O_3 is a strong photochemical oxidant that is formed when NO reacts with volatile organic compounds (VOCs, also referred to as hydrocarbons), and oxygen in the presence of sunlight. O_3 is considered a secondary pollutant because it is not directly emitted from pollution sources but is formed in the ambient air.

Short-term standards (1-, 8-, and 24-hour periods) have been established for criteria pollutants that contribute to acute health effects, while long-term standards (annual averages) have been established for pollutants that contribute to chronic health effects. Each state has the authority to adopt standards stricter than those established under the federal program; however, Texas accepts the federal standards. AQCRs that exceed the NAAQS are designated as *nonattainment* areas and those in accordance with the standards are designated as *attainment* areas. EPA has designated Fannin County as an attainment area for all criteria pollutants (40 CFR 81.39). Because the project is in an attainment area, the General Conformity Rule[2] requirements do not apply.

The EPA monitors levels of criteria pollutants at representative sites in each region throughout the U.S.; however, Fannin County does not have a monitoring station. Therefore, data from the two closest air monitoring stations were used to provide a baseline for air quality emissions in the area surrounding the proposed reservoir site. The two monitoring stations are the Hunt County regional air monitor (approximately 35 miles from the proposed reservoir site) and the Collin County monitor (approximately 51 miles from the proposed reservoir site). Due to their locations, these monitoring stations provide the best available data on historical air emissions in the area surrounding the proposed reservoir site. Table 3.5-1 shows the monitored concentrations of O_3 for 2013 to 2015 for these two stations as well as the primary and secondary air quality standards for O_3. No other criteria pollutants are monitored at these locations. As shown in Table 3.5-1, Collin County did not meet the ozone standard in 2013, 2014, or

[2] Established under the Clean Air Act, the General Conformity Rule ensures that the actions taken by federal agencies do not interfere with a state's plans to attain and maintain the National Ambient Air Quality Standards. According to the rule, if a project takes place in an area that is in attainment then the general conformity requirements do not apply to the project.

2015 while Hunt County exceeded the standards in 2013, but reduced emissions to below the standard in 2014 and 2015. These data are consistent with EPA's list of counties currently designated as nonattainment areas which shows Collin County as a nonattainment area for O_3 (USEPA, 2017a).

Table 3.5-1. Ozone Standards and Ambient Air Concentrations Near Lower Bois d'Arc Reservoir

Pollutant	2013		2014		2015		Federal Standards	
	Collin	Hunt	Collin	Hunt	Collin	Hunt	Primary[a]	Secondary[b]
8-hour highest[c] (ppm)	0.082	0.075	0.083	0.064	0.083	0.064	0.070	0.070
8-hour 2nd highest (ppm)	0.081	0.074	0.075	0.063	0.082	0.063	0.070	0.070

ppm = parts per million

Notes:

[a] National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health.

[b] National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects from a pollutant.

[c] Not to be exceeded by the 3-year average of the annual 4th highest daily maximum 8-hour average.

Source: USEPA, 2016

3.5.2 Greenhouse Gas Emissions

It is well documented that the Earth's climate has fluctuated throughout its history from entirely natural causes. However, recent scientific evidence indicates a correlation between increasing global temperatures over the past century and the worldwide increase in anthropogenic (human) greenhouse gas (GHG) emissions. Climate change associated with global warming is predicted to produce negative environmental, economic, and social consequences across the globe in the coming years.

The direct environmental effect of GHG emissions is an increase in GHG atmospheric concentrations and average global temperatures, which indirectly causes numerous environmental and social effects. Therefore, the analysis domain for proposed GHG impacts would be global. These cumulative global impacts would be manifested as impacts on resources and ecosystems in Texas.

Greenhouse Gas Emissions and Effects

GHGs are gases that trap heat in the atmosphere by absorbing outgoing infrared radiation. GHG emissions occur from natural processes and human activities. Water vapor is the most important and abundant GHG in the atmosphere. However, human activities produce only a small amount of the total atmospheric water vapor. The most common GHGs emitted from natural processes and human activities include carbon dioxide (CO_2), methane, and nitrous oxide. The main source of GHGs from human activities is the combustion of fossil fuels, such as oil, coal, and natural gas. Other examples of GHGs created and emitted primarily through human activities include fluorinated gases (hydrofluorocarbons and perfluorocarbons) and sulfur hexafluoride. The main sources of these man-made GHGs are refrigerants and electrical transformers.

Each GHG is assigned a global warming potential (GWP). The GWP is the ability of a gas or aerosol to trap heat in the atmosphere. The GWP rating system is standardized to CO_2, which is given a value of one. For example, methane has a GWP of 28, which means that it has a global warming effect 28 times greater than CO_2 on an equal-mass basis (IPCC, 2013). To simplify GHG analyses, total GHG emissions from a source are often expressed as a CO_2 equivalent, which is calculated by multiplying the emissions of each GHG by its GWP and adding the results together to produce a single, combined emission rate representing all GHGs. While methane and nitrous oxide have much higher GWPs than carbon dioxide, carbon dioxide is emitted in such greater quantities that it is the predominant contributor to global CO_2 equivalent emissions from both natural processes and human activities.

Numerous studies document the recent trend of rising atmospheric concentrations of carbon dioxide. The longest continuous record of carbon dioxide monitoring extends back to 1958 (Keeling, 1960; Scripps, 2017). These data show that atmospheric CO_2 levels have risen an average of 1.5 parts per million per year over the last 56 years (NOAA, 2017). As of 2014, carbon dioxide levels are about 30 percent higher than the highest levels estimated for the 800,000 years preceding the industrial revolution, as determined from carbon dioxide concentrations analyzed from air bubbles in Antarctic ice core samples (USGCRP, 2014).

Recent observed changes due to climate change include rising temperatures, shrinking glaciers and sea ice, thawing permafrost, a lengthened growing season, and shifts in plant and animal ranges. International and national organizations independently confirm these findings (IPCC, 2013; USGCRP, 2014).

3.6 ACOUSTIC ENVIRONMENT (NOISE)

This section discusses the existing conditions of the acoustic environment that would be affected by Alternatives 1 and 2. A brief discussion on what sound is and how it is measured as well as applicable noise guidelines are also provided.

3.6.1 Noise Overview

Sound is a physical phenomenon consisting of vibrations that travel through a medium, such as air, and are sensed by the human ear. Noise is defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, or is otherwise intrusive. Human response to noise varies depending on the type and characteristics of the noise, distance between the noise source and the receptor, receptor sensitivity, and time of day. Noise is often generated by activities essential to a community's economy and quality of life, such as construction, vehicular traffic, or even music, which may be pleasing to some ears, but too loud (noisy) for others.

Sound varies by both intensity and frequency. Sound pressure level, described in decibels (dB), is used to quantify sound intensity. The dB is a logarithmic unit that expresses the ratio of a sound pressure level to a standard reference level. Hertz (Hz) are used to quantify sound frequency. The human ear responds differently to different frequencies. *A-weighting*, measured in A-weighted decibels (dBA), approximates a frequency response expressing the perception of sound by humans. Table 3.6-1 includes sounds encountered in daily life and their dBA levels.

Table 3-6.1. Common Sounds and Their Level

Outdoor Sound	Sound Level (dBA)	Indoor Sound
Automobile horn	120	Loud rock concert
Power mower at 3 feet	110	Power saw at 3 feet
Motorcycle	100	Subway train, pneumatic drill
Tractor, bulldozer, excavator	90	Garbage disposal
Downtown (large city)	80	Ringing telephone
Freeway traffic	70	TV audio

Outdoor Sound	Sound Level (dBA)	Indoor Sound
Normal conversation	60	Sewing machine
Rainfall	50	Refrigerator
Quiet residential area	40	Library

Source: Harris, 1998

The dBA noise metric describes steady noise levels, although very few noises are, in fact, constant. Therefore, Day-Night Sound Level (DNL) has been developed. DNL is defined as the average sound energy in a 24-hour period with a 10-dB penalty added to the nighttime levels (10 p.m. to 7 a.m.). It is a useful descriptor for noise because 1) it averages ongoing yet intermittent noise, and 2) it measures total sound energy over a 24-hour period. In addition, Equivalent Sound Level (L_{eq}) is often used to describe the overall noise environment. L_{eq} is the average sound level in dB.

3.6.2 Noise Guidelines

The Noise Control Act of 1972 (PL 92-574) directs federal agencies to comply with applicable federal, state, interstate, and local noise control regulations. In 1974, the EPA provided information suggesting that continuous and long-term noise levels in excess of DNL 65 dBA are normally unacceptable for noise-sensitive land uses such as residences, schools, churches, and hospitals. However, in 1982, the EPA transferred the primary responsibility of regulating noise to state and local governments. Fannin County and the State of Texas do not have noise laws or regulations. The city of Bonham has a nuisance noise ordinance that addresses common noises such as car radios, but not construction noise (City of Bonham Code of Ordinances Sec. 8.06.002).

3.6.3 Affected Acoustic Environment

Different types of land uses and the human activities associated with them have different sensitivities to changes in ambient noise levels. In order to characterize land uses and activities in the project area, aerial maps were reviewed and a visual survey of the project area was performed. In general, the area is rural, and the properties within the area are typically low-density residential. The majority of the project area is in undeveloped and underdeveloped portions of Fannin County; however, there are some residences located near the project area. There are no sensitive receptors (e.g., daycares, hospitals, schools) in the immediate project area.

Existing sources of noise near the proposed project sites include typical noise sources associated with ranching and activities associated with Caddo National Grasslands and surrounding recreation areas including: rural roadway traffic, high-altitude aircraft overflights, small craft motorized boating activities, farm equipment, and natural noises such as the rustling of leaves and bird vocalizations. In general, noise levels are typical of a rural setting, and existing noise is predominantly due to secondary roadways. Existing noise levels (L_{eq} and DNL) were estimated for the surrounding area using the techniques specified in the *American National Standard Quantities and Procedures for Description and Measurement of Environmental Sound Part 3: Short-term measurements with an observer present* (ANSI, 2003) and are presented in Table 3.6-2.

Table 3.6-2. Estimated Existing Noise Levels in the Project Area

Land Use	Estimated Existing Sound Levels (dBA)		
	DNL[a]	L_{eq}[b] (Daytime)	L_{eq}[b] (Nighttime)
Very quiet suburban and rural residential	45	43	37

DNL = day-night sound level; L_{eq} = equivalent continuous noise level

Source: ANSI, 2003

3.7 RECREATION

The analysis of recreational resources identifies aspects of the proposed activities related to visitation, revenue, and the recreational experience that are sensitive to changes and that may be affected by the proposed alternatives. The analysis specifically considers how Alternatives 1 and 2 might affect recreational opportunities, resources, and values to individuals and communities in the area. The reservoir, 35-mile raw water pipeline, WTP, and TSR – components of both Alternatives 1 and 2 – would be located in Fannin County. The 25-mile pipeline from Lake Texoma to the balancing reservoir – a component of Alternative 2 – would be located in Grayson County. Changes to visitation, revenue, and the recreational experience would be felt most by individuals, communities and outfitters in Fannin and Grayson counties, and as such are the primary focus for potential direct impacts. Visitation and the recreational experience at other nearby, regional reservoirs may also be affected and therefore are considered for indirect impacts as appropriate throughout the section.

The 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation revealed that 6.3 million Texas residents and nonresidents participated in fishing, hunting, or wildlife watching. The most popular activity was wildlife watching, followed by fishing and then hunting (USDOI et al., 2011). The importance of wildlife observation and fishing to recreation in Texas is particularly salient when analyzing the impacts of a recreational reservoir. This Revised DEIS considers popular water- and land-based activities in the project area, including fishing, hunting, wildlife watching (observing and photographing wildlife), boating (motorized and non-motorized), swimming, picnicking, camping, and enjoying the scenic quality of nature.

3.7.1 Bois d'Arc Creek

There are no designated public recreation areas within the reservoir footprint of either Alternative 1 or 2. Private landowners and their guests access the Bois d'Arc Creek for recreation activities such as boating, fishing, trapping, hunting, wildlife observation, birding, and the enjoyment of scenic natural beauty (Graves, 2010).

3.7.2 Legacy Ridge Country Club

The Legacy Ridge Country Club is a semi-private golf course in the immediate vicinity of the proposed reservoir. It includes a clubhouse, golf center, real estate currently under or planned for construction, driving range, and a par-72, 18-hole golf course which winds into the wetlands of Bois d'Arc Creek. Eighty percent of the revenue at this golf course comes from out of town golfers (NTEN, 2010).

The 18-hole golf course consists of two distinctly different nines. The "front nine" starts high and weaves through lakes and waterfalls, transitioning into a parkland-style route highlighted by pecans and oaks. The wetlands of Bois d'Arc Creek line the "back nine" fairways, keeping water in play most of the nine (Golf Texas, 2017). The golf course is currently partially protected by berms, but the "back nine" of the golf course is below the 100-year flood plain level at 541 feet MSL, and experiences intermittent flooding after heavy rain events (NTEN, 2010).

3.7.3 Caddo National Grasslands Wildlife Management Area

The Caddo National Grasslands Wildlife Management Area (WMA) is administered by the US Forest Service (USFS) and is managed under a cooperative agreement with Texas Parks and Wildlife. It is made up of two separate units – the 13,360-acre Bois d'Arc Creek Unit and the 2,780-acre Ladonia Unit. The Bois d'Arc Unit is near Honey Grove and can be accessed from FM 100. It is located directly northeast of the proposed dam and spillway under both Alternatives 1 and 2. The Ladonia Unit is located near Ladonia in the southeastern portion of Fannin County, and can be accessed from SH 34.

The Caddo National Grasslands WMA is open year-round and provides opportunities for recreation such as camping, hiking, fishing, hunting, horseback riding, mountain biking, picnicking, wildlife viewing and photography (USFS, No Date). Recreational facilities include camping sites, boat launches, swimming sites, group shelters, picnic units, vistas/overlooks, and wildlife viewing sites (USFS, 2009). As shown in Figure 3.7-1, most of the recreational facilities are located in the larger Bois d'Arc Unit.

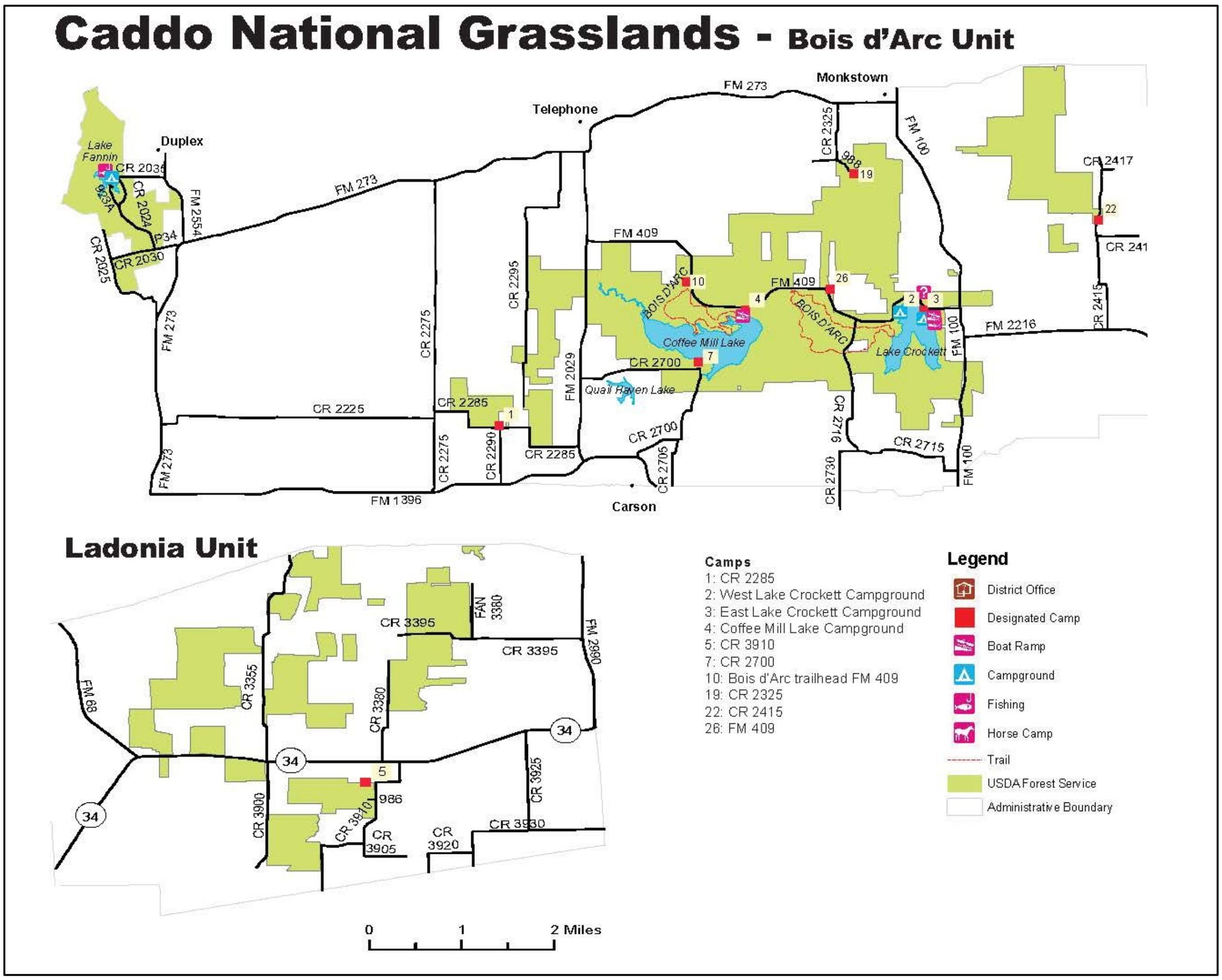


Figure 3.7-1. Developed Recreation Sites in Caddo National Grasslands WMA

Source: USFS, 2016.

Recreational fishing is available at all three lakes in the Bois d'Arc Unit: Lake Crockett, Coffee Mill Lake, and Lake Fannin. Lake Fannin is further removed from the other recreational fishing lakes – about nine miles from Coffee Mill Lake and 13 miles from Lake Crockett. Coffee Mill Lake and Lake Crockett, located directly northeast of the proposed dam and spillway, offer fishing for perch, crappie, catfish and largemouth bass; and Lake Crockett also offers fishing for Florida largemouth bass. Fishing is regulated under the state of Texas fishing rules and regulations. There is one boat ramp at Coffee Mill Lake and one at Lake Crockett (TPWD, no date-e).

Other recreation activities at Caddo National Grasslands WMA include camping, hiking, horseback riding, mountain biking, wildlife viewing and photography. Camping occurs in designated campsites that are owned and operated by the USFS. Multi-use trails shown in Figure 3.7-2 below are shared by bicyclists, hikers, and horseback riders (TPWD, no date-e).

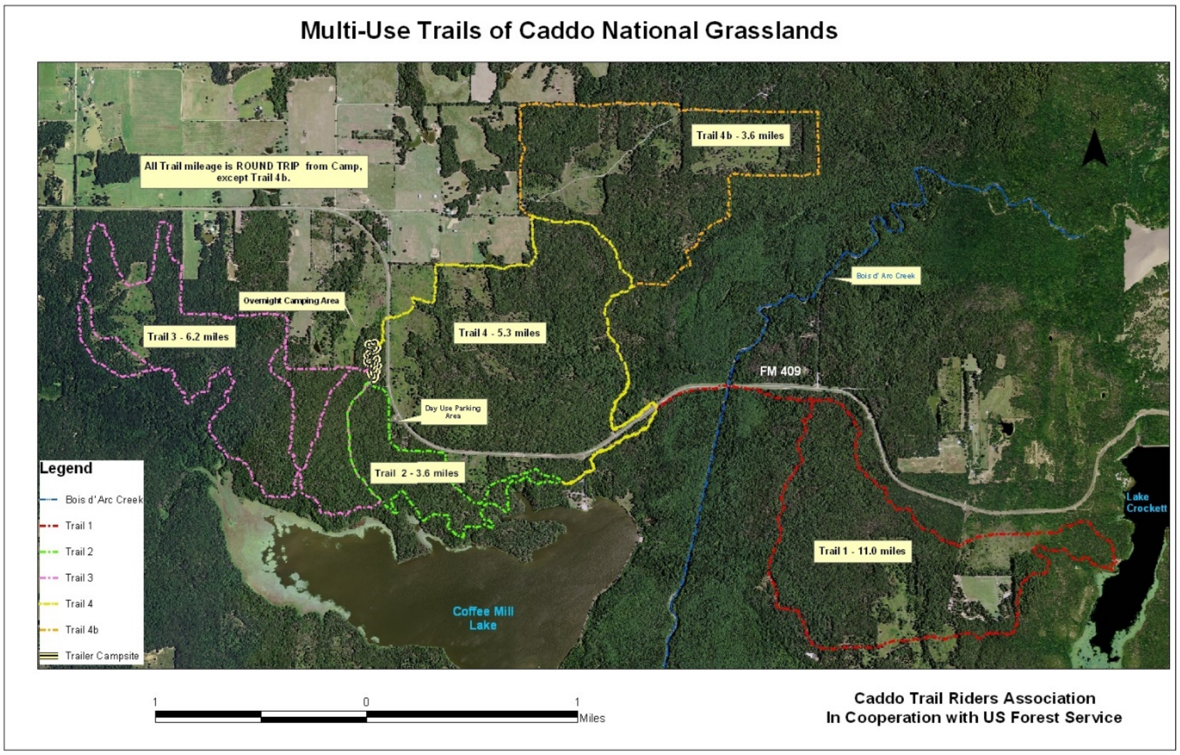


Figure 3.7-2. Multi-Use Trails in Bois d'Arc Unit, Caddo National Grasslands WMA

Source: Pons, No Date.

Most hunting at Caddo National Grasslands WMA occurs on the Bois d'Arc Unit, and includes white-tailed deer, squirrel, and waterfowl (among others). Limited dove and quail hunting occurs on the Ladonia Unit (TPWD, no date-e). Hunting opportunities at Caddo National Grasslands WMA and on public lands in surrounding counties are summarized in Table 3.7-1 below.

Table 3.7-1. Hunting Opportunities Near the Proposed Project Area

Unit #	Unit Name	County	Acres	Species Hunted
901N	Bois d'Arc Unit – Caddo National Grasslands WMA	Fannin	13,370	Deer, feral hog, turkey, dove, teal, waterfowl, other migratory birds, squirrel, rabbit, coyotes, furbearers
901S	Ladonia Unit – Caddo	Fannin	2,780	Dove and quail

Unit #	Unit Name	County	Acres	Species Hunted
	National Grasslands WMA			
501	Ray Roberts Public Hunting Lands	Cooke/Denton/ Grayson	41,303	Feral hog, dove, teal, waterfowl, other migratory birds, quail, squirrel, rabbit
731	Cooper WMA (next to Jim Chapman Lake)	Delta/Hopkins	14,160	Deer, feral hog, dove, teal, waterfowl, other migratory species, squirrel, rabbit,
708	Tawakoni WMA	Hunt/ Rains/ Van Zandt	39,125	Deer, feral hog, dove, teal, waterfowl, other migratory birds, squirrel, rabbit, furbearers
705	Pat Mayse WMA	Lamar	8,925	Deer, feral hog, dove, teal, waterfowl, other migratory birds, quail, squirrel, rabbit, furbearers

Source: TPWD, 2017b.

Texas Parks and Wildlife manages the wildlife hunting opportunities at Caddo National Grasslands WMA. Hunters are required to possess a valid hunting license, the appropriate tags and stamps, and a public hunting permit or an Annual Public Hunting permit to hunt on public lands (TPWD, no date-e). Hunting regulations comply with Texas Hunting and Fishing Regulations for outdoor annual hunting and vary based on the animal (game animal, upland game birds, migratory game birds, other animals) and the special seasons (archery-only, falconry, muzzleloader deer, youth only) (TPWD, 2017c).

3.7.4 Regional Lakes and Reservoirs

Natural lakes and man-made reservoirs offering recreation in the region are shown in Table 3.7-2. Lakes and reservoirs located in Fannin and Grayson counties (and therefore close to the proposed LBCR) include Bonham City Lake, Bonham State Park Lake, Lake Texoma, Lake Ray Roberts and in the Caddo National Grasslands WMA Coffee Mill Lake, Lake Fannin, and Lake Crockett. Big Creek Reservoir, Jim Chapman Lake, Lake Crook, Pat Mayes Lake, Lake Lavon, and Lake Tawakoni are located in the surrounding counties.

Bonham City Lake is located three miles northeast of Bonham off of FM 273, and is the lake closest to the proposed reservoir. It has two access points: Bonham City Lake Recreation Area and North Ramp. Bonham City Lake Recreation Area is located on the south shore at the east end of the lake, and can be accessed via FM 273 and Recreation Road 3. The North Ramp is located approximately two miles north of Recreation Road 3 off of FM 273. It can be accessed via Fannin County Road 2524 and Boat Ramp Road. Bonham City Lake has a surface area of 1,020 acres and offers facilities for picnicking, camping, boating, fishing, and swimming. Predominant fish species include largemouth bass, channel and blue catfish, and crappie (TPWD, no date-f).

Table 3.7-2. Lakes and Reservoirs with Recreation Near the Proposed Project Area

Lake/Reservoir	County	Managing Authority
Bonham City Lake	Fannin	City of Bonham
Bonham State Park Lake	Fannin	Texas Parks and Wildlife
Coffee Mill Lake	Fannin (Caddo National Grasslands)	US Forest Service
Lake Fannin	Fannin (Caddo National Grasslands)	US Forest Service
Lake Crockett	Fannin (Caddo National Grasslands)	US Forest Service
Lake Texoma	Grayson	US Army Corps of Engineers
Lake Ray Roberts	Grayson	Texas Parks and Wildlife*
Big Creek Reservoir	Delta	Delta County Clerk
Jim Chapman Lake	Delta	Texas Parks and Wildlife*

Lake/Reservoir	County	Managing Authority
Lake Crook	Lamar	City of Paris
Pat Mayse Lake	Lamar	US Army Corps of Engineers
Lake Lavon	Collin	US Army Corps of Engineers
Lake Tawakoni	Hunt	Sabine River Authority; Texas Parks and Wildlife*

[a] USACE is the managing authority of these lakes/reservoirs, but TPWD manages recreational properties associated with them.

Sources: TPWD, no date-f; USFS, no date

The location of recreational lakes and state parks in relation to the reservoir, pipeline, and water treatment facility for Alternative 1 are shown in Figure 3.7-3. Bonham City Lake, Bonham State Park Lake, and in the Caddo National Grasslands WMA Coffee Mill Lake and Lake Crockett, are located closest to the proposed LBCR. Bonham State Park Lake is approximately three miles away from the proposed LBCR. Lake Crockett is a little over a mile away and Coffee Mill Lake is about a half mile away. Bonham City Lake is immediately adjacent to the proposed LBCR.

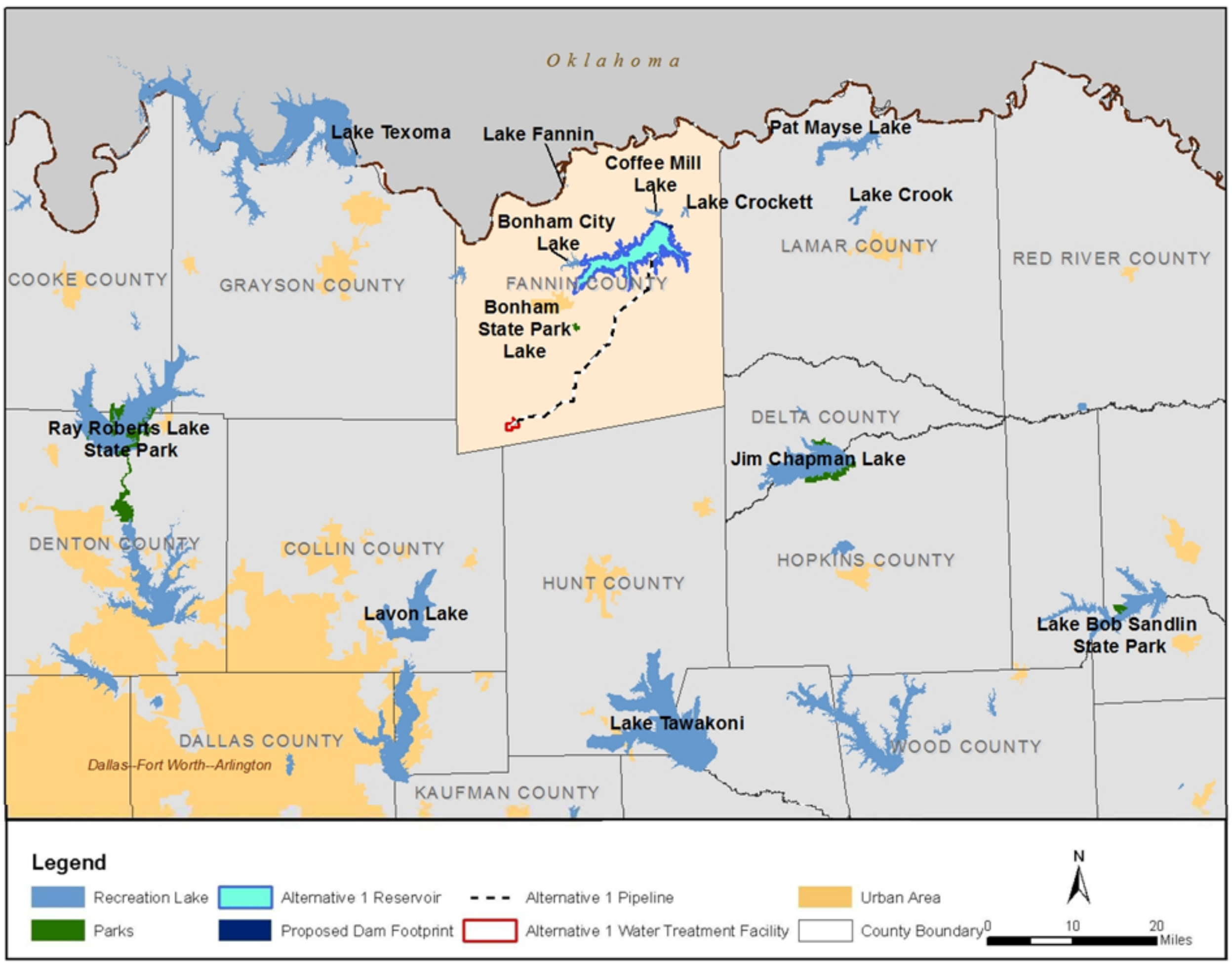


Figure 3.7-3. Location of Regional Lakes and Reservoirs Relative to Alternative 1

Source: TWDB, 2014

Visitation

Visitation, surface area, recreational facilities and opportunities, and water fluctuation for USACE and TPWD-managed lakes are presented in Table 3.7-3 (data for lakes managed by cities or counties are not available and as such are not included). The Gateway website provides USACE Lake Level Reports for FY 2012. The visitation data were derived from the Operations and Maintenance Business Information Link (OMBIL) and the Visitation Estimation and Reporting System (VERS) databases with 2012 data. A "visit" is defined as the entry of one person onto a USACE site to engage in one or more recreational activities regardless of the length of stay. A "person trip" is equivalent to a "visit."

Texas Parks and Wildlife Department (TPWD) provided visitation for FY 2016, estimated using a combination of collection and calculation methods. Visitation data is collected for each person entering a park during regular business hours, and entered manually into the "TXParks" software. After-hours visitation is calculated using collected vehicle data, the park's unique visitation multiplier (based on year-long surveys measuring the number of vehicles, overnight visitors, day users, etc.), and payment information received from visitors arriving after-hours (Cater, 2017).

TPWD characterizes water fluctuation as minimal, moderate, or considerable. These descriptors, included in Table 3.7-3 below, are based on general visual or measured observations, and are not uniquely categorized or defined for scientific purposes. This information is provided by TPWD for the benefit of the general public interested in a lake's conditions, and is provided here to help describe each lake's conditions (Cater, 2017).

Table 3.7-3. Visitation and Other Characteristics of Regional Lakes and Reservoirs

Lake/Reservoir	Recreational Facilities and Opportunities	Surface Area (acres)	Annual Visitation (Person-trips)	Water Fluctuation
Bonham State Park Lake	Camping (campground), swimming, fishing, hiking, playground, boating, picnicking	65	51,663[a]	Minimal
Pat Mayse Lake	Fishing, dock, picnic areas, camping, hunting	5,940	214,202[b]	Moderate
Jim Chapman Lake	Camping (campground), shelters, cabins, beaches, picnic areas, boat ramps, lighted fishing piers, hunting	19,305	295,842[b]	Moderate
Lavon Lake	Fishing, dock, picnic areas, camping	21,400	1,204,742[b]	Moderate
Lake Ray Roberts	Fishing, camping, picnic areas, boat gas, courtesy docks, hunting	25,600	1,188,694[b]	Moderate
Lake Tawakoni	Fishing, camping, RV sites, motels, boat ramps, bait and tackle shops, water sports, hunting, trails	37,879	75,724[a]	Considerable
Lake Texoma	Fishing, camping, RV sites, picnicking, resorts, cabin/lake house/condo rentals, inns, motels, sailing, golfing, hunting, trails	74,686	5,073,550[b]	Considerable

[a] Visitors to TPWD-managed lakes reported for FY 2016
[b] Visitors to USACE-managed lakes reported for FY 2012
Sources: TPWD, no date-f; Cater, 2016; USACE, 2012

Despite considerable water fluctuation, Lake Texoma receives the greatest number of visitors, with over five million in FY 2012. It also has the largest surface area of the regional lakes, and the lake is stocked with largemouth bass, smallmouth bass, white bass, hybrid striped bass, white crappie, black crappie, channel catfish, flathead catfish and blue catfish. It is one the few reservoirs in the United States where striped bass reproduces naturally, and is known as the "Striper Capital of the World" (USACE, no date-c). Lake Texoma is also bordered by the 12,000-acre Hagerman National Wildlife Refuge (NWR) at the Big Mineral Arm, a popular destination for sports fishermen seeking catfish, sand bass, stripers, crappie, and pan fish year-round (USFWS, 2015b). In addition to water-based activities, Lake Texoma offers 90,000 acres of public land for game hunting, including deer, turkey, small game, dove and other migratory game birds, waterfowl and feral hogs (USACE, no date-c). Hagerman NWR provides additional hunting opportunities for white-tailed deer, feral hogs, and wild turkey through a lottery permit system. Hunting for small game including squirrel and rabbit and dove hunting is also available (USFWS, 2015c). There are several options for overnight stays (i.e. resorts, cabin/lake house/condo rentals, inns, motels). The recreation area also includes 10 campgrounds and 25 miles of equestrian and hiking trails, including the scenic Cross Timbers hiking trail (USACE, no date-c). The number, type and quality of recreational facilities and opportunities offered at Lake Texoma likely contribute to its popularity, and explain why it has been dubbed the "Playground of the Southwest."

In contrast to Lake Texoma, despite minimal water fluctuation, Bonham State Park Lake received the least number of visitors, with 51,663 in FY 2016. It is also the smallest of the lakes and does not offer facilities conducive to overnight stays. In the case of Lake Tawakoni, considerable water fluctuation may contribute to its low visitation. Considering its relatively large surface area and despite offering some facilities conducive to overnight stays (i.e., RV sites and motels) as well as hunting opportunities (summarized above in Table 3.7-1), it only received about 80,000 visitors in FY 2012. Said otherwise, Lake Tawakoni has about half the surface area of Lake Texoma, but received less than one percent of the visitors Lake Texoma received in FY 2012.

Generally speaking, the number and type of recreational facilities and opportunities, surface area, and water fluctuation all seem to be related to visitation at the regional reservoirs, though it is difficult to tell in these cases if any one factor directly increases or decreases visitation. A study on the effect of Tennessee Valley Authority (TVA) reservoir water levels on recreational fishing concluded that while water levels were not a major barrier to participation, levels did affect the number of trips taken by anglers. In the case of the TVA reservoirs, lower water levels left many coves and boat ramps landlocked for much of the year, restricting the ability of reservoir anglers to launch boats (Jakus et al., 2000). With the information at hand, considerable water fluctuation does not appear to deter visitors from Lake Texoma; and minimal water fluctuation does not appear to attract visitors to Bonham State Park Lake. Considerable water fluctuation would appear to deter visitors to Lake Tawakoni, though other factors could include the quality of developed recreational facilities, biological or geological factors, and proximity to population centers.

Economic Impacts

The money spent by visitors to USACE lakes on trip expenses adds to the local and national economies by supporting jobs and generating income. The Gateway website provides visitor spending, jobs, labor income, and value added within 30 miles of USACE lakes. Spending profiles were estimated from a national visitor spending survey that was conducted in 1999/2000 and price indexed to 2012 dollars using the Consumer Price Index by sectors. Impact Analysis for Planning (IMPLAN), an input-output modeling system uses recreation spending and visitor use estimates to estimate capture rates and economic multipliers. Spending averages were computed and multiplied by visitation statistics to estimate total annual visitor spending. Generalized spending profiles were developed for two sets of visitor segments: 1) campers, other overnight visitors and day users, and 2) boaters and non-boaters.

These profiles were applied to recreation use data gathered from the visitation use survey and from the OMBIL and VERS to estimate total spending by each segment (USACE, 2016).

Visitor spending represents a sizable component of the economy in many communities around USACE lakes. For example, at Lavon Lake, 1.2 million visits and almost $4 million in visitor spending within 30 miles of the lake created about 250 jobs, $8.4 million in labor income (salaries, wages, and work benefits), and $12.5 million in value added to the local economy (i.e., the contribution to the overall wealth of the economy). The economic impacts within 30 miles of USACE-managed lakes (Pat Mayse Lake, Jim Chapman Lake, Lavon Lake, Lake Ray Roberts, and Lake Texoma) are summarized in Table 3.7-4 below. The economic impacts of both local and non-local visitor spending within 30 miles of a USACE lake are reported for FY 2012. The economic impacts of non-local visitor spending within 20 miles of TWPD lakes are reported for FY 2014.

Table 3.7-4. Economic Impacts of Regional Lakes and Reservoirs

Reservoir	Visitor Spending	Labor Income	Value Added	Jobs
Managed by US Army Corps of Engineers (FY 2012)				
Pat Mayse Lake	$6,121,000	$974,000	$1,632,000	48
Jim Chapman Lake	$10,540,000	$1,761,000	$2,916,000	84
Lavon Lake	$39,739,000	$8,444,000	$12,596,000	263
Lake Ray Roberts	$40,318,000	$7,522,000	$11,602,000	291
Lake Texoma	$169,135,000	$29,157,000	$47,514,000	1,680
Managed by Texas Parks and Wildlife (FY 2014)				
Bonham State Park Lake	$528,362	$201,607	$362,964	7.2
Lake Tawakoni	$1,304,145	$376,971	$945,505	19.1

Sources: USACE, 2012 and Jeong and Crompton, 2014.

Note: Economic impacts for USACE-managed lakes are reported for FY 2012, and TWPD-managed lakes are reported for FY 2014.

That said, compared to other industries in the counties where these lakes are located, recreation-related industries account for relatively small portions of total industry compensation. Total industry compensation provides a good picture of relative sizes of market-related or business activity performed in a county, and it is reported in terms of employee compensation for work in a sector. Compensation includes salaries and wages as well as employer contributions for employee retirement funds, social security, health insurance, and life insurance. This income is not always received by a person living in the county, because a person from a neighboring county may cross county lines to go to work. Employee compensation by industry is a measure of economic activity generated in a county, regardless of where the employee resides.

Table 3.7-5 shows the employee compensation for the Art, Entertainment, and Recreation and Accommodation and Food Services industries as well as the percent of total industry compensation for the counties in which the regional lakes are located. Tables 3.12-9 and 3.12-14 in the Socioeconomics section in Chapter 3 show total employee compensation by industry in Fannin and Grayson Counties, respectively, in 2010.

Table 3.7-5. Total Employee Compensation for Recreation-Related Industries (2010)

County	Art, Entertainment, and Recreation		Accommodation and Food Services	
	Employee Compensation	Percent of Total Industry Compensation	Employee Compensation	Percent of Total Industry Compensation
Fannin	$644,000	0.2	$6,372,000	2.3
Grayson	$16,073,000	0.7	$77,613,000	3.8
Collin	$106,211,000	0.5	$585,617,000	3.0
Hunt	$2,054,000	0.1	$34,691,000	2.3
Lamar	$4,794,000	0.5	$25,804,000	3.0
Delta	(D)	n/a	(D)	n/a

(D) = Not shown to avoid disclosure of individual confidential information; n/a = not available.

Source: BEA, 2011a.

3.8 VISUAL RESOURCES

3.8.1 Terminology and Methodology

A visual resource is the interaction between a human observer and the landscape he or she is observing. The subjective response of the observer to the various natural and artificial elements of a given landscape is fundamental to visual resources impacts analysis (USDA, 2007). A viewshed is the view of an area from a specific location. The limits of a viewshed are defined as the visual limits of the views from a specific location (Caltrans, no date).

Federal land management agencies such as the Bureau of Land Management (BLM), USFS, and the National Park Service are concerned with the management of visual resources. Visual resource management (VRM) is a system developed by the BLM for minimizing the visual impacts of surface-disturbing activities and maintaining scenic values for the future. While the VRM was developed for application on the public lands managed by BLM, it is a useful tool to assess impacts on private lands as well. VRM consists of two stages – inventory (visual resource inventory) and analysis (visual resource contrast rating).

VRM's visual resource inventory consists of rating the visual appeal of a tract of land, measuring public concern for scenic quality, and determining whether the tract of land is visible from travel routes or observation points. Once the inventory is completed, the area's visual resources are assigned to management classes, Class I to Class IV, with Class I being the most highly valued visually[3]. Each management class has established management objectives (BLM, 2017):

- Class I Objective – Preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention.
- Class II Objective – Retain the existing character of the landscape. The level of change to the characteristic landscape should be low.
- Class III Objective – Partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate.

[3] Determining the value of an area's visual resources is a subjective process that factors in the scenic quality of the area and the sensitivity of the area.

- Class IV Objective – Provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high.

VRM's analysis stage involves determining whether the potential visual impacts from proposed surface-disturbing activities or developments will meet the management objectives established for the area, or whether design adjustments will be required.

The first step in the VRM visual resource inventory is the scenic quality evaluation. Scenic quality is a measure of the visual appeal of a tract of land. In the visual resource inventory process, the landscape under evaluation is rated as A, B, or C (most to least scenic) based on its aggregate score in the seven rating criteria (landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications [BLM, no date). The next step in the VRM visual resource inventory is the sensitivity level analysis. Sensitivity levels are a measure of public concern for scenic quality. The landscape being inventoried is assigned high, medium, or low sensitivity levels by analyzing the various indicators of public concern (e.g., type of users, amount of use, public interest, and adjacent land use) (BLM, 1986a).

The VRM described above was used to evaluate the affected environment for the proposed project. The area within the proposed dam and reservoir footprint (Alternatives 1 and 2) was chosen for analysis because the dam and reservoir would be the dominant feature of the project and would represent the largest potential for impacts to visual resources. It was determined that the proposed dam and reservoir would primarily be visible from portions of the Caddo National Grasslands and roadways in and around the reservoir footprint (specifically FM 1396). Therefore, for purposes of analysis, the viewshed of individuals visiting the Caddo National Grasslands and individuals utilizing FM 1396 was used to evaluate the potential impacts to visual resources under each alternative (see Section 4.10).

The pipeline from the proposed reservoir to the WTP (Alternatives 1 and 2) and the pipeline from Lake Texoma to the WTP (Alternative 2 only) were not included in the analysis because most of the pipeline(s) would be buried and; therefore, would have a much smaller potential to impact visual resources. The WTP and TSR were not included because they are much smaller than the proposed dam and reservoir and would be constructed next to an area that has already been developed and therefore would have a much smaller potential to impact visual resources. Section 3.8.2 provides a summary of the VRM results.

3.8.2 Visual Resource Management Results

The proposed reservoir footprint would have a maximum area of 16,641 acres of various land use types. The Bois d'Arc Creek, surrounding wetlands, and riparian areas comprise 36 percent (5,991 acres) of the land affected. Cropland, grassland, and old field succession account for another 38 percent (6,324 acres) of the affected area. The remaining area is predominantly forested land, with a small area used for transportation and scattered single family homes. The elevations within the proposed reservoir footprint range from 462 to 553.5 feet MSL, which is a 91.5-foot change in elevation. This change in elevation indicates a generally flat to gently sloping landscape.

Due to the large area affected by Alternatives 1 and 2, it was divided into three Scenic Quality Rating Units (SQRUs) for the visual resource inventory. According to the VRM guidelines, SQRUs are delineated on the basis of similar physiographic characteristics (land cover types), areas of similar visual patterns, texture, and color, and areas which have similar impacts from man-made modifications (BLM, no date). In this case, the project area was divided primarily based on land cover types: the Bois d'Arc Creek itself and the wetlands adjacent to the creek (SQRU-1); cropland, grassland, and old field succession (SQRU-2); and upland forest and woodlands, including deciduous forest, evergreen forest, tree savanna, and shrubland (SQRU-3). See Figure 3.8-1 for a map showing the project area and each SQRU.

Using the visual resource inventory methodology described above, each SQRU was given a management class rating. SQRU-1 was rated as a Class III area because, while the area predominantly consists of undeveloped wetlands with little aesthetic appeal (consistent with a Class IV rating), the area contains water which the VRM ranks as visually more appealing. Class III represents areas of moderate visual value. The areas within SQRU-2 were determined to not be visually appealing and were given a rating of Class IV. Class IV represents areas of the least visual value. The final area evaluated, SQRU-3, was also determined to not be visually appealing and was given a Class IV rating (least visual value). Overall, the three ratings for the entire proposed reservoir location range from Class III to Class IV, moderate to low visual quality.

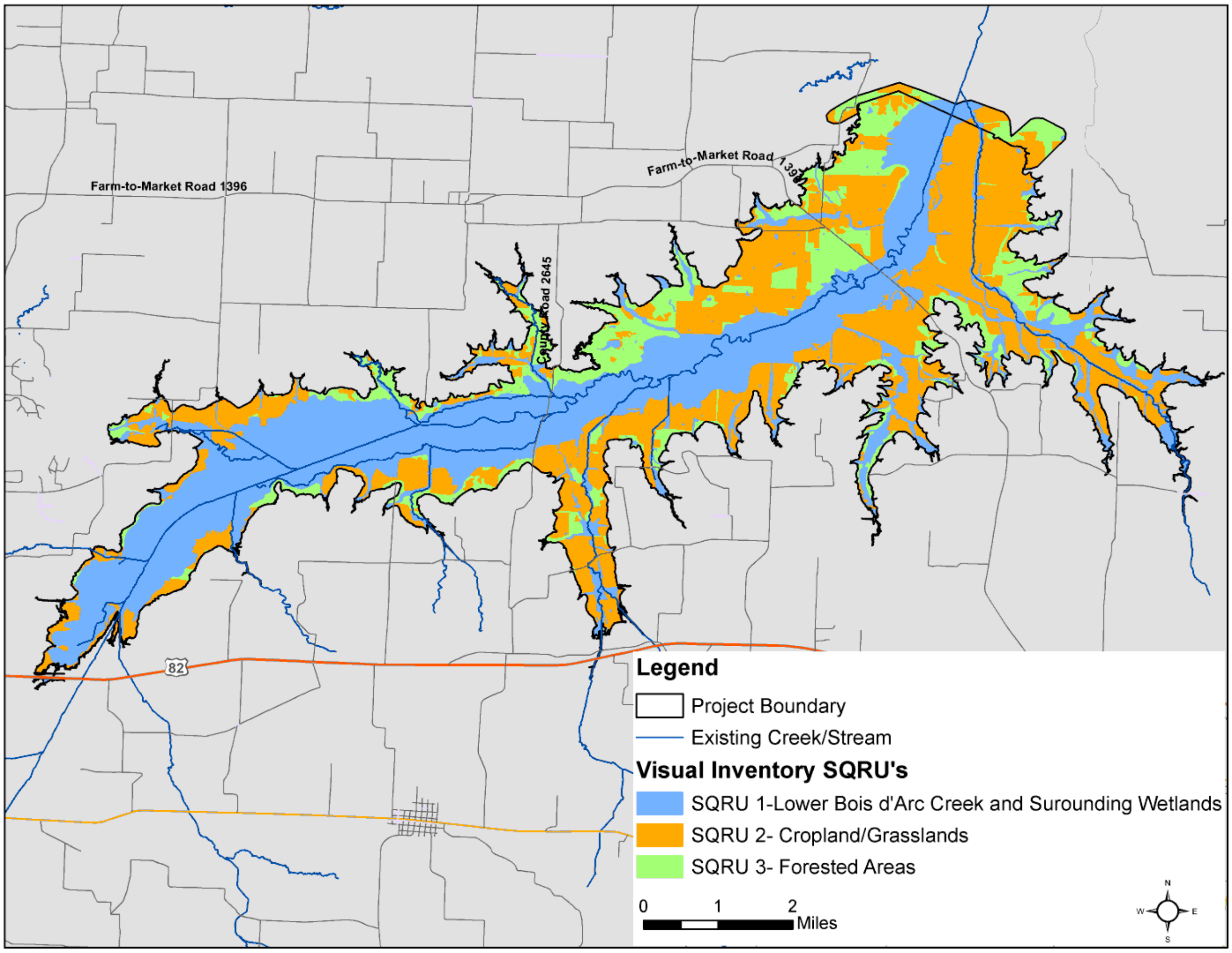


Figure 3.8-1. Proposed Dam and Reservoir Footprint with the SQRUs Designated

3.9 UTILITIES

The purpose of NTMWD constructing and operating a new reservoir would be to develop an additional and reliable water supply of at least 105,804 AFY by 2025. This new water source would provide water to NTMWD's member cities and customers. Because the operation of the proposed reservoir under Alternatives 1 and 2 would provide additional water supply that could stimulate population growth in the region, the utilities in the surrounding area were considered when analyzing the potential impacts of each alternative. The utilities considered include electrical transmission lines, gas/petroleum pipelines, and other minor utilities.

Specific utilities that could be impacted by project activities include an overhead electrical transmission line located inside the reservoir footprint (no other utilities are located within the reservoir footprint), utilities located along the proposed pipeline from the proposed reservoir to the proposed WTP (Alternatives 1 and 2), and utilities located along the proposed pipeline from Lake Texoma to the proposed WTP (Alternative 2 only). The utilities potentially impacted along the pipeline routes include electrical transmission lines, gas/petroleum pipelines, and other minor utilities. Other project components (e.g., the TSR and WTP) would not impact any existing utilities.

Figure 3.9-1 shows the electric power line located in the reservoir footprint that could be affected by the proposed reservoir. These power lines are classified as medium voltage distribution lines and are between one and 33 kilovolts. Medium voltage distribution lines are used for energy distribution in urban and rural areas (ESRI, 2010). These overhead power lines could either be raised above the conservation pool or could require deconstruction and relocation.

The other utilities that could be affected by the pipeline(s) would be of varying size and capacity. If necessary, these utilities would be crossed or bypassed according to the requirements of each facility's owner and permitted as required by the relevant permitting authority.

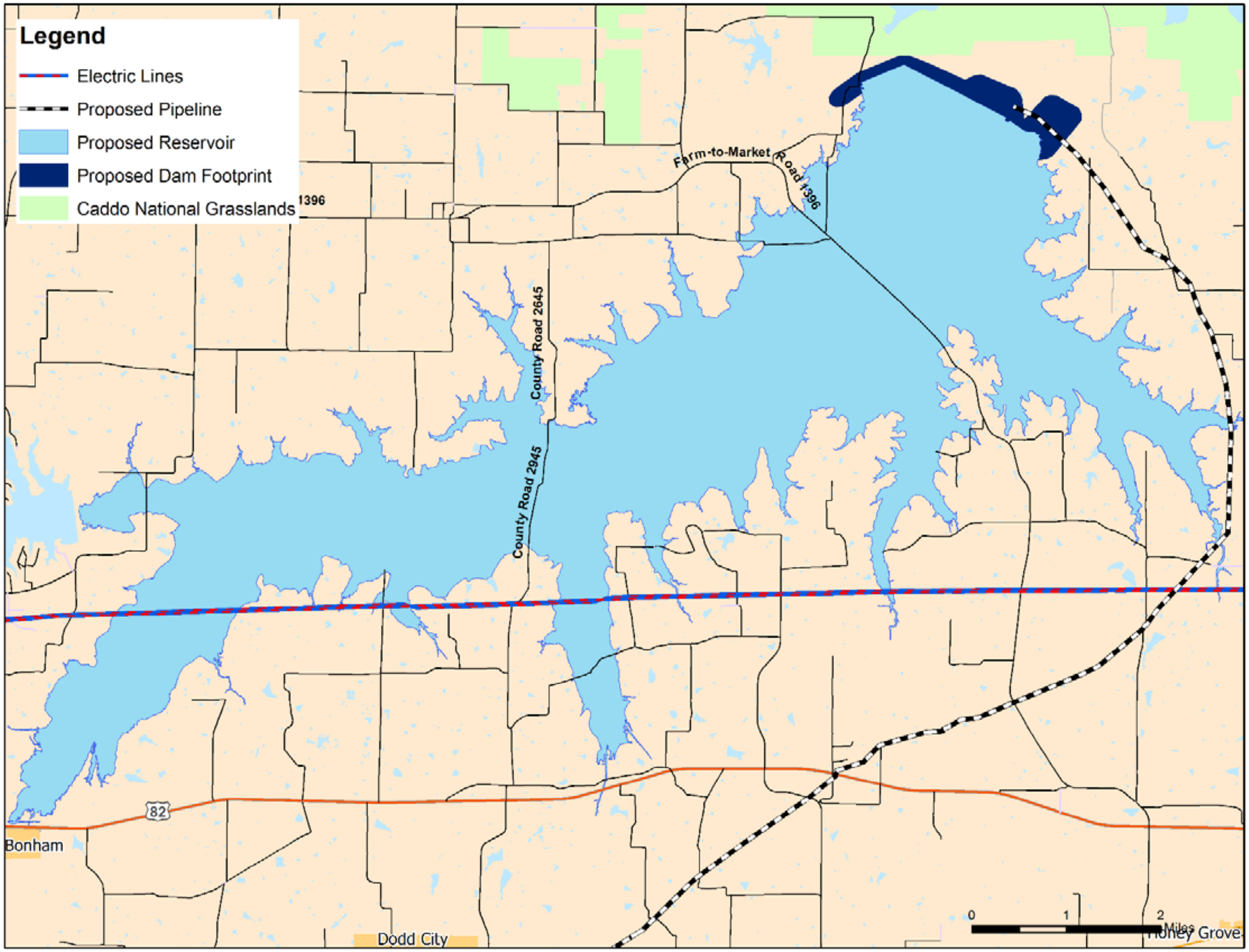


Figure 3.9-1. Aboveground Power Lines Within the Proposed Reservoir Footprint

3.10 TRANSPORTATION

This section provides a discussion of the existing transportation resources near the proposed reservoir site, including an overview of the regional and local traffic, airports, boating, and rail resources. The area can be accessed via many transportation modes, and Fannin County can be easily accessed from all directions except the north, where only one route, Highway 78, crosses the Red River from Oklahoma into the county.

3.10.1 Regional and Local Roads and Traffic

Transportation in and around the proposed project site is achieved mainly via road and street networks. The closest interstate is approximately 40 miles south: Interstate (I)-30, which runs east-west from Dallas-Fort Worth to Texarkana. I-35 travels north-south approximately 60 miles west of Fannin County and connects the Dallas-Fort Worth area to Oklahoma City. The transportation system serves local and regional traffic consisting of work commuters, general daily travel, and recreationists. Fannin County and its surrounding transportation area is within the Paris District of the Texas Department of Transportation (TxDOT) (TxDOT, 2010).

Because of the rural nature of the area surrounding the proposed reservoir site, the transportation network does not contain major roadways (i.e., interstates). As shown in Figure 3.10-1, a network of state highways and farm-to-market (FM) roads leads to the major interstates; however, there is no direct route to an interstate from the proposed site. The proposed dam development is between FM 1396 and FM 409, southwest of the Caddo National Grasslands. The closest towns to the proposed site are Allens Chapel approximately four miles to the south, and Telephone approximately five miles to the north. Due to Fannin County's rural location, public transit is unavailable and there is no cohesive network supporting non-motorized and pedestrian transportation.

The roadway most likely to be affected by the Proposed Action is FM 1396, which is adjacent to and crosses the proposed project site. A list of roads leading to major interstates that currently transect the 16,641-acre proposed reservoir area is presented in Table 3.10-1. Traffic on roadways surrounding the proposed development is free-flowing during both the a.m. and p.m. peak traffic periods.

Table 3.10-1. Roadways Within the Proposed Site Boundaries that Lead to Major Interstates

Road Name	Road Length (miles)
Farm-to-Market Road 1396	2.1
County Road 2945 & County Rd 2645	1.4
County Road 2655	1.0
County Road 2705	0.8
County Road 2950	0.6
County Road 2700	0.5
County Road 2610	0.3

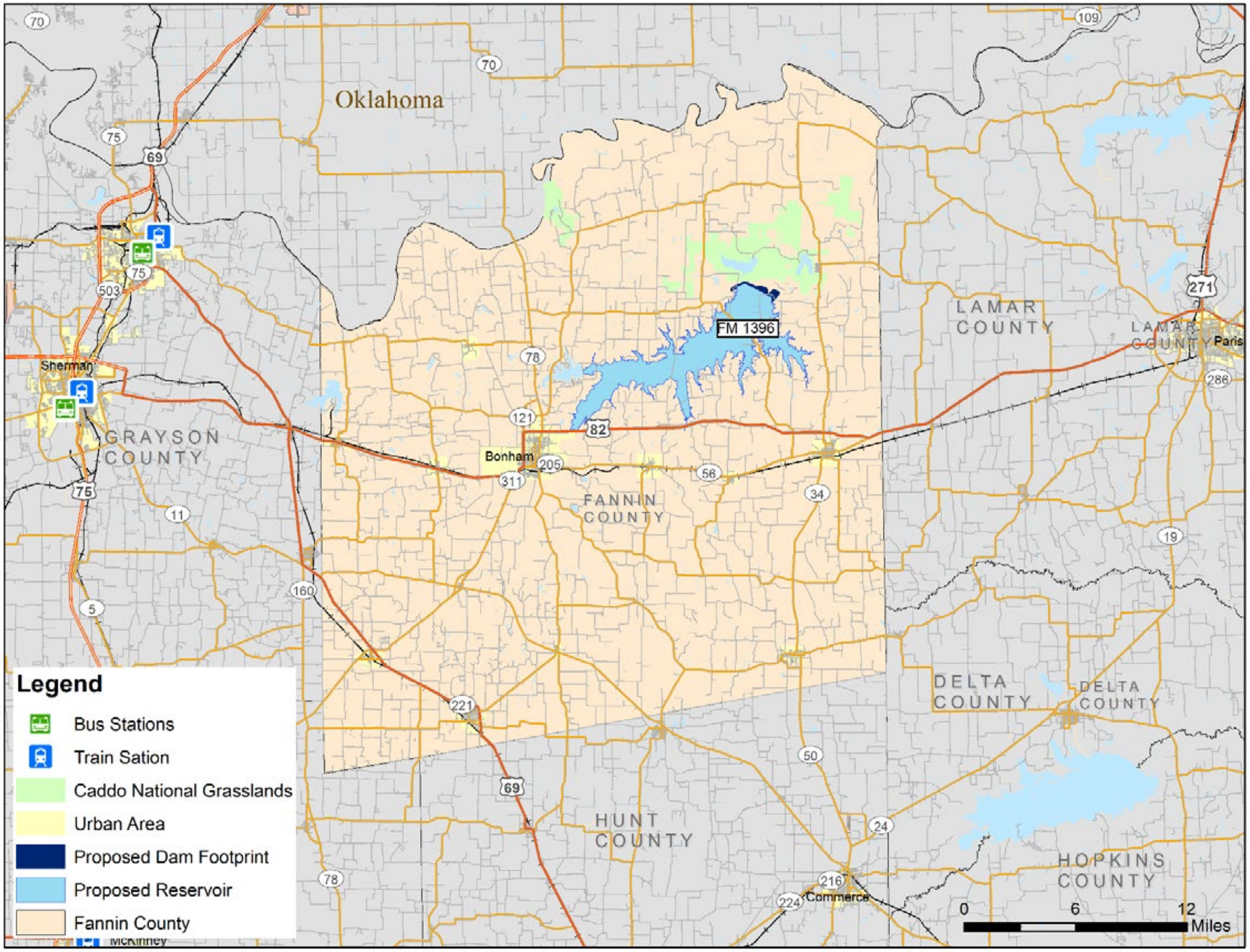


Figure 3.10-1. Road Network in Fannin County and Surrounding Areas

3.10.2 Air Transit, Rail, and Boating

The North Texas Regional Airport (GYI) is approximately 40 miles west of the proposed dam site. This airport was founded in 1941 as a training site for World War II pilots and as part of the Perrin Air Force Base. Grayson County currently owns and operates GYI, which averages 219 flights per day including single- and multi-engine propeller planes, small jets, helicopters, and ultralights (AirNav, 2017). The Dallas-Fort Worth International Airport (DFW) is approximately 80 miles southwest of the proposed dam site and provides passenger, commercial, and cargo services. DFW averages 1,853 flights per day (AirNav, 2017b).

There are many active rail spurs throughout the area. The Fannin Rural Rail Transportation District was developed to preserve railroad service in eastern Grayson, Fannin, and Lamar counties to meet present and future transportation requirements. The closest active rail spur runs east to west four miles south of the proposed site. Union Pacific and Texas Northeastern Division Railroad are the primary rail carriers in Fannin County. Amtrak does not provide direct passenger train service to Bonham, and the closest Amtrak passenger station is approximately 60 miles from the proposed site in Gainesville.

3.11 ENVIRONMENTAL CONTAMINANTS AND TOXIC WASTES

This section is based entirely on a preliminary desktop study conducted by the Applicant in 2010 (Freese and Nichols, 2010c). The purpose of this preliminary study was to broadly characterize environmental conditions at the proposed project site by evaluating factors such as land use, site history, obvious evidence of environmental contamination, and the presence of adjacent or nearby properties that could pose environmental concerns. The 2010 study was conducted in response to concerns raised during initial project scoping and consisted of an historical review of past land uses and a review of regulatory agency records for the site. No site visit was carried out as part of the study; however, it followed the desktop protocols outlined in the following regulations and standards:

- American Society of Testing and Materials (ASTM) Standard E-1527-05, Standard Practice for Phase I ESAs (2005), and
- Title 40 of the Code of Federal Regulations, Part 312 (40 CFR §312), Standards and Practices for All Appropriate Inquiries (AAI), Final Rule.

Site visits may be made to specific areas of concern at a later date, as appropriate.

Aerial photographs indicate that little development has taken place in the project area over the past half-century, other than an increase in agricultural land and homesteads on the outskirts of the proposed reservoir site. Heavy farming on agricultural lands is evident within the proposed reservoir site and environs over the past three decades. The Fannin County Clerk's Office did not have any environmental records for the proposed project area or surrounding areas. A review of regulatory database searches by Environmental Data Resources, Inc. (EDR) did not disclose any current or historical facilities or incidents that are likely to pose a problem.

Agricultural activities conducted in recent decades in the proposed project area have included livestock grazing, hay production, and row crop production. It is probable that agricultural chemicals such as fertilizers, herbicides and pesticides, and petroleum products have been used in the proposed project area. However, review of land use and records did not provide any indication of widespread inappropriate use, storage, or disposal of these chemicals. The desktop study found no documentation of the past presence of industrial facilities or commercial businesses within the proposed reservoir footprint or nearby.

In sum, the desktop study did not identify any recognized or potential environmental concerns in the project area. Since the desktop study was performed, there have been two environmental issues of concern in or near the proposed project area brought to NTMWD's attention by local residents: a tire disposal site and the closed City of Bonham landfill. These issues and the actions taken by NTMWD are discussed below.

3.11.1 Tire Disposal Sites

In March 2011, a local resident notified NTMWD of suspected illegal disposal and burning of tires on property already purchased by NTMWD and within the proposed LBCR footprint. On behalf of NTMWD, FNI staff conducted a site visit on March 14, 2011 to the tire disposal site, where they observed one open burn pit and several additional backfilled pits. The open pit was approximately 20 feet in diameter and 10 feet deep; it contained burned tires, tire scraps, wheel wire from radial tires, ash, and other debris. The debris inside the pit was still smoldering at the time of the site visit (Chambers, 2012).

The remaining pits and burn piles had already been backfilled and covered over with dirt. Thus, FNI was unable to determine the actual depths or lateral extent of each burn pit during this initial site visit. FNI staff observed three additional locations where surface disturbance may have indicated the presence of buried tires or additional burn pits. Large quantities of tires discarded on the ground surface were found in two locations. There were approximately 600 tires visible at one location, although no evidence of burning or subsurface disposal was found at this site. The other large surface pile contained approximately 50 tires, many of which had been cut into pieces but did not appear to have been burned.

In view of these preliminary observations, NTMWD retained FNI to conduct an environmental investigation of the site. A backhoe was used to determine the lateral and vertical extent of the tire pits, while soil borings and a temporary monitoring well were used to collect soil and groundwater samples to ascertain if potential chemicals of concern had migrated outside the physical limits of the tire pits. Samples were analyzed for a combination of volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and RCRA heavy metals (Chambers, 2012).

Thirty-three soil samples from the pits and surrounding area were analyzed in a laboratory. VOCs and PAHs were considered to be potential chemicals of concern due to the burning of the rubber tires. Several of these organic chemicals were detected in many of the samples, however, all detected concentrations were below applicable Tier 1 protective concentration levels (PCLs)[4]. Several of the 33 samples from the tire pits and borings also contained heavy metals – in particular arsenic, barium, cadmium, lead, and selenium.

The investigation indicated that there was not widespread contamination at the site from the burning and dumping of tires. Soils in direct contact with tires or partially burned debris did contain slightly elevated concentrations of heavy metals in some locations. A groundwater sample was collected from a temporary monitoring well and, while ethylbenzene and naphthalene were detected, the concentrations were three orders of magnitude below their PCLs. Lead was detected at concentrations exceeding its PCL and a permanent monitoring well was installed at the site. Subsequent testing of the groundwater from the permanent well did not detect any lead. Overall, there did not appear to be significant soil or groundwater contamination outside the immediate footprint of the tire pits (Chambers, 2012).

Cleanup of the site is regulated by TCEQ under the Texas Risk Reduction Program (TRRP). Under the TRRP guidelines, the site was eligible for a pollution cleanup remedy in which the affected media are removed from the site to another location for storage, processing, or disposal in accordance with all

[4] The Tier 1 PCLs are the default cleanup standards in the Texas Risk Reduction Program.

applicable requirements (TCEQ, 2008). If confirmation samples collected after excavation and removal of tire wastes were below PCLs, the site could obtain closure following submission of a report to TCEQ documenting investigation and excavation activities, thereby avoiding the requirement to prepare a comprehensive Affected Property Assessment Report. The illicit tire disposal and burning site was cleaned up by a contractor under the supervision of the Applicant in late 2012. A notice to proceed was issued by TCEQ on November 15, 2012 and the construction/cleanup activity was completed by December 14, 2012. The contractor recycled approximately 15.8 tons of tires and excavated, transported, and disposed of 2,071 tons of mixed soil and debris at the NTMWD landfill (Chambers, 2013).

All field investigations at the site were completed by early 2013. Results of tests conducted on soil and waste samples obtained at the former tire disposal/burning site indicate that it is eligible for "no further action" approval from TCEQ. In September 2013, FNI prepared and submitted a summary report on the investigation of the site and its cleanup to TCEQ; however, TCEQ has not responded (Chambers, 2013; NTMWD, 2014a).

3.11.2 City of Bonham Landfill

In early 2016, a local resident expressed concern about the possibility of leakage from the closed City of Bonham Landfill into the proposed reservoir due to its close proximity. The City of Bonham Landfill was a 122-acre Type 1 landfill that was capped and closed on March 1, 1996. In May of 2016, TCEQ performed an inspection of the City of Bonham Landfill by observing the surface of the landfill and the perimeter of the site (TCEQ, 2016b). TCEQ noticed several locations on the landfill with ponded water; multiple areas of ponded water were discolored and appeared to be impacted by leachate. TCEQ also observed stressed or no vegetation in some of these locations and evidence of trespassing (e.g., holes in the fenceline and mechanized equipment tracks). On the southern edge of the property, multiple deep erosion rills were observed (see Figure 3.11-1); however, neither waste nor leachate was observed in the rills (TCEQ, 2016b).

As of January 2017, the City of Bonham has repaired the fence line and is in the process of addressing the low areas and erosion rills. Once the site work has been completed, TCEQ will be asked to perform an additional site investigation to verify that all previous findings have been addressed (Capehart, 2017).

In May of 2016, FNI reviewed available water quality data for Bois d'Arc Creek and permitting records for the Bonham Landfill to determine the likelihood that environmental contaminants from the landfill had contaminated the waters of Bois d'Arc Creek. In a report published on May 10, 2016, FNI determined that, because of the landfill's location outside the proposed reservoir project area and the 500-year floodplain, and the continuing TCEQ supervision over the closed landfill, there was no evidence that the landfill had negatively impacted the waters of Bois d'Arc Creek. This report was based on an evaluation of nine years of water quality testing data (Freese and Nichols, 2016c).

Figure 3.11-1. Erosion Rills on the Southern Edge of the City of Bonham Landfill

3.12 SOCIOECONOMICS

The analysis of socioeconomic resources identifies those aspects of the social and economic environment that are sensitive to change and that may be affected by actions associated with the construction and operation of the proposed dam, reservoir, pipeline, and water treatment facilities. Social impacts would be felt most by individuals, communities, residents, and workers in Fannin County, especially residents located in or adjacent to the dam and reservoir. Businesses, community services, and economic systems of Fannin and surrounding counties could change in response to the implementation of either of the action alternatives. The assessment specifically considers how these actions might affect individuals, surrounding communities, and the larger social and economic systems of Fannin County, the surrounding region, and the state of Texas as a whole.

As shown in Figure 3.12-1, Fannin County is surrounded by Hunt County to the south, Collin County to the southwest, Grayson County to the west, Lamar and Delta counties to the east; and the state of Oklahoma to the north. Temporary local economic impacts from dam, pipeline, and related infrastructure construction would be expected to occur in Fannin, Collin, Hunt, Lamar, Grayson, and Delta counties during the three- to four- year project construction period. Recurring annual local economic impacts would be expected to occur in Fannin County through the multi-decadal operational life of the project.

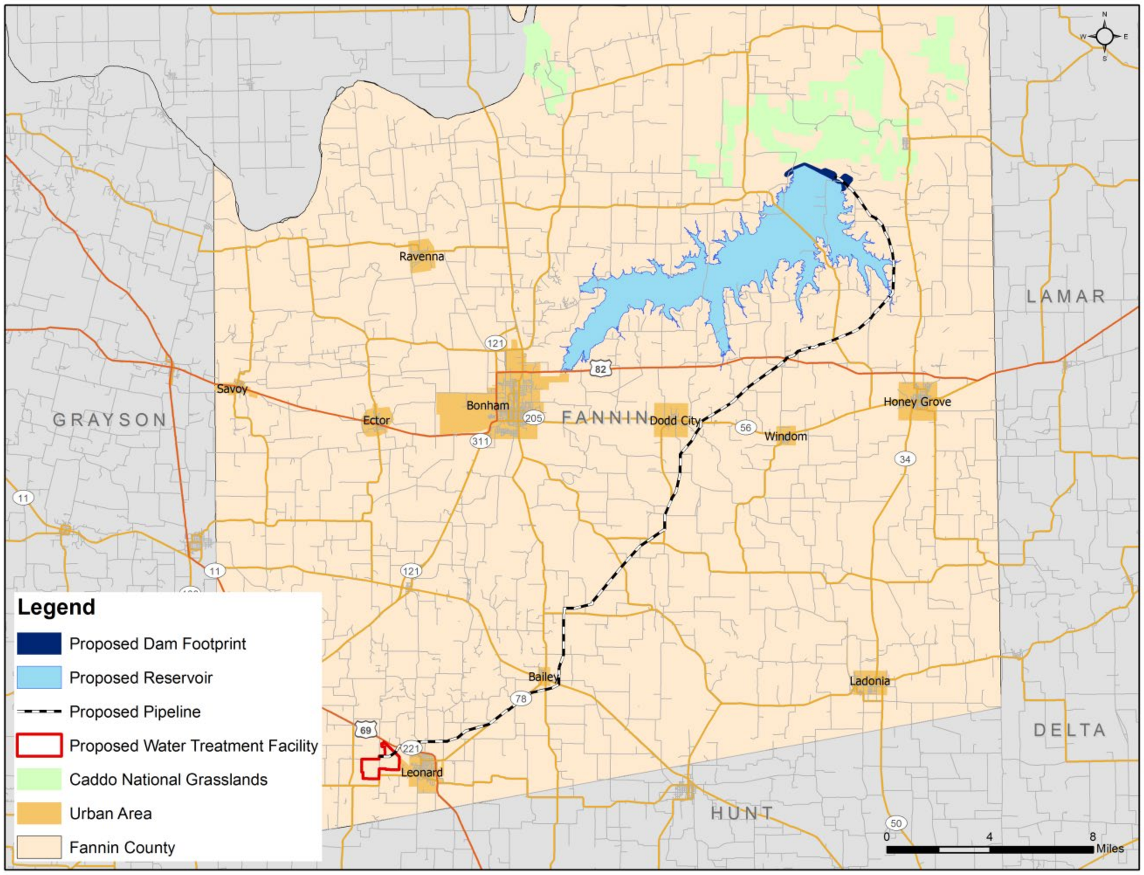


Figure 3.12-1. Map of Alternative 1, Fannin and Surrounding Counties

Because potential impacts with the greatest magnitude (based on severity, duration, size or physical extent, and likelihood) would occur in Fannin County, it represents the primary focus for any direct impacts that may be associated with implementation of Alternatives 1 and 2. In addition to Fannin County, the five directly adjacent counties – Collin, Hunt, Lamar, Grayson, and Delta – are included as the Region of Influence (ROI) since indirect impacts to individuals, communities, and economic systems are expected. Regional impacts would also be expected for the entire NTMWD service area (which includes Collin and Hunt counties), since the provision of needed water would allow for realization of projected long-term population and economic growth within the entire NTMWD service area as discussed in Chapter 1.

Table 3.12-1 summarizes the type and location of socioeconomic concerns identified during scoping meetings, many of which were used to frame the discussion of socioeconomic impacts. Prime farmland is discussed under Section 3.1, Topography, Geology, and Soils.

Table 3.12-1. Potential Socioeconomic Concerns Identified During Scoping

Potential impact	Region of Influence (ROI)					
	Fannin County	Collin County	Lamar County	Hunt County	Delta County	Grayson County
Loss of prime farmland	✓	–	–	–	–	–
Loss of tax revenue	✓	–	–	–	–	–

Potential impact	Region of Influence (ROI)					
	Fannin County	Collin County	Lamar County	Hunt County	Delta County	Grayson County
Retain timber in impoundment area	✓	–	–	–	–	–
Loss of timber sales	✓	–	–	–	–	–
Removal of existing structures	✓	–	–	–	–	–
Relocate homes/ cemeteries	✓	–	–	–	–	–
Cost of relocation/ compensation	✓	–	–	–	–	–
Equipment and workers	✓	✓	✓	✓	✓	✓
Increase housing needs	✓	✓	✓	✓	✓	✓
Create temporary employment	✓	✓	✓	✓	✓	✓
Increase local/regional income and revenues	✓	✓	✓	✓	✓	✓
Provision of water from NTMWD	✓	✓	–	✓	–	–

The data supporting this analysis were collected from standard sources, including federal agencies such as the U.S. Census Bureau (USCB) and Bureau of Economic Analysis (BEA); state agencies such as the Texas Workforce Commission (TWC) and Texas Comptroller of Public Accounts (TCPA); local agencies such as Fannin County Appraisal District (FCAD); as well as other research institutes. Demographic and economic data are presented for Fannin, Delta, Lamar, Collin, Hunt, and Grayson counties and compared to the state of Texas overall. The most recent and best available data are presented throughout the section.

3.12.1 Population and Quality of Life

Sections 3.12.1.1 and 3.12.1.2 describe population changes for the ROI and the state of Texas overall. Past and existing population data is from the USCB, and projected population estimates are from the Texas Water Development Board (TWDB). Section 3.12.1.3 describes quality of life considerations, including recreational and aesthetic values and community cohesion. Demographic and economic indicators in Section 3.12.1.3 used to describe the level of community cohesion in Fannin County are from the USCB.

<u>Existing Population</u>

The 2010 estimated combined population of Fannin, Collin, Hunt, Lamar, Grayson, and Delta counties is 1,078,286, a net increase of 314,352 or 41 percent from the 2000 population of 763,934. As shown in Table 3.12-2, Collin County has the largest population of the five affected counties, and also experienced the largest percentage growth during this period (59 percent), significantly higher than the other six counties and Texas' 21 percent change. The total population of Collin County in 2010 was 782,341, the seventh largest county in the state and largest of the five affected counties. Hunt and Grayson counties experienced smaller, though still positive growth, at 12 and nine percent, respectively, over this same time period. Fannin County experienced positive growth at nine percent, while Lamar had the lowest positive growth at three percent. Delta County, the smallest in population size of the five counties experienced a two percent reduction in population (USCB, 2000 and 2010a).

Table 3.12-2. Population Change in ROI and Texas, 2000-2010

County	Population Estimates				
	2000	**2010**	**Numeric Change**	**Percent Change**	**Texas Ranking**
Fannin	31,242	33,915	2,673	8.6	88
Collin	491,675	782,341	290,666	59.1	7
Hunt	76,596	86,129	9,533	12.4	43
Lamar	48,499	49,793	1,294	2.6	63
Delta	5,327	5,231	-96	-1.8	203
Grayson	110,595	120,877	10,282	9.2	34
Total for Counties in ROI	**763,934**	**1,078,286**	**314,352**	**41.1**	**n/a**
All Counties in Texas	20,851,820	25,145,561	4,293,741	20.6	n/a

Sources: USCB, 2000 and 2010a.

Statewide, the population grew from 20,851,820 in 2000 to 25,145,561 in the 2010, a net increase of 4,293,741 or 21 percent. The Fannin, Hunt, Lamar, Grayson, and Delta county populations grew at rates slower than that of the state of Texas. The ten fastest-growing counties in Texas were either part of the Dallas-Fort Worth-Arlington, Houston-The Woodlands-Sugar Land, Austin-Round Rock, or the San Antonio-New Braunfels Metropolitan Statistical Areas. Of the thirteen counties that make up the Dallas Fort Worth Metroplex, three were in the top ten fastest-growing counties in the state: Rockwall, Collin, and Denton counties (USCB, 2000 and 2010a).

The USCB identifies two types of urban areas: Urbanized Areas (UAs) of 50,000 or more people and Urban Clusters (UCs) of at least 2,500 and less than 50,000 people. "Rural" encompasses all population, housing, and territory not included within an urban area (USCB, 2017). Nine of the ten fastest-growing counties in Texas are UAs, and one is an UC. Of the counties included in the ROI, Collin, Hunt, and Grayson counties are UAs, with populations greater than 50,000. Fannin, Delta, and Lamar counties are UCs, with populations between 2,500 and 50,000. None of the counties in the ROI are considered rural.

Figure 3.12-2 depicts population centers within Fannin County itself. The City of Bonham and Fannin County are both considered UCs, with populations greater than 2,500 and less than 50,000 people.

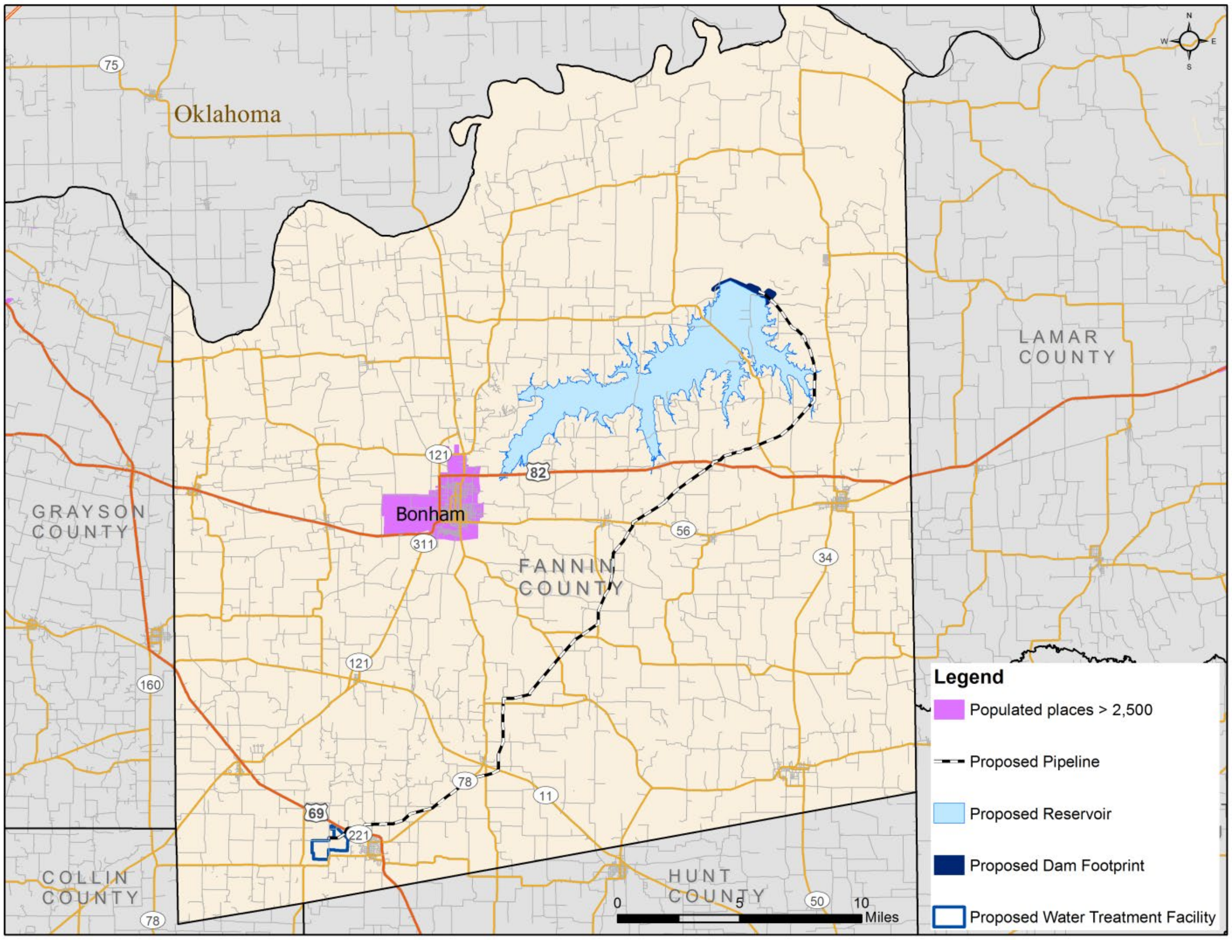


Figure 3.12-2. Population distribution in Fannin County

Projected Population Change

As seen in Table 3.12-3, the population of Texas is expected to increase from the 2010 level of 25.1 million to 46.3 million by 2060 (USCB, 2010a; TWDB, 2011a). Fannin County itself is expected to grow at a faster pace than the state over this same time span. The state population projections (not shown in Table 3.12-3) show the NTMWD's service population to increase from 1.5 million to 3.3 million by 2060 (TWDB, 2007).

The six-county ROI is expected to grow at a very fast pace well into the foreseeable future. As shown in Tables 3.12-3 and 3.12-4, Collin County is forecasted to be responsible for most of the six counties' growth. Collin County is expected to add over one million to its not-yet one million current population, an increase of 148 percent. Similarly, the population of Fannin County is expected to grow at over 156 percent in the next 50 years. Hunt County's population is expected to increase at the fastest rate: by 236 percent from the year 2010 to 2060. Currently, the outlook for Collin, Hunt, and Grayson counties' growths is at a considerably faster pace than the statewide growth. The other two counties would likely grow at a substantially slower rate than the statewide population over the six-decade interval. The projected percentage change in the ROI is expected to grow almost twice as fast as the projected statewide growth of 84 percent (USCB, 2010a; TWDB, 2011a).

Table 3.12-3. Projected ROI and Texas Populations, 2010-2060

County	Actual	Projected Population Levels				
	2010	2020	2030	2040	2050	2060
Fannin	33,915	42,648	49,775	60,659	74,490	86,970
Collin	782,341	1,046,601	1,265,373	1,526,407	1,761,082	1,938,067
Hunt	86,129	94,401	110,672	137,371	196,757	289,645
Lamar	49,793	56,536	60,286	64,036	64,036	64,036
Delta	5,231	6,244	6,744	7,244	7,244	7,244
Grayson	120,877	152,028	179,725	203,822	227,563	253,568
Total for Counties in ROI	**1,078,286**	**1,398,458**	**1,672,575**	**1,999,539**	**2,331,172**	**2,639,530**
All Counties in Texas	25,145,561	29,650,388	33,712,020	37,734,422	41,924,167	46,323,725

Sources: USCB, 2010a and TWDB, 2011.

Table 3.12-4. Projected Percentage Change in Population in ROI and Texas, 2010-2060

County	Projected Percentage Change in Population					
	2010-2020	2020-2030	2030-2040	2040-2050	2050-2060	2010-2060
Fannin	25.7	16.7	21.9	22.8	16.7	156.4
Collin	33.8	20.9	20.6	15.4	10.0	147.7
Hunt	9.6	17.2	24.1	43.2	47.2	236.2
Lamar	13.5	6.6	6.2	0	0	28.6
Delta	19.3	8.0	7.4	0	0	38.4
Grayson	25.8	18.2	13.4	11.6	11.4	109.8
Total for Counties in ROI	**29.7**	**19.6**	**19.5**	**16.6**	**13.2**	**144.8**
All Counties in Texas	17.9	13.7	11.9	11.1	10.5	84.2

Source: TWDB, 2011.

Quality of Life and Community Cohesion

Quality of life can be characterized as a person's well-being and happiness. Quality of life is a subjective measure and cannot be solidly defined. For this analysis, quality of life considerations focus on those elements that the public generally associates with a high quality of life: education, safety, recreation opportunities, access to transportation facilities, and a positive general living environment. Other factors, such as air quality and noise, could also contribute to a person's sense of quality of life. See sections 3.5, Air Quality and 3.6, Acoustic Environment (Noise) for more information about air quality and noise impacts.

Recreational and Aesthetic Values

The recreational value of natural resources can link residents to an area or attract new residents to an area. Environmental amenities like a reservoir can contribute to the region's identity, as well as the area's quality of life. Proximity to nature, in particular to public lands, can influence where people choose to live and how much people are willing to pay for housing (i.e., property values). Research indicates that people make regional housing and labor market decisions based in part on the availability of and proximity to public lands, such as state parks, national forests, and recreational lakes. Living near public lands provides amenities such as convenient access to recreation and wildlife viewing. Population movement and migration into environmentally desirable areas can be explained by the presence of, and density of, natural resources and associated environmental amenities (Garber-Yonts, 2004; Hand et al., 2008).

Landscape appearance and scenery can be important public land amenities, not just as recreational opportunity settings, but also as elements of the region's identity. Factors such as clean air and water quality, scenery and natural landscape, open space, and the number of recreational opportunities can be economic assets for local communities. A more detailed description of recreation opportunities in and around the project area is included in Section 3.7 (Recreation).

Community Cohesion

Community cohesion is the degree to which residents have a sense of belonging to their neighborhood or community, including commitment to the community or a strong attachment to neighbors, institutions, or particular groups. What makes a community cohesive is subjective and cannot be solidly defined, though specific indicators include interaction among neighbors, use of community facilities and services, community leadership, participation in local organizations, desire to stay in the community and length of residency, satisfaction with the community, and the presence of families in communities (FDOT, 2000).

Cohesive communities are associated with specific social characteristics which may include long average lengths of residency, frequent personal contact, ethnic homogeneity, high levels of community activity, and shared goals. Some studies indicate that single family home ownership, working class families, ethnic group clusters, mothers working at home, and the elderly correlate with active community participation and high community cohesion. Residential stability and longevity can be a strong neighborhood link. Other indicators include things like Neighborhood Watch programs, pedestrian activity, children at play, predominance of single family dwellings or apartment with courtyards, shared parking lots and yards of a housing complex, condition of houses, parks and other community facilities. The intensity of controversy may be an indicator of potential community disruption (CDOT, 1997).

Cohesion can be greatly affected by the physical layout of the community. The book *Image of the City* describes elements that help define the physical layout of a community: paths, edges, districts, and landmarks. These elements can encourage or hinder the social interaction in a community and are described below (Lynch, 1960).

- *Paths* are linear features such as roads and trails along which people and vehicles travel. Paths can encourage cohesion or create a physical separation that decreases cohesion.
- *Edges* are linear elements that separate the landscape and can include boundaries between different types of land use, boundaries of large developments, or major roads.
- *Districts* are areas of the community that have a distinctive character or degree of unity. The presence of districts, such as a historic downtown, is often a good indicator of community cohesion.
- *Landmarks* are points of reference in the community with which people can identify.

Community Cohesion Indicators: Fannin County

As documented in the 2010 Scoping Report in Appendix B, several commenters were concerned that an influx of "outsiders" – especially workers during the construction phase – could erode community cohesion. There was also concern that the culture of the area would change against the wishes of longtime residents due to influx of outsiders who may not share the same values (USACE, 2010c). Based on the community cohesion indicators discussed further below, news articles, and phone interviews with community leaders, Fannin County has a medium level of community cohesion.

Fifty-five percent of householders moved into their Fannin County unit after 2000. Said otherwise, 6,508 of the 11,824 occupied housing units in Fannin County were "newly" occupied in the last decade. Fannin County has a 74 percent homeownership rate and owner-occupied housing units (USCB, 2010b). Additionally, 71 percent of all households are family households (USCB, 2010a).

Of the 7,113 children under the age of 18 in Fannin County, 5,220 live with two parents. Approximately 36 percent of those children had only one parent in the labor force, and (presumably) one parent at home (USCB, 2010c). Additionally, 17 percent of Fannin County's population is over the age of 65, a relatively high concentration compared to the state of Texas (USCB, 2010a).

Because social classes lack clear boundaries and overlap, there are no definite income thresholds for what is considered "working class." Sociologist Leonard Beeghley identifies a combined household income of $66,000 as a typical working-class family (Beeghley, 2004). Sociologists William Thompson and Joseph Hickey estimate an income range of roughly $16,000 to 30,000 for the working class (Thompson and Hickey, 2005). The "working class" is typically associated with manual labor and a high school education. The 2010 median household income in Fannin County is $42,605; 82.6 percent are high school graduates or higher and 15 percent have a bachelor's degree or higher (USCB, 2010d; USCB, 2010e). Considering the two definitions described and for purposes of this analysis, Fannin County qualifies as a "working class" community.

Ethnic homogeneity, or monoculturalism, is a term used to describe an area whose population has a similar ethnic background. In Fannin County, over 80 percent of the population is identified as having "one race"; in this case, white (USCB, 2010a). As such, Fannin County is considered to be an area with ethnic homogeneity.

3.12.2 Labor

Because the NTMWD anticipates hiring local construction workers, civilian labor force, employment, and unemployment figures are presented for the ROI, as these would likely be directly affected by the implementation of either Alternative 1 or 2.

Labor Force

The size of a county's labor force is measured as the sum total of those currently employed and unemployed. People are classified as unemployed if they do not have a job, are looking for a job, and are available to work (BLS, 2015). As can be seen in Table 3.12-5, from 2000 through 2010 only the Collin County labor force grew at a rate faster than the state's. The labor forces of Fannin, Hunt, Lamar, and Grayson grew at small but still positive rates. Delta County's labor force actually shrank by almost 11 percent. Overall the labor force in the ROI increased 30.8 percent from 2000 to 2010, much higher than the statewide 17.3 percent, due to the overriding influence and rapid growth of Collin County's labor force within the ROI.

Table 3.12-5. Annual Labor Force Size in ROI and Texas, 2000-2010

County	Annual Labor Force			
	2000	2005	2010	Percent Change 2000-2010
Fannin	13,916	13,836	14,005	0.6
Collin	299,204	368,326	429,236	43.5
Hunt	38,797	38,608	39,708	2.3
Lamar	23,024	23,034	24,112	4.7
Delta	2,563	2,418	2,285	-10.8
Grayson	56,260	56,552	57,995	3.1
Total for Counties in ROI	**433,764**	**502,774**	**567,341**	**30.8**
All Counties in Texas	10,347,847	11,150,684	12,136,384	17.3

Source: TWC, 2011.

Employment

The unemployment rate is calculated based on the number of unemployed persons divided by the labor force, where the labor force is the number of unemployed persons plus the number of employed persons. Table 3.12-6 presents the annual employment levels in the six counties for the years 2000, 2005, and 2010. Collin County has the largest number of employed with 397,797 in 2010, representing a 36.9 percent increase from the 290,673 employed in 2000. Collin was the only county in the ROI to experience both a notable increase in employment overall as well as a positive percent change in employment consistently above the state's 12.6 percent. The number employed in Lamar County declined from 2000 to 2005, then increased from 2005 to 2010; with an overall 0.3 percent increase over the entire interval. The number employed in Fannin, Hunt, Delta, and Grayson counties decreased over the decade-long interval.

Table 3.12-6. Annual Employment in ROI and Texas

County	Number in Employment			
	2000	2005	2010	Percent Change 2000-2010
Fannin	13,238	12,957	12,698	-4.1
Collin	290,673	351,264	397,797	36.9
Hunt	37,149	36,510	33,365	-10.1
Lamar	21,880	21,610	21,942	0.3
Delta	2,432	2,285	2,082	-14.4
Grayson	53,970	53,524	53,071	-1.7
Total for Counties in ROI	**419,342**	**478,150**	**520,955**	**24.2**
All Counties in Texas	9,896,002	10,551,547	11,141,903	12.6

Source: TWC, 2011.

Unemployment Rates

From 2000 to 2010, Fannin and Lamar counties' annual unemployment rates have been consistently at or above the statewide averages. Collin County's unemployment rate has been consistently lower than the state's rate during this same time period. The unemployment rate in Grayson County was lower than the state level in 2000, and at or above the state level between 2001 and 2010. Hunt County's unemployment rate was lower than that for the state until 2006, at which point the rate increased above the state rate. Delta County's unemployment rate was higher than that of the state in 2000, below between 2002 and 2004, then remained above the statewide rate until 2010. Unemployment rates in the ROI and for the state are shown in Figure 3.12-3.

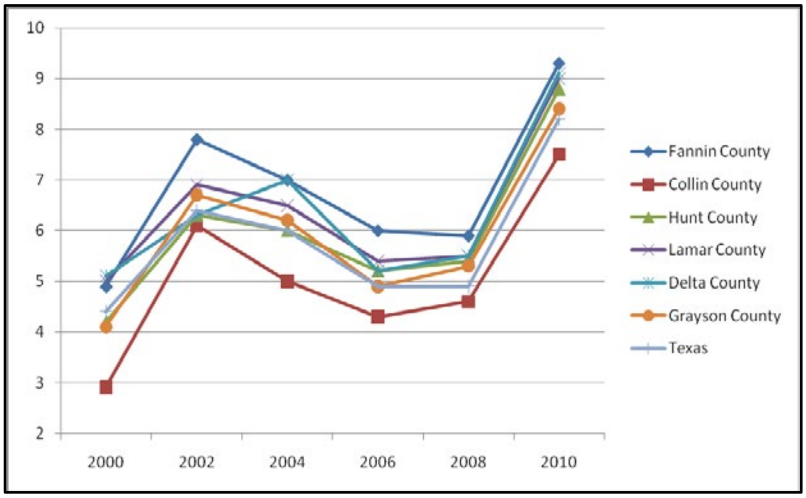


Figure 3.12-3. Annual Unemployment Rates in ROI and Texas, 2000-2010

Source: TWC, 2011

3.12.3 Earnings

Several measures are used to discuss earnings, including per capita personal income, total industry income, and compensation by industry. Personal income data are measured and reported for the county of residence. Per capita personal income is the personal income for county residents divided by the county's population. Compensation data, however, are measured and reported for the county of work location, and are typically reported on a per job basis. Compensation data indicate the wages and salaries for work done in a particular place (e.g., a county), but if the worker does not live in the county where the work occurred then a sizeable portion will be spent elsewhere. Most of the worker's expenditures will not remain in or flow back into that county's economy. Total compensation includes wages and salaries as well as employer contribution for employee retirement funds, social security, health insurance, and life insurance. Because the NTMWD anticipates hiring local construction workers, personal income and compensation data for the ROI are presented in the next several tables as they would likely be affected by Alternative 1 and 2.

Per Capita Personal Income

Personal income is the income received by all persons from all sources, or the sum of net earnings by a place of residence, property income, and personal current transfer receipts (BEA, 2011b). This includes earnings from work received during the period, interest and dividends received, and government transfer payments, such social security checks. It is measured before the deduction of personal income taxes and other personal taxes and is reported in current dollars.

Table 3.12-7 contains per capita personal income for the ROI and Texas for the years 2000, 2005, and 2010. All dollar estimates are in current dollars (not adjusted for inflation). For 2010, of the six counties, Collin ($48,229) had the highest personal income per capita. Grayson ($32,225), Lamar ($31,654), and Hunt ($31,504) followed; with Delta ($28,405) and Fannin ($27,939) having the smallest per capita personal incomes. All counties except Collin County had a smaller per capita income compared to the state average (BEA, 2011a).

Delta County experienced the largest percentage change in per capita income from 2000 to 2010 with an increase of 48.9 percent. All but Collin County had a percentage increase over the period greater than the state's. Not only was Collin the only one of the six counties with a percentage increase less than the 35.5 percent statewide increase, it experienced a comparably low percent change of 6.0 percent.

Table 3.12-7. Annual Per Capita Personal Income in ROI and Texas (in dollars)

County	Per Capita Personal Income			
	2000	2005	2010	Percent Change 2000-2010
Fannin	20,150	23,281	27,939	38.7
Collin	45,491	45,741	48,229	6.0
Hunt	23,055	26,888	31,504	36.6
Lamar	22,217	25,268	31,654	42.5
Delta	19,071	21,092	28,405	48.9
Grayson	23,285	26,532	32,225	38.4
All Counties in Texas	28,506	33,220	37,747	32.4

Note: not adjusted for inflation

Source: BEA, 2011a

Total Industry Compensation

Income is generated by economic activity through a variety of sectors related to business as well as government. "Total Industry Compensation," a term often used in economic data, is somewhat of a misnomer in that a portion of the "industry earnings" stem from government-related activity. Nevertheless, total industry compensation provides a good picture of the relative sizes of market-related or business activity performed in a county.

Total industry compensation is reported in terms of employee compensation for work in a sector. Compensation for work is broader than salaries and wages; it also includes employer contributions for employee retirement funds, social security, health insurance, and life insurance. These supplements to income comprise roughly 20 percent of total compensation. This income is not always received by a person in the county, because persons from neighboring counties may cross county lines to go to work. The employee compensation by industry is a measure of economic activity generated in the counties, regardless of where the employee resides. The 2010 total compensation of employees for each county in the ROI as well as all counties in the state of Texas is shown in Table 3.12-8. The compensation of employees working in Collin County is notably higher compared to the other five counties in the ROI.

Also, total compensation measures are presented "per job," meaning in terms of full-time and part-time wage and salary employment. Therefore, total average compensation per job is the compensation of employees received divided by total full-time and part-time wage and salary employment. In contrast, per capita personal income (discussed above in 3.12.3.1) includes government transfers to people who are not employed. 2010 total average compensation per job for each county in the ROI and for all counties in the state of Texas is also shown in Table 3.12-8 below.

Table 3.12-8. Total and Average Compensation of Employees in ROI, 2010

County	Average Compensation ($000)	Total Compensation ($000)
Fannin County	42,520	282,678
Collin County	64,285	19,663,877
Hunt County	50,585	1,482,862
Lamar County	42,256	849,167
Delta County	29,477	35,940
Grayson County	45,065	2,015,911
Total for Counties in ROI	**45,698**	**24,330,435**
All Counties in Texas	57,303	620,072,178

Source: BEA, 2011a

The counties in the ROI display a variety of business activity, and the sources of economic activity in the six counties are also individually discussed below. A table with 2010 compensation of employees by industry and the percent this compensation represents is included for each county in the pursuant sections.

Fannin County, Compensation by Industry

As shown in Table 3.12-9, Government and Government Enterprises account for a total of $146.5 million of the annual compensation of employees in 2010. The city of Bonham – the county seat – is home to Texoma Medical Clinic (TMC) Bonham Hospital (formerly known as the Red River Regional Hospital), which serves the area and operates a branch of Grayson County College. As such, the Health Care and Social Assistance sector was the second highest in annual compensation. The city of Bonham, known for its affordable property taxes and rent, is also unofficially known as "booming Bonham."

Table 3.12-9. Compensation of Employees by Industry in Fannin County, 2010

Industry Description	Compensation ($000)	Percent
Government and Government Enterprises	146,492	51.8
Retail Trade	29,674	10.5
Manufacturing	23,828	8.4
Wholesale Trade	14,248	5.0
Other Services Except Public Administration	12,799	4.5
Finance and Insurance	10,711	3.8
Construction	7,727	2.7
Transportation and Warehousing	6,643	2.4
Accommodation and Food Services	6,372	2.3
Utilities	6,234	2.2
Professional, Scientific, and Technical Services	5,072	1.8
Farm	4,821	1.7
Mining	2,353	0.8
Forestry, Fishing, Related Activities	1,822	0.6
Information	1,671	0.6
Real Estate and Rental and Leasing	1,566	0.6
Arts, Entertainment, Recreation	644	0.2

Industry Description	Compensation ($000)	Percent
Management of Companies	(D)	n/a
Administrative and Waste Services	(D)	n/a
Educational Services	(D)	n/a
Health Care and Social Assistance	(D)	n/a
Total Compensation of Employees	**282,678**	**99.9**

(D) Not shown to avoid disclosure of individual confidential information
*Note: Numbers may not add up to exactly 100 percent due to rounding
Source: BEA, 2011a

Like many rural counties in Texas, Fannin County saw its historical peak of economic activity around the turn of the 20th century. Cotton and corn production were the chief crops in an economy dominated by agricultural production. Later in the 20th century, dairy operations rose in prominence, but the county suffered tremendous economic losses during the depression years and after World War II (Clower, 2012). The only livestock to show promise during this time were beef cattle. The number of cattle increased considerably in the 1930s and continued to increase slowly during the rest of the century (TSHA, 2016).

Cotton production took a sharp decline during the 1950s, dropping by half to 24,928 bales in 1959. In 1987 only 337 bales were produced in the county. Corn steadily declined to only 496,557 bushels in 1987. Wheat, the only major agricultural product to increase in the late twentieth century in Fannin County, peaked in 1982 at 1,997,530 bushels. Peanuts and sorghum also increased production in the latter part of the twentieth century (TSHA, 2016).

The number of farms steadily decreased from its 1900 peak of 7,202 to only 1,533 in 1987. Stock farming moved from hogs and dairy cattle to beef cattle. Swine production slowly declined in the twentieth century to only a little over one thousand hogs in the 1980s. By 1987, Fannin County had nearly 65,000 beef cattle but only a few thousand dairy cattle. In 2002 the county had 1,976 farms and ranches covering 483,446 acres, 59 percent of which were devoted to crops, 32 percent to pasture, and 8 percent to woodland. That year farmers and ranchers in the area earned $57,364,000; livestock sales accounted for $37,683,000 of the total. Beef cattle, wheat, milo, corn, pecans, and hay were the chief agricultural products (TSHA, 2016).

Record-breaking droughts and temperatures in the last few years have compounded economic losses in Texas. The Texas AgriLife Extension Service economists reported that the 2011 drought caused agricultural losses totaling $7.6 billion. Livestock accounted for $3.23 billion in losses. Lost hay production was valued at $750 million, cotton at $2.2 billion, corn at $763 million, wheat at $314 million and sorghum at $385 million. The losses represent about 43 percent of the average value of agricultural production over the last four years (AgriLife, 2012).

Much of the land that would be inundated by the reservoir under Alternative 1 is agricultural. Fannin County assesses taxable values for agricultural land according to the nature of the land, the use of the land, and irrigation status. These valuations range from $65 per acre for native grasslands that are not irrigated to $323 per acre for irrigated land or land in horticultural uses (Clower, 2012).

Collin County, Compensation by Industry

Table 3.12-10 displays the compensation of employees by industry for Collin County in 2010. Government and Government Enterprises generated more employee compensation than did other sectors, accounting for nearly $2.3 billion. The Collin County Regional Airport, Collin Community College, and the Collin County Jail account for a large number of jobs. The manufacturing sector, a close second, is dominated by durable goods and computer and electronic product manufacturing. Texas Instruments, a worldwide manufacturer of semiconductors and computer technology, moved their flight operations to Collin County Regional Airport around 2008.

Table 3.12-10. Compensation of Employees by Industry in Collin County, 2010

Industry Description	Compensation ($000)	Percent
Government and Government Enterprises	2,314,273	11.8
Manufacturing	2,058,642	10.5
Professional, Scientific, and Technical Services	2,007,142	10.2
Finance and Insurance	1,959,089	10.0
Information	1,911,718	9.7
Health Care and Social Assistance	1,678,040	8.5
Retail Trade	1,408,688	7.1
Management of Companies	1,298,365	6.6
Wholesale Trade	1,198,676	6.0
Administrative and Waste Services	997,334	5.0
Construction	773,024	3.9
Accommodation and Food Services	585,617	3.0
Other Services Except Public Adm.	575,823	3.0
Real Estate and Rental and Leasing	346,340	1.7
Transportation and Warehousing	146,032	0.7
Mining	131,965	0.7
Arts, Entertainment, Recreation	106,211	0.5
Educational Services	105,045	0.5
Utilities	51,072	0.3
Farm	6,246	0.0
Forestry, Fishing, Related Activities	4,535	0.0
Total Compensation of Employees	**19,663,877**	**99.7**

*Note: Numbers may not add up to exactly 100 percent due to rounding.

Source: BEA, 2011a.

Hunt County, Compensation by Industry

Table 3.12-11 below displays the compensation of employees by industry for Hunt County in 2010. The manufacturing sector generated more employee compensation than did other sectors. Government and Government Enterprises, Health Care and Social Assistance, are the second and third sources of employee compensation. Greenville Municipal Airport is located in the City of Greenville, and the Hunt Regional Healthcare Hospital serves the county.

Table 3.12-11. Compensation of Employees by Industry in Hunt County, 2010

Industry Description	Compensation ($000)	Percent
Manufacturing	641,387	43.3
Government and Government Enterprises	337,302	22.7
Health Care and Social Assistance	98,370	6.6

Industry Description	Compensation ($000)	Percent
Retail Trade	95,350	6.4
Professional, Scientific and Technical Services	42,301	2.9
Wholesale Trade	41,929	2.8
Construction	39,312	2.7
Other Services Except Public Administration	38,817	2.6
Transportation and Warehousing	35,149	2.4
Accommodation and Food Services	34,691	2.3
Finance and Insurance	31,841	2.1
Utilities	14,214	0.1
Information	11,946	0.8
Real Estate and Rental and Leasing	9,331	0.6
Educational Services	4,636	0.3
Farm	4,232	0.3
Arts, Entertainment, Recreation	2,054	0.1
Forestry, Fishing, and Related Activities	(D)	n/a
Mining	(D)	n/a
Management of Companies	(D)	n/a
Administrative and Waste Services	(D)	n/a
Total Compensation of Employees	**1,482,862**	**99.0**

(D) Not shown to avoid disclosure of individual confidential information

*Note: Numbers may not add up to exactly 100 percent due to rounding.

Source: BEA, 2011a.

Lamar County, Compensation by Industry

Table 3.12-12 below displays the compensation of employees by industry for Lamar County in 2010. In 2010, manufacturing was the leader in employee compensation, totaling $262.8 million. The county is home to several historic homes, in addition to a 65-foot high replica of the Eiffel Tower in the City of Paris, its county seat. Government and Government Enterprises and Health Care and Social Assistance are close second and third sources of employee compensation. Paris has one major hospital divided into two campuses: Paris Regional Medical Center South (formerly St. Joseph's Hospital) and Paris Regional Medical Center North (formerly McCuistion Regional Medical Center). It serves as the center for healthcare in much of Northeast Texas and Southeast Oklahoma. Both campuses are now operated jointly under the Paris Regional Medical Center, a division of Essent Healthcare. The health network is the largest employer in the Paris area.

Table 3.12-12. Compensation of Employees by Industry in Lamar County, 2010

Industry Description	Compensation ($000)	Percent
Manufacturing	262,826	31.0
Government and Government Enterprises	150,171	17.7
Health Care and Social Assistance	126,284	14.9
Retail Trade	71,386	8.4
Construction	57,845	6.8

Industry Description	Compensation ($000)	Percent
Finance and Insurance	34,102	4.0
Other Services Except Public Administration	25,958	3.1
Accommodation and Food Services	25,804	3.0
Administrative and Waste Services	22,206	2.6
Transportation and Warehousing	18,228	2.1
Utilities	18,200	2.1
Wholesale Trade	16,352	1.9
Information	6,848	0.8
Arts, Entertainment, Recreation	4,794	0.6
Real Estate and Rental and Leasing	4,004	0.5
Farm	3,061	0.4
Educational Services	1,098	0.1
Forestry, Fishing, Related Activities	(D)	n/a
Mining	(D)	n/a
Professional, Scientific, and Technical Services	(D)	n/a
Management of Companies	(D)	n/a
Total Compensation of Employees	**849,167**	**100.0**

(D) Not shown to avoid disclosure of individual confidential information

Source: BEA, 2011a.

Delta County, Compensation by Industry

As shown in Table 3.12-13, the three largest generators of compensation for employees in Delta County in 2010 are the 1) Government and Government Enterprises, and 2) Health Care and Social Assistance, and 3) Wholesale Trade sectors.

Table 3.12-13. Compensation of Employees by Industry in Delta County, 2010

Industry Description	Compensation ($000)	Percent
Government and Government Enterprises	14,205	39.5
Health Care and Social Assistance	10,410	29.0
Wholesale Trade	9,629	26.8
Farm	1,000	2.8
Retail Trade	696	1.9
Mining	0	0
Educational Services	0	0
Construction	(D)	n/a
Forestry, Fishing, Related Activities	(D)	n/a
Manufacturing	(D)	n/a
Transportation and Warehousing	(D)	n/a
Utilities	(D)	n/a
Information	(D)	n/a

Industry Description	Compensation ($000)	Percent
Real Estate and Rental and Leasing	(D)	n/a
Finance and Insurance	(D)	n/a
Professional, Scientific, and Technical Services	(D)	n/a
Management of Companies	(D)	n/a
Administrative and Waste Services	(D)	n/a
Arts, Entertainment, Recreation	(D)	n/a
Accommodation and Food Services	(D)	n/a
Other Services Except Public Administration	(D)	n/a
Total Compensation of Employees	**35,940**	**100.0**

(D) Not shown to avoid disclosure of individual confidential information

Source: BEA, 2011a.

Grayson County, Compensation by Industry

As shown in Table 3.12-14, the manufacturing sector led employee compensation, primarily manufacturing durable goods and computer and electronic products. In 2010, Manufacturing Consortium partnered with Grayson Community College – which operates a branch campus in Sherman - to provide job training using a Texas Workforce Commission (TWC) grant. Closely behind the manufacturing sector: Health Care and Social Assistance and Government and Government Enterprises. The Texas Department of Criminal Justice operates the Sherman District Parole Office in Sherman, and the United States Postal Service operates the Sherman Post Office.

Table 3.12-14. Compensation of Employees by Industry in Grayson County, 2010

Industry Description	Compensation ($000)	Percent
Manufacturing	418,827	20.8
Health Care and Social Assistance	381,398	18.9
Government and Government Enterprises	332,764	16.5
Retail Trade	173,955	8.6
Construction	115,462	5.7
Finance and Insurance	113,282	5.6
Accommodation and Food Services	77,613	3.9
Other Services Except Public Administration	65,427	3.2
Administrative and Waste Services	61,915	3.1
Wholesale Trade	61,665	3.1
Transportation and Warehousing	48,387	2.4
Professional, Scientific, and Technical Services	38,248	1.9
Educational Services	25,469	1.2
Information	22,577	1.1
Utilities	21,131	1.0
Arts, Entertainment, Recreation	16,073	0.8
Real Estate and Rental and Leasing	16,004	0.8
Mining	13,730	0.7

Industry Description	Compensation ($000)	Percent
Farm	6,543	0.3
Forestry, Fishing, Related Activities	3,697	0.2
Management of Companies	1,744	0.0
Total Compensation of Employees	**2,015,911**	**99.8**

(D) Not shown to avoid disclosure of individual confidential information

*Note: Numbers may not add up to exactly 100 percent due to rounding.

Source: BEA, 2011a.

3.12.4 Public Finance

The primary non-federal taxation in the local area is of property and retail sales. Property taxes are dependent upon the appraised value of the property for taxation purposes and on the property tax rates. In the short-term, the proposed project would affect taxable land that would be cleared for reservoir impoundment, including agricultural and timberlands. In the long-term, property taxation could change with new housing construction and business development and recruitment. As such, property taxation is discussed in 3.12.4.1 and 3.12.4.2.

Retail sales that are qualified for taxation are taxed at a state sales tax plus potential county and city tax rates. Part of these taxes helps fund schools in the local area. The proposed project could also affect retail sales and the associated taxable sales and local sales dollars returned to each county. In the short-term, these changes would be associated with the purchase of construction materials and construction worker spending in the ROI. In the long-term, these changes would be associated with non-local recreational spending as well as new permanent and weekend residents. As such, retail sales taxation is discussed in 3.12.4.3 and taxable sales and local sales dollars returned to the counties are discussed in 3.12.4.4.

Property Taxation

The FCAD is responsible for appraising properties within the county boundaries. The FCAD has jurisdiction over Fannin County; the cities in Fannin County (Bailey, Bonham, Dodd City, Ector, Honey Grove, Ladonia, Leonard, Pecan Gap, Savoy, Trenton, and Windom); and several Independent School Districts (ISDs), some of which are split with surrounding counties. The ISDs include Blue Ridge ISD (Split with Collin County), Bonham ISD, Dodd City ISD, Ector ISD, Fannindel ISD (Split with Delta County), Honey Grove ISD, Leonard ISD (Split with Hunt County), North Lamar ISD (Split with Lamar County), Savoy ISD, Sam Rayburn ISD, Trenton ISD (Split with Collin County), Whitewright ISD (Split with Grayson County), and Wolfe City ISD (Split with Hunt County).

As shown in Table 3.12-15, the district is comprised of 33,246 property accounts. Under the standards of the Property Tax Assistance Division (PTAD), properties are classified by type. Table 3.12-15 also shows the various property types and their percent of the overall parcel count and market value, respectively. Single Family Residences and Qualified Agricultural Land represent the largest property types, both in terms of size and market value (FCAD, 2012).

Table 3.12-15. Property Types Appraised in Fannin County Appraisal District (2012)

PTAD Classification	Property Type	Parcel Count	Market Value	Parcel Count (%)	Market Value (%)
A	Single Family Residences	9,424	$596,211,346	28.3	35.3
B	Multi-family Residences	11	$13,602,272	0.4	0.5
C	Vacant Lots	1814	$14,082,180	5.5	0.5
D1	Qualified Ag Land	9,050	$947,204,160	27.2	35.3
D2	Non-Qualified Ag Land	2,173	$90,039,809	6.5	3.4
E	Farm Improvement	5,226	$351,000,548	15.7	13.1
F1	Commercial Real Property	965	$82,280,291	2.9	3.1
F2	Industrial Real Property	70	$27,342,890	0.2	1.0
G1	Oil and Gas Properties	10	$13,799	0.0	0.0
J	Utilities Properties	377	$126,763,680	1.1	4.7
L1	Business Personal Property	1268	$38,285,390	3.8	1.4
L2	Industrial Personal Property	234	$34,462,050	0.7	1.3
M1	Manufactured Housing	284	$3,755,980	0.9	0.1
O	Residential Inventory	256	$2,121,810	0.8	0.1
S	Special Inventory	27	$7,071,730	0.1	0.3
X	Exempt Property	1,951	$346,005,650	5.9	12.9
	Total	**33,246**	**$2,680,243,585**	**100**	**100**

Source: FCAD, 2012.

The Chief Appraiser certified market and taxable values to each taxing jurisdiction on July 17, 2012. The values are included in Table 3.12-16.

Table 3.12-16. Certified Market and Taxable Values by Jurisdiction (2012)

Entity	Parcel Count	Market Value	Net Taxable Value
City of Bailey	149	$5,437,809	$4,338,525
City of Bonham	4,925	$448,303,779	$289,201,349
City of Dodd City	294	$14,814,190	$9,622,624
City of Ector	386	$22,479,559	$15,569,568
City of Honey Grove	1,365	$72,823,985	$50,246,661
City of Ladonia	665	$19,688,366	$13,944,076
City of Leonard	1,168	$82,203,744	$59,758,643
City of Pecan Gap	11	$570,260	$528,170
City of Savoy	481	$31,043,759	$18,485,981
City of Trenton	616	$47,949,936	$29,422,380
City of Whitewright	2	$108,870	$108,870
Town of Windom	203	$8,378,017	$6,312,687
Fannin County	28,385	$2,770,629,917	$1,460,523,745

Entity	Parcel Count	Market Value	Net Taxable Value
Blue Ridge ISD in Fannin	46	$4,211,740	$1,678,251
Bonham ISD	10,823	$1,078,126,529	$580,839,424
Dodd City ISD	1,192	$100,423,231	$41,278,876
Ector ISD	951	$109,484,211	$36,928,595
Fannindel ISD	1,504	$92,126,665	$38,229,360
Honey Grove ISD in Fannin	4,424	$389,882,037	$157,819,502
Leonard ISD in Fannin	2,391	$230,748,400	$130,574,054
North Lamar ISD in Fannin	12	$5,486,040	$2,126,950
Sam Rayburn ISD	2,472	$278,285,169	$89,277,972
Savoy ISD	1,600	$177,848,298	$85,158,712
Trenton ISD in Fannin	2,393	$239,055,258	$141,774,513
Whitewright ISD in Fannin	464	$45,666,853	$20,972,870
Wolfe City ISD in Fannin	128	$16,186,697	$4,986,333

Source: FCAD, 2012.

As shown in Table 3.12-17, the total appraised value available for county taxation in Fannin County in 2012 was almost $1.5 billion. Table 3.12-17 also includes the property tax rate for each county. Delta County has the highest property tax rate, with a rate of $0.877440 of tax per $100 of a property's assessed value. Next highest is Fannin County, with a rate of $0.605100 per $100; which is $0.27 less per $100 in assessed property value compared to Delta. Collin County has the lowest rate with $0.24 of tax per $100, which is more than $0.60 less per $100 in assessed property value than in Delta County.

Table 3.12-17. Total Appraised Property Value in ROI, 2012

County	Total Appraised Value Available for County Taxation	Total County Property Tax Rate*
Fannin	$1,460,378,298	0.605100
Collin	$74,583,795,911	0.24
Hunt	$4,285,597,282	0.527534
Lamar	$2,767,639,762	0.438700
Delta	$201,037,738	0.877440
Grayson	$6,631,509,595	0.4909

* Dollar per $100 of assessed property value

Source: TCPA, 2012a and 2012b.

Agriculture and Timber

Fannin County assesses taxable values for agricultural land according to the use of the land, and the nature of the land and its irrigation status. In 2005, 37 percent of the parcels in Fannin County were appraised as agricultural land and 17 percent farm and ranch improvement. Most of the land that would be inundated with implementation of the proposed project is agricultural. These valuations range from $65 per acre for native grasslands that are not irrigated to $323 per acre for irrigated land or land in horticultural uses (Clower, 2012).

As discussed above and shown in Table 3.12-15, the FCAD appraised 33,246 property accounts, or parcels, in 2012. Sub-classifications for agricultural and timberland include irrigated cropland; dry land cropland; barren/ wasteland; orchards; improved pasture; native pasture; temporary quarantined land; timber at productivity; timberland at 1978 market value; timberland at restricted use; transition to timber; wildlife management; and other agricultural land as defined in Tax Code Section 23.51 (2) (TCPA, 2012a). As shown in Table 3.12-18, in 2012, 27.2 percent of parcels in Fannin County were appraised as agricultural land. These 9,050 parcels are equal to $947,204,160 in market value; or 35.3 percent of the county's total market value. Table 3.12-18 shows the parcel count, market value, and their percent of the overall parcel count and market value for the four agricultural and timberland property types (FCAD, 2012).

Table 3.12-18. Appraised Agricultural and Timberland in Fannin County (2012)

PTAD Classification	Property Type	Parcel Count	Market Value	Parcel Count (%)	Market Value (%)
D1	Qualified Ag Land	9,050	$947,204,160	27.2	35.3
D2	Non-Qualified Ag Land	2,173	$90,039,809	6.5	3.4
E	Farm Improvement	5,226	$351,000,548	15.7	13.1
X	Exempt Property	1,951	$346,005,650	5.9	12.9

Source: FCAD, 2012

Farmers and ranchers are not exempt entities; nor are all purchases by farmers and ranchers exempt from sales tax. Sales of some agricultural items, however, are always exempt, regardless of who is buying the item or how it will be used. Non-taxable agricultural items include seeds and annual plants such as corn, oats, soybeans, and cotton seed (the products of which are commonly recognized as food for humans or animals); animals including cattle, sheep, poultry and swine (the products of which are ordinarily food); horses and mules; water; feed for farm and ranch animals or wild game including oats, hay, chicken scratch, wild bird seed and deer corn. Other agricultural items are taxable unless purchased for exclusive use on a commercial farm or ranch in the production of agricultural products for sale. "Exclusively used" means the item must be used 100 percent of the time on a commercial farm or ranch in the production of food or other agricultural products. For example, a tractor used exclusively on a commercial farm to plow fields, mow hay and harvest crops qualifies for exemption. But, the tractor does not qualify for the exemption if it is used for any non-qualifying activity such as providing an amusement service (i.e. hayrides), or if it is used on any property other than a commercial farm or ranch for any reason. A tractor used to mow grass on a utility line right-of-way does not qualify for exemption (TCPA, 2011a).

For sales tax purposes, a farm or ranch is land used wholly or in part in the production of crops, livestock and/or other agricultural products held for sale in the regular course of business. Examples of farms and ranches include commercial greenhouses, feed lots, dairy farms, poultry farms, commercial orchards and similar commercial agricultural operations. A farm or ranch is not a home garden, timber operation, kennel, land used for wildlife management or conservation, land used as a hunting or fishing lease or similar types of operations that do not result in the sale of agricultural products in the normal course of business.

Certain items used exclusively in the production of timber for sale in the regular course of business qualify for exemption from Texas sales and use tax. Timber production includes activities to prepare the production site, and to plant, cultivate, or harvest commercial timber that will be sold in the regular course of business; and the construction, repair, and maintenance of private roads and lanes exclusively used for access to commercial timber sites (TCPA, 2012c).

Real property, including certain leasehold interests, and personal property are taxable. Real property is the rights, interests and benefits connected with real estate. Section 1.04 of the Property Tax Code defines real property to include standing timber (Texas A&M, 2011). The main natural resource in

Fannin County is timber. Consequently, wood-product manufacture has been important in the local economy (TSHA, 2016). Large swaths of clearcut bottomland timber are already visible in the proposed project area, as landowners, in anticipation of the proposed project, sell off their timber to make additional income before selling the land.

Retail Sales Taxation

The state of Texas retail sales tax stands at 6.25 percent. Local sales taxes vary by county and by city. As displayed in Table 3.12-19, most counties in the local area have a retail sales tax of 0.5 percent, but as in the case of Collin and Grayson Counties, some have none. In addition, as is common in Texas, most cities and towns in the local area impose additional tax rates of one to two percent on retail sales.

Table 3.12-19. Retail Sales Tax Rates in ROI

County	City	Retail Sales Tax Rate (%)	Total State and Local Tax Rate (%)
Fannin	–	0.5	6.75
	Bailey	1.0	7.75
	Bonham	1.5	8.25
	Dodd	1.0	7.75
	Ector	1.0	7.75
	Honey Grove	1.5	8.25
	Ladonia	1.0	7.75
	Leonard	1.5	8.25
	Ravenna	1.0	7.75
	Savoy	1.5	8.25
	Trenton	1.5	8.25
	Windom	1.0	7.75
Collin	–	0.0	6.25
	Allen	2.0	8.25
	Anna	2.0	8.25
	Blue Ridge	2.0	8.25
	Celina	2.0	8.25
	Dallas	1.0	7.25
	Fairview	0.0	6.25
	Farmersville	2.0	8.25
	Frisco	2.0	8.25
	Garland	0.0	6.25
	Josephine	1.0	7.25
	Lavon	1.5	7.75
	Lowry Crossing	1.0	7.25
	Lucas	1.0	7.25
	McKinney	2.0	8.25
	Melissa	2.0	8.25
	Murphy	2.0	8.25
	Nevada	1.75	8.00
	New Hope	1.0	7.25
	Parker	1.0	7.25

County	City	Retail Sales Tax Rate (%)	Total State and Local Tax Rate (%)
	Plano	1.0	7.25
	Princeton	2.0	8.25
	Prosper	2.0	8.25
	Richardson	1.0	7.25
	Royse	2.0	8.25
	Sachse	1.5	7.75
	St. Paul	1.0	7.25
	Van Alstyne	2.0	8.25
	Weston	1.0	7.25
	Wylie	2.0	8.25
Hunt	–	0.5	6.75
	Caddo Mills	1.5	8.25
	Campbell	1.25	8.0
	Celeste	1.25	8.0
	Commerce	1.5	8.25
	Greenville	1.5	8.25
	Hawk Cove	1.0	7.75
	Josephine	1.0	7.75
	Lone Oak	0.0	6.75
	Neylandville	1.0	7.75
	Quinlan	1.5	8.25
	Roys	2.0	8.75
	Union Valley	1.0	7.75
	West Tawakoni	1.5	8.25
	Wolfe	1.5	8.25
Lamar	–	0.5	6.75
	Blossom	1.25	8.0
	Deport	1.0	7.75
	Paris	1.5	8.25
	Reno	1.0	7.75
	Roxton	1.0	7.75
	Sun Valley	1.0	7.75
	Toco	1.0	7.75
Delta	–	0.5	6.75
	Cooper	1.0	7.75
	Pecan	1.0	7.75
Grayson	–	0.0	6.25
	Bells	2.0	8.25
	Collinsville	2.0	8.25
	Denison	2.0	8.25
	Dorchester	1.0	7.25

County	City	Retail Sales Tax Rate (%)	Total State and Local Tax Rate (%)
	Gunter	2.0	8.25
	Howe	2.0	8.25
	Knollwood	2.0	8.25
	Pottsboro	2.0	8.25
	Sadler	1.0	7.25
	Sherman	2.0	8.25
	Southmayd	2.0	8.25
	Tioga	2.0	8.25
	Tom Bean	2.0	8.25
	Van Alstyne	2.0	8.25
	Whitesboro	2.0	8.25
	Whitewright	2.0	8.25

Source: TCPA, 2011b

Taxable Sales and Local Sales Dollars Returned

Table 3.12-20 shows taxable sales in the local area from 2005-2010. Collin County has the most sales subject to state and local sales taxes, with $9.5 billion in 2010. The next highest amount of taxable sales is just under $1 million in Grayson County, which represents approximately 10 percent of Collin County's total.

Table 3.12-20. Taxable Sales in ROI (in $1,000s)

County	2005	2006	2007	2008	2009	2010
Fannin	100,598	105,509	110,519	113,708	109,830	109,400
Collin	8,020,256	8,870,383	9,604,264	9,534,874	9,019,346	9,549,447
Hunt	535,328	490,356	527,664	533,400	536,932	540,892
Lamar	365,690	393,485	398,412	420,033	404,866	406,938
Delta	7,690	7,058	6,330	6,162	6,230	6,657
Grayson	942,929	1,006,651	1,054,571	1,061,146	1,001,111	995,342
Total	**9,972,491**	**10,873,442**	**11,701,760**	**11,669,323**	**11,078,315**	**11,608,676**

Source: TCPA, 2010a

Table 3.12-21 shows the allocation historical summary of total dollars returned to a local sales taxing city, county, special purpose district or transit authority by the Comptroller's office for their local sales tax collection. Collin County, by far the largest in taxable sales of the five counties, does not impose a county sales tax, while most of the individual cities within do. Grayson County, like Collin County, also does not impose a county sales tax, while its individual cities do levy sales taxes.

Table 3.12-21. Local Sales Taxes Returned to the Counties in ROI by the Texas Comptroller of Public Accounts (in dollars)

County	2005	2006	2007	2008	2009	2010
Fannin	599,276	710,162	719,443	944,226	782,322	708,672
Collin	0.0	0.0	0.0	0.0	0.0	0.0
Grayson	0.0	0.0	0.0	0.0	0.0	0.0

County	2005	2006	2007	2008	2009	2010
Hunt	2,517,479	2,669,123	2,884,755	2,945,433	2,909,476	2,991,815
Lamar	2,157,350	2,293,670	2,328,929	2,830,631	3,199,651	2,517,828
Delta	51,939	77,500	44,987	49,662	56,593	56,238

Source: TCPA, 2010b

3.12.5 Summary of Socioeconomics

The socioeconomics section above identifies aspects of the social and economic environment sensitive to change and that may be affected by the proposed actions. Fannin County is the primary focus of any direct impacts that may occur. The five surrounding counties are also included in the ROI, since indirect impacts are expected, though to a lesser extent.

Population – The existing population, projected population change, as well as community cohesion and quality of life, are all described for the ROI.

- The 2010 estimated combined population of Fannin, Collin, Hunt, Lamar, Grayson, and Delta counties is over one million, a net increase of about 40 percent since 2000.
- The six-county ROI is expected to grow by almost 150 percent by 2060, almost twice as fast as the projected statewide growth.
- Concern exists that an influx of "outsiders" – especially workers during the construction phase – could erode community cohesion. Community cohesion is the degree to which residents have a sense of belonging to their neighborhood or community. Fannin County has a medium level of community cohesion, qualifies as a "working class" community, and is considered to be an area with relative ethnic homogeneity

Labor – The size of the civilian labor force, employment, and unemployment rates from 2000-2010 describe the size and availability of workers in the ROI.

- The labor forces of Fannin, Hunt, Lamar, and Grayson counties have grown slightly since 2000. Only Collin County's labor force grew at a rate higher than the state's.
- Annual employment in Fannin, Hunt, Delta and Grayson counties decreased from 2000 to 2010, increased slightly in Lamar County, and grew by 37 percent in Collin County.
- Fannin and Lamar counties have had unemployment rates consistently at or above the statewide averages from 2000 through 2010.

Earnings – Measures such as per capita personal income, total industry income, and compensation by industry describe earnings in the ROI.

- Collin County had the highest per capita personal income in 2010. All counties except Collin had a per capita income smaller than the statewide average. All but Collin County had more than a 30 percent increase in income from 2000-2010.
- The average compensation per job for 2010 was just under $30,000 for Delta County; approximately $40,000 for Fannin, Lamar, and Grayson counties; just over $50,000 for Grayson County; and approximately $65,000 for Collin County.
- The Government and Government Enterprises, Manufacturing, and Health Care and Social Assistance sectors generated the most compensation of employees for all counties in the ROI.

Public Finance – The primary non-federal taxation in the local area is of property and retail sales. A portion of these taxes help fund schools in the local area.

- The total appraised value available for county taxation in Fannin County in 2010 was almost $1.5 billion. In 2005, 37 percent of Fannin County parcels were appraised as agricultural land and 17 percent as farm and ranch improvement.
- The Texas retail sales tax is 6.25 percent; however, local sales taxes vary. Most counties in the local area have a retail sales tax of 0.5 percent, but Collin and Grayson have no retail sales tax.
- Collin County had the most sales subject to state and local sales taxes, with $9.5 billion in 2010. The next highest amount of taxable sales is just under $1 billion in Grayson County. Neither imposes a county sales tax, while the other four counties do.

3.13 ENVIRONMENTAL JUSTICE AND PROTECTION OF CHILDREN

Executive Order (EO) 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (The White House, February 11, 1994), requires that federal agencies consider as a part of their action, any disproportionately high and adverse human health or environmental effects to minority and low income populations. Agencies are required to ensure that these potential effects are identified and addressed.

EO 13045 "Protection of Children from Environmental Health Risks and Safety Risks" (The White House, April 21, 1997), places a high priority on the identification and assessment of environmental health and safety risks that may disproportionately affect children. The EO requires that each agency "shall ensure that its policies, programs, activities, and standards address disproportionate risks to children." It considers that physiological and social development of children makes them more sensitive than adults to adverse health and safety risks and recognizes that children in minority and low-income populations are more likely to be exposed to and have increased health and safety risks from environmental contamination than the general population.

3.13.1 Environmental Justice

The EPA defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." The goal of "fair treatment" is not to shift risks among populations, but to identify potential disproportionately high adverse impacts on minority and low-income communities and identify steps to mitigate any adverse impacts. For purposes of assessing environmental justice under NEPA, the Council on Environmental Quality (CEQ) defines a minority population as one in which the percentage of minorities exceeds 50 percent or is substantially higher than the percentage of minorities in the general population or other appropriate unit of geographic analysis (CEQ, 1997).

Alternative 1 would include the construction of a 16,641-acre reservoir and a 35-mile pipeline from the proposed reservoir site to a water treatment plant (WTP) and terminal storage reservoir (TSR) near the City of Leonard in southwest Fannin County. As such, Fannin County represents the primary focus and region of influence (ROI) for any direct and indirect impacts related to environmental justice and protection of children that may be associated with the implementation of either action alternative. For purposes of this analysis, the five surrounding counties – Collin, Hunt, Lamar, Delta, and Grayson – are defined as the region of comparison (ROC), or appropriate units of geographic analyses and the general population. For additional context, data is also provided for the state of Texas. The blending portion of Alternative 2 would also include a 25-mile water pipeline from Texoma to the balancing reservoir near Howe, Texas in Grayson County. For this portion of the project, Grayson County is also considered the ROI for any direct and indirect impacts. And for purposes of comparison for this portion of the project, Fannin, Collin, Hunt, Cooke, and Denton counties are defined as the geographic units of analyses and the "general" population.

Due to the site-specific nature of the proposed project, United States Census Bureau (USCB) block group (BG) and census tract (CT) data were used to identify high concentration "pockets" of environmental justice populations near the project area, defined as the dam and reservoir (impoundment area) and water pipeline. Figures 3.13-1, 3.13-2, and 3.13-3 help describe the distribution of minorities, low-income populations, and children in the vicinity of the project area.

Minority Populations

The CEQ defines "minority" as including the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic Origin; or Hispanic (CEQ, 1997). Data presented in Table 3.13-1 were based on the USCB's 2010 decennial census. BG and county level census data are used where appropriate throughout the section.

The CEQ defines a minority population in one of two ways:

1. "…If the percentage of minorities exceeds 50 percent..." (CEQ, 1997). In this more straightforward scenario, if more than 50 percent of the Fannin County or Grayson County population consists of minorities (the sum of minority groups), this would qualify the county as comprising an environmental justice population.
2. "…[If the percentage of minorities] is substantially higher than the percentage of minorities in the general population or other appropriate unit of geographic analysis" (CEQ, 1997). For purposes of the analysis, under Alternative 1 and 2, a discrepancy of 10 percent or more between minorities (the sum of all minority groups) in Fannin County as compared to the surrounding five counties (Collin, Grayson, Hunt, Lamar, Delta) or the state of Texas would be considered "substantially" higher. Any discrepancy higher than 10 percent would categorize Fannin County as an environmental justice population. For Alternative 2, a discrepancy of 10 percent or more between minorities in Grayson County as compared to the surrounding five counties (Collin, Fannin, Cooke, Denton, and Hunt) or the state of Texas would be considered "substantially" higher and would categorize Grayson County as an environmental justice population.

Table 3.13-1 summarizes minority population groups in Fannin, Collin, Delta, Hunt, Cooke, Denton, Grayson, and Lamar counties as well as the state of Texas.

Table 3.13-1. Summary of Minority and Minority Groups in the ROI and ROC [a]

County	Total Population	Minority *(%)*	American Indian and Alaska Native *(%)*	Black or African American *(%)*	Asian *(%)*	Native Hawaiian and Other Pacific Islander *(%)*	Hispanic or Latino *(%)*
Fannin[b]	33,915	6,039 *(17.8)*	369 *(1.1)*	2,312 *(6.8)*	125 *(0.4)*	7 *(0.0)*	3,226 *(9.5)*
Collin	782,341	274,389 *(35.1)*	4,448 *(0.6)*	66,387 *(8.5)*	87,752 *(11.2)*	448 *(0.1)*	115,354 *(14.7)*
Lamar	49,793	10,947 *(22.0)*	700 *(1.4)*	6,703 *(13.5)*	311 *(0.6)*	10 *(0.0)*	3,223 *(6.5)*
Delta	5,231	770 *(14.7)*	72 *(1.4)*	380 *(7.3)*	30 *(0.6)*	0 *(0.0)*	288 *(5.5)*
Hunt	86,129	20,751	804	7,133	916	147	11,751

County	Total Population	Minority (%)	American Indian and Alaska Native (%)	Black or African American (%)	Asian (%)	Native Hawaiian and Other Pacific Islander (%)	Hispanic or Latino (%)
		(24.1)	*(0.9)*	*(8.3)*	*(1.1)*	*(0.2)*	*(13.6)*
Grayson[c]	120,877	23,691 *(19.6)*	1,835 *(1.5)*	7,081 *(5.9)*	1,046 *(0.9)*	41 *(0.0)*	13,688 (11.3)
Cooke	38,437	38,437 *(20.2)*	402 *(1.0)*	1,054 *(2.7)*	290 (0.8)	19 *(0.0)*	5997 *(15.6)*
Denton	662,614	224,861 (33.9)	4,551 *(0.7)*	55,534 *(8.4)*	43,478 *(6.6)*	462 *(0.1)*	120,836 *(18.2)*
All Counties in Texas	25,145,561	13,597,743 *(54.1)*	170,972 *(0.7)*	2,979,598 *(11.8)*	964,596 *(3.8)*	21,656 *(0.1)*	9,460,921 *(37.6)*

[a] Percentage of total population in parentheses
[b] ROI for Alternative 1
[c] Also part of ROI for Alternative 2
Source: USCB, 2010a

As Table 3.13-1 indicates, Fannin County does not meet the regulatory definition of a minority population. Fannin County's population consists of approximately 18 percent minorities, compared to Collin County's 35 percent; Lamar County's 22 percent; Grayson County's 20 percent; Hunt County's 24 percent; and Delta County's 15 percent (USCB, 2010a). The percentage of minorities in Fannin County is higher than the percentage of minorities in Delta County; less than the percentage of minorities Collin, Lamar, Grayson, and Hunt counties; and less than the state's 54 percent. The discrepancy in the percentage of minorities between Fannin and Delta counties is about three percent – or less than ten percent. The minority populations in Fannin and Grayson counties also represent less than half of their total county populations, respectively. Minorities in Fannin County are neither greater than 50 percent of the total county population nor are they substantially higher than the percentage of minorities in the five surrounding counties (Collin, Lamar, Grayson, Hunt, Delta) or the state of Texas as a whole.

Grayson County does not meet the regulatory definition of a minority population, either. Grayson County's population consists of 20 percent minorities, compared to Collin County's 35 percent, Fannin County's 18 percent, Hunt County's 24 percent, Cooke County's 20 percent, and Denton County's 34 percent (USCB, 2010a). The percentage of minorities in Grayson County is higher than the percentage(s) of minorities in Fannin County, and less than the state's 54 percent. The discrepancy in the percentage of minorities between Grayson County and Fannin County is about two percent; or less than ten percent. The minorities in Grayson County are neither greater than 50 percent of the county population nor are they a substantially higher than the percentage of minorities in the five surrounding counties (Fannin, Collin, Hunt, Cooke, Denton) or the state of Texas as a whole.

Minority Populations by Block Groups

The discussion of environmental justice up until this point describes the existing minority population on the county level. Due to the site-specific nature of the proposed project, in addition to describing the proportion of minorities on the county level, BG data are used to describe the distribution of minorities in the vicinity of the project area. A BG is a statistical subdivision of a CT, generally defined to contain between 600 and 3,000 people and 240 and 1,200 housing units. It is the smallest geographic unit for which the United States Census Bureau (USCB) tabulates sample data, i.e. data which are only collected from a fraction of households. BGs are statistical areas bounded by visible features such as roads, streams, and railroad tracks, and by nonvisible boundaries such as property lines, city, township, school district, county limits and short line-of-sight extensions of roads. CTs coincide with the limits of cities, towns, or other administrative areas, and are "designed to be relatively homogeneous units with respect to population characteristics, economic status, and living conditions…" (USCB, 2013). Fannin County is made up of nine CTs and 30 BGs.

Minority data for BGs in the project area were evaluated, as impacts from noise or delays from traffic would be felt most by populations in these locations. These include the towns of Bonham, Honey Grove, Windom, Dodd City, Bailey, and Leonard. Applying the CEQ definition(s) from above, BGs (and associated towns) are identified as having an environmental justice population if:

- More than 50 percent of a BG consists of minorities.
- The percentage of minorities in a BG is substantially higher than the percentage of minorities in Fannin County. For purposes of this analysis, a discrepancy of ten percent or more between minorities (the sum of all minority groups) in a BG and Fannin County would be considered "substantially" higher, and would categorize that BG as an environmental justice population.

Figure 3.13-1 shows the distribution of minority populations within Fannin County, color-coding the proportion of minorities using ranges. These ranges were developed based on commonalities or themes revealed by the BG data. Each BG is outlined black, and the percentage of minorities in each BG is indicated in the figure.

The data revealed that Alternative 1 would affect an area where minority populations represent between four to nine percent of the population (color-coded red in Figure 3.13-1), which is less than Fannin County's 17.8 percent of the total population. The southwestern portion of the project area under Alternative 1 would occur adjacent to Bonham, though technically avoiding the city itself. One of the BGs in Bonham is comprised of 58 percent minorities (color-coded purple in Figure 3.13-1), more than three times Fannin County's 17.8 percent. East of the water pipeline, minorities represent 32 and 29 percent of the BGs in Honey Grove and Ladonia (color-coded blue in Figure 3.13-1), respectively; both figures are "substantially" higher than the county's. Because the percentage of minorities in Honey Grove, Ladonia, and Bonham BGs is substantially higher than Fannin County's 17.8 percent, these are defined as environmental justice populations.

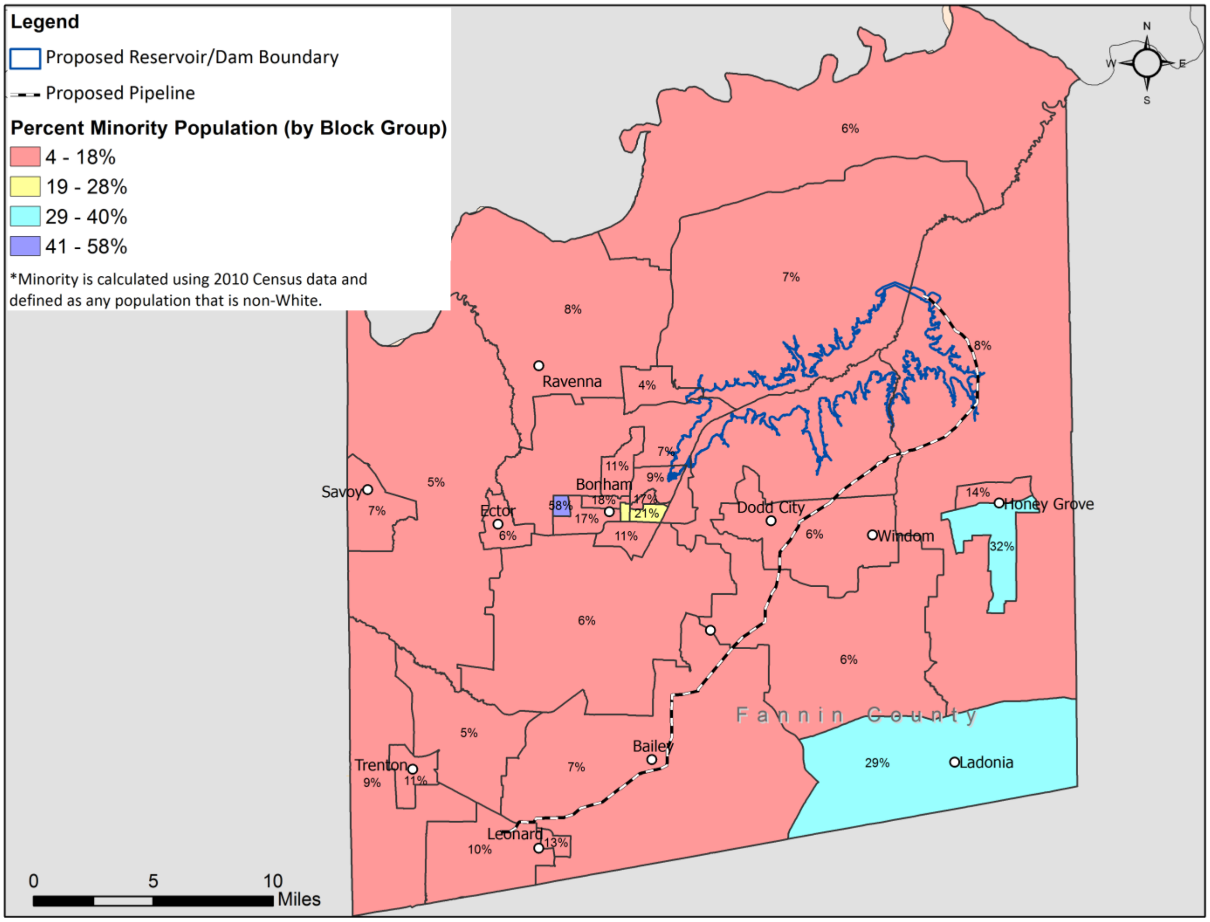


Figure 3.13-1. Distribution of Minorities Within Fannin County

Low-Income Populations

Low-income populations are defined as households with incomes below the federal poverty level. There are two slightly different versions of the federal poverty measure: poverty thresholds defined by the USCB and poverty guidelines defined by the U.S. Department of Health and Human Services (DHHS).

The poverty thresholds are the original version of the federal poverty measure, and are updated each year by the USCB. The USCB uses a set of income thresholds that vary by family size and composition (number of children and elderly) to determine who is in poverty. If a family's total income is less than the family's threshold, then that family and every individual in it is considered in poverty. The same applies for a single individual. The official poverty thresholds do not vary geographically, but are updated for inflation. The official poverty definition considers pre-tax income and does not include capital gains or non-cash benefits such as public housing, Medicaid, and food stamps (CEQ, 1998). Poverty thresholds are primarily used for statistical purposes, such as calculating poverty population figures or estimating the number of Americans in poverty each year. Poverty threshold figures are reported in the annual poverty report, and provide a yardstick for progress or regress in antipoverty efforts. *Environmental Justice Guidance Under NEPA* recommends that USCB poverty thresholds be used to identify low-income populations (CEQ, 1997).

The DHHS poverty guidelines are simplifications of the USCB's detailed matrix of poverty thresholds and are used mostly for administrative purposes, such as determining financial eligibility for certain federal programs. The DHHS guidelines are also used as the basis for many state and regional guidelines, including Head Start, the Food Stamp Program, the National School Lunch Program, the Low-Income Home Energy Assistant Program, and the Children's Health Insurance Program. Similar to the USCB's poverty thresholds, the DHHS poverty guidelines are updated annually and vary based on family size (but not the number of children and elderly). The poverty guidelines do not vary geographically for the 48 contiguous states. The DHHS 2014 poverty guidelines define low-income populations as those whose median household income is at or below the maximum annual income of $19,790 for a family of three (DHHS, 2014).

The best available data for poverty and economic characteristics in the ROI and ROC under both alternatives were 2010 American Community Survey (ACS) estimates for Selected Economic Characteristics. Table 3.13-2 uses these data and provides statistics relevant to assessing the presence of low-income populations in the areas that would be affected by Alternatives 1 and 2.

Table 3.13-2. Income and Poverty Statistics in the ROI and ROC

County	Total Population	Median Household Income[a,b]	Average Family Size	Percentage of All People Below the Poverty Threshold[b]	Percentage of All Families Below the Poverty Threshold[b]
Fannin	33,915	$42,605	3.01	14.0	10.6
Collin	782,341	$77,090	3.25	8.1	5.4
Hunt	86,129	$40,218	3.12	22.8	17.5
Lamar	49,793	$37,659	2.99	17.3	13.1
Delta	5,231	$37,908	2.95	14.5	9.1
Grayson	120,877	$45,577	3.02	14.4	10.4
Cooke	38,437	$46,804	3.09	14.7	12.2
Denton	662,614	$70,464	3.24	8.2	5.1
All Counties in Texas	25,145,561	$48,615	3.31	17.9	13.8

[a] 2010 inflation-adjusted dollars.
[b] From 2010 American Community Survey estimates for Selected Economic Characteristics dataset.
Sources: USCB, 2010a and USCB, 2010d

Because CEQ guidance does not specify a threshold for identifying low-income communities, the same approach as described to identify environmental justice minority populations is applied to low-income populations. As displayed in Table 3.13-2, the percentage of all people living below the poverty threshold in Fannin County is higher than in Collin County. The discrepancy in the percentage of persons living below the poverty threshold between Fannin and Collin counties is approximately six percent – or less than ten percent. The percentage of all families living below the poverty threshold in Fannin County is higher than in Collin, Delta, and Grayson counties; however, the differences are less than 10 percent. Both the percentages of persons and families living below the poverty threshold in Fannin County is lower than in the state of Texas overall. Neither the percentage of all people living below the poverty threshold nor the percentage of families below the poverty threshold are more than 50 percent of the Fannin County population. For purposes of the analysis under both Alternative 1 and 2, Fannin County does not qualify as an environmental justice population by either CEQ definition (USCB, 2010a; USCB, 2010d).

The percentage of all people below the poverty threshold in Grayson County is higher than in Fannin, Collin, and Denton counties. The discrepancy in the percentage of persons living below the poverty threshold between Grayson County and Fannin, Collin and Denton counties is less than ten percent (between less than one percent and about five percent). The percentage of all families living below the poverty threshold in Grayson County is higher than in Collin, Delta, and Denton counties. The discrepancy in the percentage of families living below the poverty threshold between Grayson and Collin, Delta, and Denton counties is less than ten percent (between less than one percent and five percent). Both the percentages of people and families living below the poverty threshold in Grayson County is lower than in the state of Texas overall. Neither the percentage of all people living below the poverty threshold nor the percentage of families below the poverty threshold are more than 50 percent of the Grayson County population. For purposes of the analysis for the additional 35-mile pipeline included under Alternative 2, Grayson County does not qualify as an environmental justice population by either CEQ definition (USCB, 2010a; USCB, 2010d).

Low-Income Populations by Census Tracts

As with minority populations, because of the site-specific nature of the proposed project, data are used to identify high concentration "pockets" of low-income populations and describe the distribution of income across Fannin County. Unlike with minority populations, poverty and income data is not available on the BG level. CT data are used to describe the distribution of persons living below the poverty threshold in the vicinity of the project area. CTs are small, relatively permanent statistical subdivisions of a county or equivalent entity, generally with a population size between 1,200 and 8,000 people (CTs are made up of several BGs, therefore BGs are a smaller geographic unit). A CT usually covers a contiguous area; and its boundaries usually follow visible and identifiable features such as streams or roads (USCB, 2013).

Low-income CTs that would be affected by the proposed project were evaluated, as impacts from noise or delays from traffic would be felt most by populations in these locations. These include the towns of Bonham, Honey Grove, Windom, Dodd City, Bailey, and Leonard. Applying the CEQ definition(s) from above, the following CTs (and associated towns) are identified as having a low-income population or environmental justice population if:

- More than 50 percent of a CT consists of families or persons below the poverty threshold.
- The percentage of low-income families or persons in a CT is substantially higher than the percentage in Fannin County. A discrepancy of ten percent or more between an individual CT and Fannin County would be considered "substantially" higher; and would categorize that CT as constituting a low-income population.

Figure 3.13-2 shows the distribution of low-income populations in Fannin County's nine CTs, color-coding the percentage of low-income populations using ranges. These ranges were developed based on commonalities or themes revealed by the CT data. The results displayed in Figure 3.13-2 indicate that low-income populations represent between 21 and 25 percent of the population in one the CTs associated with Bonham, compared to 14 percent of the county's population overall. For purposes of the analysis under both Alternatives 1 and 2, Bonham constitutes a low-income population, or an environmental justice population, on this basis.

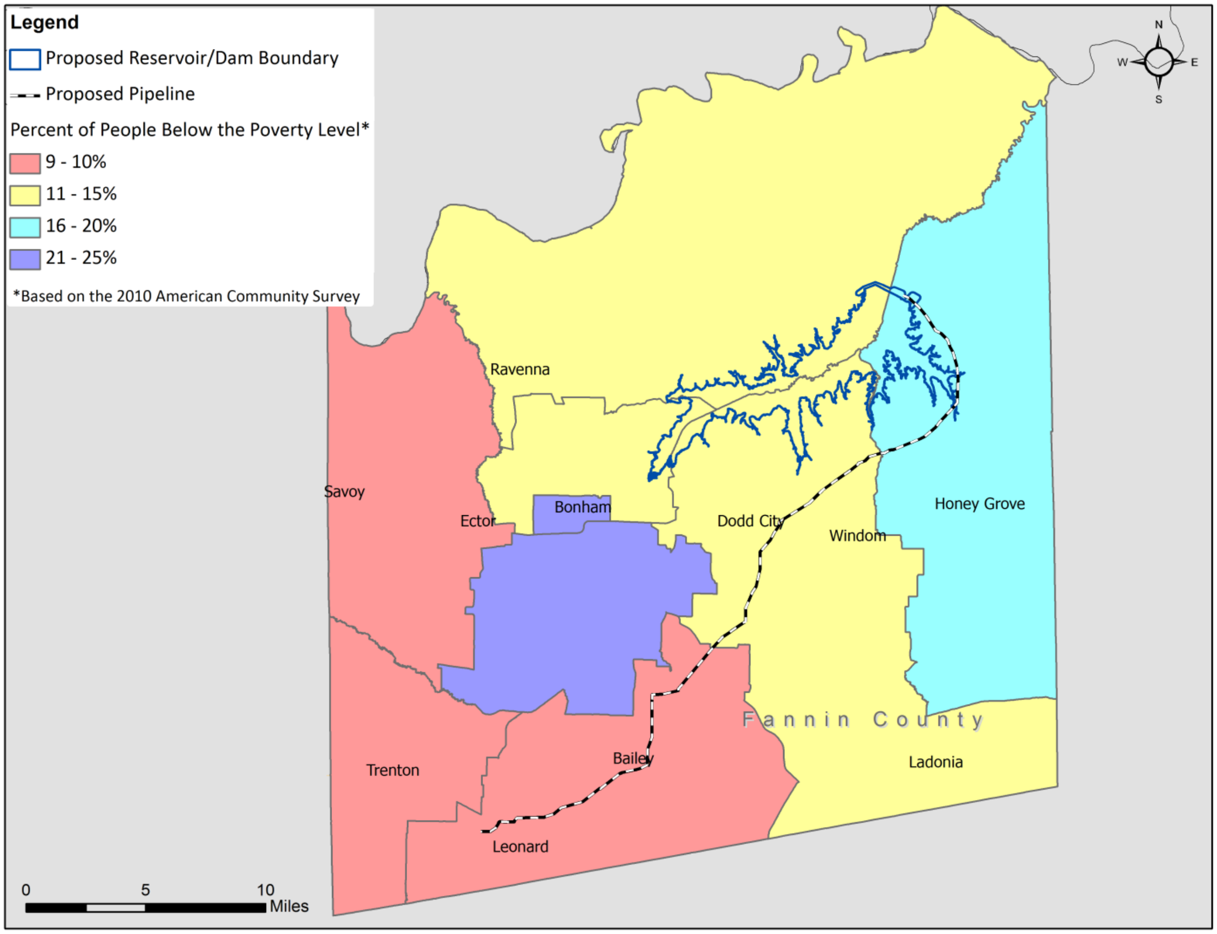


Figure 3.13-2. Distribution of Low-Income Populations in Fannin County

3.13.2 Protection of Children

EO 13045 *Protection of Children from Environmental Health Risks and Safety Risks* was prompted by the recognition that children are more sensitive than adults to adverse environmental health and safety risks because they are still undergoing physiological growth and development. EO 13045 defines "environmental health risks and safety risks [to] mean risks to health or to safety that are attributable to products or substances that the child is likely to come in contact with or ingest (such as the air we breathe, the food we eat, the water we drink or use for recreation, the soil we live on, and the products we use or are exposed to)." Children may have a higher exposure level to contaminants because they generally have higher inhalation rates relative to their size. Children also exhibit behaviors such as spending extensive amounts of time in contact with the ground and frequently putting their hands and objects in their mouths that can lead to much higher exposure levels to environmental contaminants. It is well documented that children are more susceptible to exposure to mobile source air pollution, such as particulate matter from construction or diesel emissions (USEPA, 2012b).

The Memorandum Addressing Children's Health through Reviews Conducted Pursuant to the National Environmental Policy Act and Section 309 of the Clean Air Act recommends that a Draft EIS "describe the relevant demographics of affected neighborhoods, populations, and/or communities and focus exposure assessments on children who are likely to be present at schools, recreation areas, childcare centers, parks, and residential areas in close proximity to the proposed project area, and other areas of apparent frequent and/or prolonged exposure" (USEPA, 2012b).

The analysis for EO 13045 requires the assessment of readily available demographic data and information on local, regional, and national populations. The number and distribution of children less than 18 years old in the ROI and ROC are evaluated to determine whether they would be exposed to environmental health and safety risks from Alternatives 1 and 2. Information to support this analysis was derived from the USCB's 2010 decennial census and is presented in Table 3.13-3.

As shown in Table 3.13-3, in general, the Fannin County population is older than that of the state as a whole. Fannin County contains approximately 1,981 children under the age of five and 6,380 children between the ages of five and 18; or 5.8 and 18.8 percent of the total population, respectively. The representation of children under the age of five is less than the representations in all the surrounding counties. In Fannin County, a total of 8,361 children are under the age of 18, or about 24.6 percent of the population. The representation of children in Fannin County under the age of five and also between the ages of five and 18 are lower than in each of the five surrounding counties and the state as a whole. Whether broken into age categories or not, the representation of children under the age of 18 is lower than the 30.3 percent state average (USCB, 2010a).

Table 3.13-3. Age Distribution in the ROI and ROC

County	Total Population	Children Under 5 *(Percent)*	Children 5 to 18 years *(Percent)*
Fannin	33,915	1,981 *(5.8)*	6,380 *(18.8)*
Collin	782,341	58,849 *(7.5)*	183,697 *(23.5)*
Lamar	49,793	3,187 *(6.4)*	10,394 *(20.9)*
Delta	5,231	309 *(5.9)*	996 *(19.0)*
Hunt	86,129	5,713 *(6.6)*	18,335*(21.3)*
Grayson	120,877	7,833 *(6.5)*	24,976 *(20.7)*
Cooke	38,437	2,687 *(7.0)*	38,437 *(21.4)*
Denton	662,614	49,790 *(7.5)*	151,788 *(22.9)*
All Counties in Texas	25,145,561	1,928,473 *(7.7)*	5,693,241 *(22.6)*

Source: USCB, 2010a

Youth Populations by Census Tracts

As with minority and low-income populations, because of the site-specific nature of the proposed project, data are used to identify high concentration "pockets" of youth populations and describe the distribution of children across Fannin County.

Pursuant to the EPA's 2012 Memorandum Addressing Children's Health, CTs were examined to identify the age distribution in Fannin County, specifically children under the age of five in the vicinity of the project area. Figure 3.13-3 shows that Alternative 1 is almost entirely located in an area where children represent six to seven percent of the total county population.

This CT data is compared with previously defined "pockets" of minority or low-income populations; as EO 13045 recognizes that children of environmental justice populations are more likely to be exposed to, and have increased health and safety risks from, environmental contamination than the general population. Under Alternatives 1 and 2, children in areas defined as minority or low-income environmental justice populations (i.e., Bonham and Honey Grove) will be evaluated for disproportionate impacts as it relates to a child's health and safety.

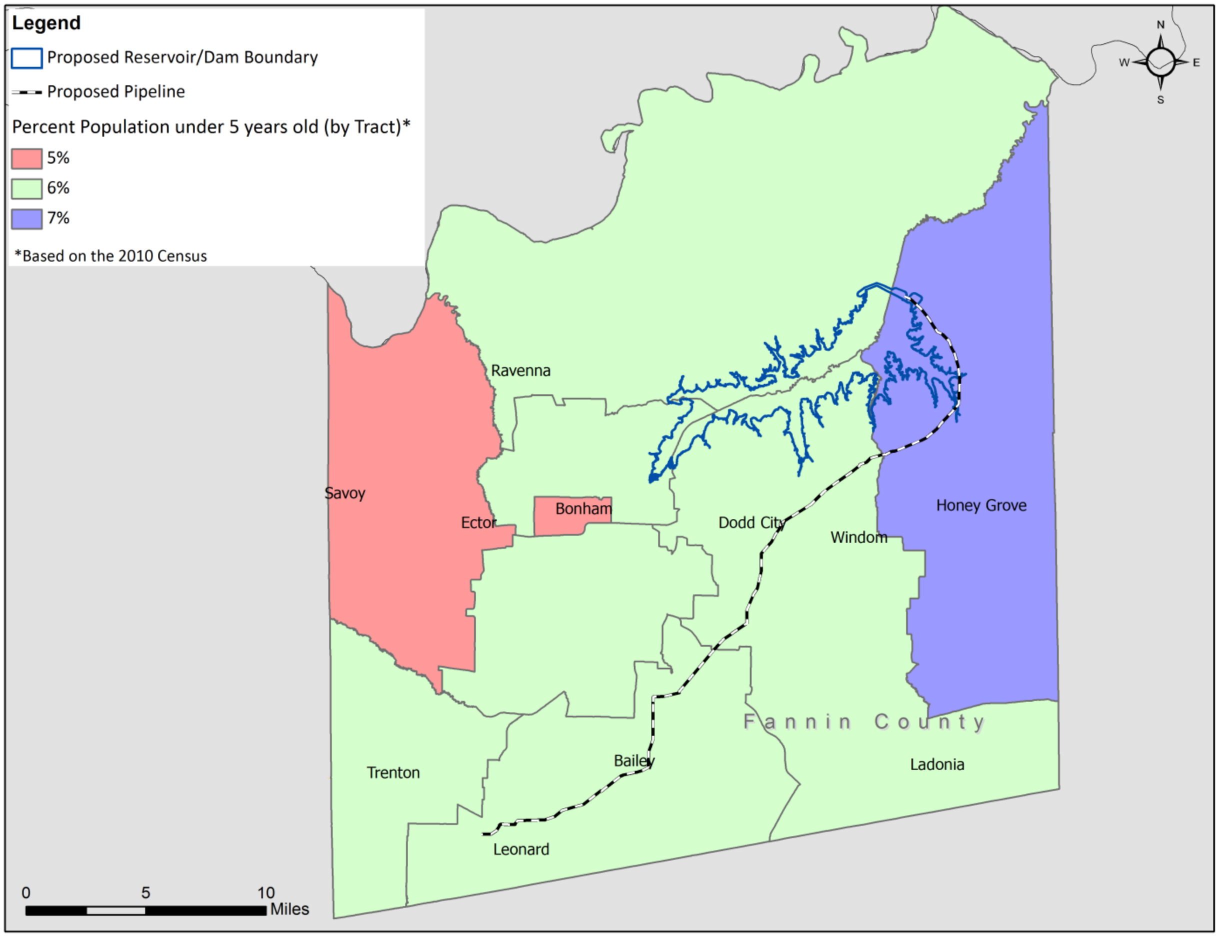


Figure 3.13-3. Age Distribution in Fannin County

3.14 CULTURAL RESOURCES

3.14.1 Cultural Chronology

This cultural chronology summarizes approximately 14,000 years of history in Fannin County and within North Central Texas generally. Because of the limited amount of previous research that has been conducted within Fannin County per se, much of the archaeological background draws from regional information gathered in adjacent counties.

The prehistoric era (12,000 B.C. to A.D. 1700) is almost exclusively composed of Native American occupations and encompasses the bulk of human occupation in the New World. It is subdivided into seven distinct sub-periods:

- Paleoindian (12,000 to 6,000 B.C.)
- Archaic (6,000 B.P. to 200 B.C.)
- Woodland/Fourche Maline (200 B.C. to A.D. 800)
- Formative Caddo (A.D. 800 to 1000)
- Early Caddo (A.D. 1000 to 1200)
- Middle Caddo (A.D. 1200 to 1400)

- Late Caddo (A.D. 1400 to 1700)

These sub-periods represent pre- to early post- European contact and reflect over 13,000 years of cultural continuity (Perttula, 2004).

The Historic Era, following initial contact by European explorers, is typically divided into two distinct phases:

- Historic European (1700 to 1815)
- Anglo-American settlement (1815 to the present)

Paleoindian Period 12,000 B.C. to 6,000 B.C.

The Paleoindian period represents the beginning of human occupation in the Americas. During this period populations arrived and spread throughout the New World. Climatic conditions in Texas were generally cooler and moister than at present though the terminal Pleistocene climate (Nickels et al., 2010; McKenzie et al., 2001). Based on the absence of Paleoindian occupations in Fannin County during this period, it is assumed that Native populations were largely nomadic and had no permanent sites in the area (Mahoney, 2001).

Isolated Paleoindian artifacts are known within the area and include Clovis, Folsom, Plainview, and other diagnostic projectile points. However, according to the Texas Historical Commission's Archeological Sites Atlas (TASA), there are no known Paleoindian-aged archaeological sites in Fannin County, although their presence is likely and would most likely be an open campsite or kill/butchering site. Several important Paleoindian sites are located in the region (e.g., North Sulphur, Aubrey, Lewisville) (Perttula, 2004). Artifact types indicative of the Paleoindian Period which could be reasonably found in the Fannin County region include Clovis, Dalton, Folsom, Midland, Plainview, San Patrice, and Angostura (Turner and Hester, 1999). Diagnostic artifacts of Paleoindian age are typically uniform throughout Texas and surrounding states. By their scarcity, Paleoindian sites are considered precious resources from which any information derived may be of great importance to the collective knowledge of the earliest Native American occupations.

Archaic Period 6,000 B.C. to 200 B.C.

The Archaic Period represents the bulk of human occupation in the New World, spanning almost 6,000 years, during which climate became drier and warmer than the cooler transitional Pleistocene conditions of the Paleoindian Period (Collins, 1995; Nickels et al., 2010). The Archaic Period is typically divided into three distinct phases: Early, Middle, and Late. During the Archaic Period, populations increased and became more specialized to the regions in which they lived. Within the region, few sites diagnostic of Archaic age are presently known (Perttula, 2004). Trends elsewhere in the state and within adjacent counties suggest that populations were semi-nomadic, following available food resources throughout a region on a seasonal basis. Sites documented by AR Consultants (ARC) in southern Fannin County show a Middle Archaic habit of harvesting mussels from streams, a theme also documented within the Bois d'Arc Creek drainage (Davis et al., 2014).

Artifact types indicative of the Archaic Period which could be reasonably found in the Fannin County region include Big Sandy, Andice, Bulverde, Wells, Morrill, Carrolton, Dallas, Trinity, Ellis, Yarbrough, and Edgewood (Turner and Hester, 1999). Diagnostic artifacts of Archaic age are typologically diverse yet spatially uniform throughout North Central Texas. Sites in the area would be expected to be seasonal open campsites with lithic scatters, small burned rock, and mussel shell concentrations. During the Late Archaic Period, evidence suggests that group mobility declined as populations increased. The result was a more localized toolkit and the beginning of sedentism in North Texas (Perttula, 1998).

Woodland Period (Fourche Maline) 200 B.C. to A.D. 800

During the Woodland Period, populations continued to regionalize into sedentary units, increasingly centered around rectangular or round structures (Perttula, 2004). Skinner et al. (2007) documented a structure 20 by 80 feet (6 to 24 meters) in size dating to this period in Lamar County. Regionally, the Woodland Period also marks the introduction of bow and arrow technology, which is reflected in the archeological record by a decrease in projectile point size from larger atlatl or hand-propelled points, to those small enough to be launched at high speeds and fly more accurately at great distances (Turner and Hester, 1999). Pottery also makes its first large-scale appearance in the region in the form of grog-tempered William Plain ware and later shell-tempered and decorated Coles Creek ceramics.

During this period, territories became established and small hunter/forager villages appear in the form of possibly communal housing at locations where occupations were apparently constant over many years, as at the Ray Site in Lamar County (Davis et al., 2014; Bruseth et al., 2001). Likewise, projectile point technology further subdivided into a more localized toolkit. Gary projectile points are typical to this period in the region and may have decreased in size in later years. Scallorn-type points make an introduction as the first arrow-type points in the regional archeological record and by the end of the period had completely replaced dart-type points (Turner and Hester, 1999).

Formative/Early Caddo Period A.D. 800 to 1000 and 1000 to 1200

During the Formative Caddo Period, horticulture makes its first appearance in the archeological record though only supplemental to hunting and foraging (Mahoney, 2001). Single-family structures and mounds were present during this period as well (Davis et al., 2014). The Early Caddo Period marks the initiation of large-scale maize production in North Central Texas, which would become the hallmark of later Caddo culture. Hunting and foraging were still practiced, but only as supplement to the fledgling agriculture (Perttula, 2004). Formative and Early Caddo sites in the middle Red River Valley are typically located on elevated, arable land along major creek and river drainages. Sites include single structures and small villages, some with burial mounds (Jones, 2008).

Middle Caddo Period A.D. 1200 to 1400

Middle Caddo settlements along the middle Red River area include such site types as farmsteads, artifact assemblages, hamlets, and large communities with one or mounds (e.g., flat-topped mound, substructure mound, burial mound) (Perttula, 2001). Agricultural domesticates such as maize are apparently being intensively cultivated during this time period. In burials, this correlates to an overall increase in the frequency of individuals afflicted with dental caries and cavities (Loveland, 1987; 1994). The recovery of Gulf Coast shell artifacts and Kay County flint, which were very common in burial features at the Sanders site at the mouth of Bois d'Arc Creek, suggest extensive trade occurred during this time period with groups located along the Gulf Coast and Great Plains (Perttula, 2001). The lithic assemblage commonly seen in Middle Caddo sites includes Bonham, Scallorn, and Morris arrow points, celts, and ground stone. Ceramics include: long-stemmed clay pipes, Canton Incised, Maxey Noded Redware/Blackware, Sanders Engraved, Paris and Sanders Plain (Perttula, 2004; Davis, 1995).

Late Caddo Period A.D. 1400 to 1700

The population increase, social complexity, and agricultural dependence that occurred within the Middle Caddo subperiod continued to evolve and expand during the Late Caddo subperiod. According to Perttula (2001), due to European diseases and an invasion from the Osage, Caddo groups had abandoned the Red River valley in northeast Texas by the late 1700s and moved to the Caddo Lake area along the Texas/Louisiana border. Historic Caddo sites commonly contain historic European beads and metal trade goods such as points, knives, lead shot, and gun parts. These areas often also contain plain and decorated shell-tempered ceramics, triangular arrow points, and many stone scrapers. Such occurrences in the immediate area include Sanders, Harling, and Goss Farm (41FN12) at the mouth of Bois d'Arc Creek, as well as in the Riverby Ranch mitigation area.

Contact Period

In 1539, Spanish conquistador Hernando de Soto and 600 soldiers landed on the western coast of Florida in order to explore the southeastern portion of the United States and acquire gold from the indigenous populations of North America (Moscoso Expedition, 2004). The proposed route used by the expedition traveled through portions of present-day Florida, Georgia, South Carolina, North Carolina, Tennessee, Alabama, Mississippi, Arkansas, and northeast Texas (Hudson et al., 1989; Bruseth and Kenmotsu, 1991; Bruseth, 1992). When the expedition (led by Louis de Moscoso) entered Texas in 1542, it supposedly traveled along the Red River to Nacogdoches. From Nacogdoches, the expedition traveled along a route known today as the Old San Antonio Road to the Guadalupe River in proximity to present-day New Braunfels (Bruseth and Kenmotsu, 1991).

Historic Period (1700 to 1815) to Present

From approximately 1760-1779, Frenchman Athanase de Mezieres led major expeditions throughout northeast Texas in order to establish trade relations with the Caddoes, Delaware, Cherokees, and Wichitas. As a result, numerous trade goods such as metal tools, gun parts, and glass beads are sometimes observed within the archaeological record of sites dating to this period (Chipman, 2012). Background and historical information discussed in this section relies heavily on ARC's report (Davis et al., 2014) and others referenced within their report.

Camp Benjamin

When the Civil War broke out in April 1861, Fannin County's citizens supported the Confederacy and secession from the Union. Several companies of Fannin County men joined the Trans-Mississippi Confederate army. Bonham was the site of three important Confederate facilities during the war, including a hospital for the soldiers, a commissary which supported seven brigades, and the military headquarters of the Northern Sub-District of Texas, Confederate States of America (C.S.A.). In addition, Camp Benjamin was established in the Bois d'Arc Creek floodplain, northeast of Bonham, and was occupied by the 9th Regiment Volunteer Texas Infantry from December 13, 1861 until January 1, 1862. At that time, the 10 company regiments left for Memphis, Tennessee (Brothers, 2010). Over 1,200 enlisted men and officers lived at the camp. A concrete cross was erected in 1980 at the reputed location of a cemetery, where at least seven 9th Regiment soldiers were buried after dying from measles or pneumonia (Honey Grove Signal-Citizen, 1980; Davis et al., 2014).

Fannin County

Anglo European settlement within the region intensified after Spain ceded control of Texas in 1828. Fannin County was carved from Red River County in 1837 and named after another Texas Revolution hero, James W. Fannin, a Colonel in the Texas Army who was killed in the Goliad Massacre (Alvarez, 2006). Prior to the Civil War, cattle ranching was the primary source of income in Fannin County. Most of the early Anglo settlers were from the Old South and many brought slaves with them; black slaves comprised nearly 20 percent of the population. Following the Civil War, agriculture continued to dominate the local economy, shifting to corn and cotton production, with corn production peaking in 1900. Following 1900, businesses and population both began dwindling within the county as cotton production grew, peaking in 1920. Efforts were made throughout the Great Depression and into World War II to increase dairy production within the county, but never with the desired outcome. Beef cattle fared better, and their numbers continued to grow (Pigott, 2012) (Davis et al., 2014).

Bonham

The largest city and county seat of Fannin County is Bonham, located at the southern end of the proposed Lower Bois d'Arc Creek Reservoir. The first settlement within present Fannin County, it was founded in

1836 when Bailey Inglish traveled from Kentucky and established a blockhouse and stockade (called Fort Inglish) along Bois d'Arc Creek in order to protect local settlers. The settlement that arose surrounding the fort was initially named Bois d'Arc, but in 1844 the town changed its name to Bonham, in honor of the Alamo defender James B. Bonham (City-Data.com, 2012a; Kleiner, 2012). Growth within the City of Bonham was fast following the Civil War, particularly after the arrival of the Texas and Pacific Railroad (T&P RR) in 1873. By the turn of the Century, Bonham boasted electric and telephone service, eight churches, three colleges, three newspapers, and several mills and manufacturing businesses (Kleiner, 2012). While population decreased in Fannin County as a whole, the population in Bonham continued to grow for a time and then stabilized during the Great Depression at 6,349 in 1940. Population remained steady until the turn of the present century rising in 2009 to 10,527 from 6,686 in 1990 (Kleiner, 2012; City-Data.com, 2012a). During World War II, Bonham, like many other Texas cities, housed German prisoners of war in a local internment camp from which prisoners were sent to work on local farms and ranches (Leonard, 2003).

Carson (Gum Springs)

The unincorporated community of Carson, formerly Gum Springs, is located directly west of the proposed LBCR and its alternatives on FM 1396. During the late 1800s, Carson was a cotton-centered community, boasting its own gin, school, and church (Minor, 2012a). The Gum Springs Cemetery is located about one kilometer (0.6 mile) south of FM 1396. Today, Carson is a small, loosely-grouped collection of homes noticeable only by a central water tower (Davis et al., 2014).

Dodd City

Dodd City is located east of Bonham on State Highway (SH) 56 approximately 2.2 miles (3.5 km) southwest of the Bullard Creek arm of the proposed reservoir. Dodd City was founded in 1839 by Kentuckian Major Edmund Hall Dodd. Previously named Licke, Quincy, and Dodd Station (following the arrival of the T&P Railroad [RR]), the name 'Dodd City' was officially adopted in 1873. Farming and railroad service boosted the city's economy until the 1930s when the local businesses and then population began to decline. By 1979 the population had dwindled to 302, less than the mid-1880s population. Today, Dodd City is a quaint, small town with a population of approximately 419 (Davis et. al, 2014; Minor, 2012b).

Honey Grove

Honey Grove is a town located on SH 56 approximately 3.1 miles (5 km) south of the Fox Grove Creek arm of the proposed LBCR and its alternatives. Honey Grove began as a small community named after a local apiary. During the Civil War, Honey Grove produced swords and Bowie knives for the Confederacy and housed an ordinance shop; it also served as a training site for soldiers (Conrad, 1988). As a sharecropping support community, Honey Grove prospered until the practice died out after World War II. Honey Grove currently maintains a population of approximately 1,828, well below its peak population of 3,000 in 1890 (Minor, 2012c; City-Data.com, 2012b).

Lamasco

Lamasco is located about a 0.5 mile (0.8 km) north of the main Sandy Creek arm of the proposed Lower Bois d'Arc Creek Reservoir and its alternatives on FM 1396. The name of this community was derived from three founders (Law, Mason, and Scott). While the town was never outstandingly large, it did support a steam gristmill, sawmill, two hotels, a general store, and a drugstore, as well as a post office until 1920. The community never recovered from the Great Depression and currently centers on a loose cluster of houses with a population of 33 (Hart, 2012a). The Lamasco Cemetery is located on the south side of FM 1396 on the west edge of the community.

Windom

The City of Windom is located approximately 5.5 miles (8.8 km) southeast of the Bullard Creek arm of the proposed reservoir, approximately half way between Dodd City and Honey Grove on SH 56.

Windom was founded in 1870 and shortly thereafter had the good fortune to have the T&P RR constructed through town. As a local center for shipping and receiving goods, Windom thrived until the Great Depression, when its already small population (317 in 1929) began to decline (Hart, 2012b). Today, Windom's population hovers around 252 (City-Data.com, 2012c).

Greens Chapel and Bois d'Arc Springs

Located approximately 2 miles (3.2 km) northeast of the proposed dam area, Greens Chapel is a small rural town located approximately one mile (1.6 km) east of Bois d'Arc Springs. The springs seep from the base of the Bonham sandstone cliffs resting on Eagle Ford shale at the confluence of Bois d'Arc and Coffee Mill creeks (Brune, 1981; Dobbs, 2012). Early settlers and people came from all over the country to enjoy the area and the pure water found there. Greens Chapel was named after Parris Green, who moved to the area before the Civil War to start a tannery which employed thirty to forty men (Dobbs, 2012). Although Parris Green reportedly moved to Arkansas in the late 1860s, the community continued to grow due to its close proximity to numerous springs, as it was the closest town to the springs themselves (Davis et al., 2014). By the 1930s, there were dozens of families living in the area, like the Martins, Roses, Newhouses, Rowtons, and Higginbothams, and the area boasted a grist mill, saw mill, cotton gin, a tannery, and a syrup mill (Dobbs, 2012). However, the area's population began to decline in the 1930s as a result of the passing of the Bankhead-Jones Farm Tenant Act (Long, 2011).

Selfs

The Selfs area was once populated by a handful of small, rural communities all located near the proposed reservoir dam: Selfs, Jones Mill, Spoonamore/Oliver-Hill, Greens Chapel, and Shilo, with only the community of Selfs still in existence today. In the 1880s, brothers, G. W. and G. T. Self built a gristmill and cotton gin at the location of the present-day Selfs (Hart, 2013; Jones, 1977). Area settlers, drawn to the gin and mill, soon formed a small community of 800 by 1900. The community at that point boasted two mills, four stores, two blacksmith shops, two barbershops, three doctors, a school, a broom factory, a post officer, a confectionery, a furniture store, Woodman Hall, and the North Texas Business College. The early 1900s represented the peak in prominence and population for the community of Selfs. The population declined to 25 during the mid-1930s and fluctuated between 25 and 50 for the next 30 years. In the mid-1960s, the population had again reached 50 persons (Davis et al., 2014).

Telephone

The community of Telephone is located approximately 12 miles northeast of Bonham at the intersection of FM 273 and FM 2029. Poke Hindman opened and owned a general store in 1886 which was the first place of business in Telephone. Typical of the many small rural communities during that time period between 1860 and 1870, Telephone consisted of a school and a church (Davis et al., 2014). The first cemetery was dedicated in 1884, and a post office followed in 1886 (Jones, 1997). From 1890 through the 1930s, the population grew from 30 to 100, reaching a peak of 280 residents and 10 businesses by the mid-1940s. One additional business existed by the late 1960s but the population remained the same (Hart, 2011a).

Caddo National Grasslands

The Caddo National Grasslands was purchased and developed under the Bankhead-Jones Farm Tenant Act of the 1930s. Located in the northeastern portion of the project area, bordering Coffee Mill Lake, the 17,785 acres were purchased to provide various recreational opportunities while improving land-use management (Long, 2011), although many owners and tenants of ranches were displaced as a result of purchases or seizures by the federal government. The grasslands served as an important gathering place for farmers because travel was limited and difficult at best. The growth patterns of small rural communities were predicated on these types of gathering locations because they provided critical access to necessities otherwise not available. As rapid technological advances and more efficient/effective travel became available, the general population, especially those of small rural communities, moved away from the agricultural lifestyle (Davis et al., 2014).

3.14.2 Known National Register Properties and Historical Markers at Reservoir and Vicinity

National Register Properties

Within the APE

There are no properties listed on the National Register of Historic Places (NRHP) within the basin of the proposed Lower Bois d'Arc Creek Reservoir.

Outside of the APE

No NRHP properties are located within one mile (1.6 km) of the proposed undertaking. The nearest NRHP property is the Clendenen-Carleton House, built around 1888 and located in Bonham about 1.6 miles (2.6 km) west of the APE. The closest National Register District is the Lake Fannin Organizational Camp located about 10 miles (16 km) northwest of the proposed reservoir.

Historical Markers

Within the APE

There are no State of Texas Historical Markers within the proposed Lower Bois d'Arc Creek Reservoir footprint.

Outside of the APE

Within a one mile (1.6 km) radius mile of the proposed LBCR site, there are four State of Texas Historical Markers:

- The Shiloh Cemetery (Marker Number 13221), which dates to the 1860s, is located 1.5 miles (2.4 km) southeast of the proposed dam site for Lower Bois d'Arc Creek Reservoir on CR 2730.
- The Allen's Chapel Methodist Church and Cemetery (Marker Number 12911), dating to 1847, is located 260 yards (240 meters) west of the southernmost extent of the Allens Creek arm of the project area on CR 2750.
- The Vineyard Grove Baptist Church (Marker Number 8943), constructed in 1853, is located 0.7 mile (1.1 km) east of the Yoakum Creek arm of the project area on FM 1396 north of the community of Allens Chapel.
- The Vicinity of Fort Inglish (Marker Number 8886) marker denotes the approximate 1,250-acre location of the original town site of Bonham, dating to 1837. The marker is located 0.8 mile (1.3 km) southwest of the project area on the edge of the City of Bonham on East 9th Street (SH 205).

In addition, more than 20 historical markers occur within the confines of the City of Bonham. These markers commemorate a variety of buildings and historical locations such as Carlton College, the Booker T. Washington School, the First United Methodist Church of Bonham, and the Steger Opera House.

3.14.3 Cultural Resource Investigations

Pre-Reservoir Investigations

Other cultural resources investigations have been conducted in the area prior to those initiated because of the undertaking (the Proposed Action) currently under study. A group from the University of Texas excavated several skeletons and recovered several artifacts from a prehistoric Caddo site (41FN12) at the Goss Farm near the mouth of Bois d’Arc Creek in 1930. In 1946, Rex Housewright of the Dallas Archeological Society subsequently uncovered a child burial at the site. The site was on a ridge in the

Red River floodplain at the west end of the Goss Plantation. The burial is assumed to be prehistoric in age and included a necklace that contained more than 260 turquoise beads and two turquoise pendants. Because workable turquoise occurs naturally in Arkansas, although the turquoise was assumed to be from New Mexico, the source of this turquoise has not been determined. In addition to the turquoise, R.K. Harris collected a cache of four mussel shell hoes from the site in 1953 (Davis et al., 2014).

The University of Texas investigated the Harling Mound, formerly the Morgan Mound (which measured approximately 230 feet long, 170 feet wide, and 7 feet high), at Riverby, Texas in 1962 (Davis, 1962a, 1962b). No burials were found during mound excavation, but the ceramics recovered dated to the Sanders phase (ca. A.D. 1000-1200). Excavation was conducted because the landowner wanted to level the mound to use the land for agriculture; however, a final report on this investigation has not been written (Davis et al., 2014). A "heavy" boatstone made of red-black hematite was collected on an earlier visit to the site (Harris, 1951).

The first recorded survey in Fannin County was conducted in 1960 for the proposed Brushy Creek Reservoir, now called Valley Lake, located near Bells, TX in west central Fannin County (TASA, 2011). Several prehistoric lithic scatters were recorded during the survey, and they range in age from the Archaic to Caddo (Davis et al., 2014). Furthermore, ground stone fragments were also found at one site.

The Texas State Building Commission (now the Texas Historical Commission [THC]) and the Texas State Water Development Board performed an archaeological survey of the proposed Timber Creek Reservoir (now Lake Bonham) and Bois d'Arc Reservoirs in 1968 (Hsu, 1968). The archaeological survey of the Timber Creek Reservoir identified two sites (41FN15 and 41FN16). Site 41FN15 consisted of a lithic scatter, a Scallorn point, two Gary points, and a potsherd. Site 41FN16 consisted of a Gary point and lithic scatter. Both sites were found on the edge of the first terrace of Timber Creek (Davis et al., 2014).

The proposed dam location that was the subject of the 1968 survey was upstream from the LBCR site currently proposed. Thirteen sites (41FN17 through 41FN29) were found approximately seven miles southwest of Bonham adjacent to Bois d'Arc Creek on knolls within the floodplain and on terraces adjacent to Bois d'Arc Creek. The sites contained mussel shells, animal bones, pottery, flakes, arrow and dart points, celts, axes, fire-cracked rock (FCR), and evidence of human burials (Davis et al., 2014). The sites were found to be either eroding out of creek banks or on the surface of plowed fields; a comprehensive survey was not conducted. One site of particular interest (41FN19) is located on a knoll adjacent to the old Bois d'Arc Creek channel (Hsu, 1968). The knoll is 300 m long by 50 m wide (330 yard by 55 yards), and the site (Hsu's collection) included two projectile points, two sherds, and lithic debris. These sites ranged in age from the Middle Archaic to the Caddo, and the landowner had collected a small ground hematite axe, a polished full groove axe, the proximal half of a polished cylindrical celt, and two incised sherds from the site surface. No functional information about the potential of finding buried cultural resources in the Bois d'Arc Creek floodplain is available because subsurface testing was not part of this survey. Nevertheless, numerous avocational archaeologists have reported finding dart points in the eroding channel bed in this area (Davis et al., 2014).

Southern Methodist University (Jurney et al., 1989) conducted an archaeological evaluation of three units of the Caddo Grasslands in Fannin County in 1989. According to their report, the Bois d'Arc Creek floodplain has high potential for prehistoric archaeological sites while the valley slope has a medium potential (Jurney et al., 1989). Figure 34 in the Jurney et al. report showed that the uplands also represent a high probability for identifying historic sites. The report states that the areas of low probability for historic sites are locations that are too far removed from historic transportation routes such as roads and railroads, and the bottomlands most likely represent a medium potential for historic sites (e.g., crossings or mills) since flooding prevented domestic occupation (Jurney et al., 1989; Davis et al., 2014).

In 2005, ARC investigated approximately 1,700 acres at the proposed location of Lake Ralph Hall, which would be constructed in Fannin County north of Ladonia, in the North Sulphur River floodplain, and seventeen historic and prehistoric sites (41FN60-76) were recorded as a result of the survey (Skinner et al., 2005). Further testing for a Middle to Late Archaic campsite (41FN68), a deeply buried Middle Archaic campsite (41FN66), and a site near the cobble core/chopper tool site (41FN73) was recommended by ARC. Further surveys, studies, or testing in the area would likely lead to the discovery of more deeply buried archaeological sites (Bousman and Skinner, 2007).

Most of these various small-scale surveys and studies that have been conducted throughout Fannin County have found little or no evidence of prehistoric or historic occupation (Davis et al., 2014). ARC surveyed for the South Wastewater Interceptor in Bonham, which tested in the Bois d'Arc Creek floodplain, as well as on the upland toe slope and the overlooking upland ridge, but did not find sites in those settings (Skinner and Davis, 2009).

Other major investigations, including surveys, testing, and site excavation, conducted in surrounding counties include the South Sulphur River valley at Cooper Lake in Delta and Hopkins counties, along Sanders Creek just to the east of Bois d'Arc Creek at Pat Mayse Reservoir, and at Camp Maxey. To the east, studies have been conducted in Pine Creek, at Crook Lake, B&B Landfill, and at the Gene Stallings Ranch near Powderly. A historic Native American site (the Womack site), is located adjacent to the Red River channel in northwest Lamar County. In Red River County further east of the surrounding counties, a survey was conducted at Big Pine Reservoir, and test excavations were conducted at the Mackin Mound site. Summer field schools of the Texas Archeological Society (TAS) conducted studies at the Sam Kaufman site in the early 1990s subsequent to site discovery and major excavation at the site in 1968, and additionally excavated the Ray site in Lamar County. Relevant site information is available from excavations and studies at Hugo Reservoir, McGee Creek Reservoir, and Pine Creek Reservoir in adjacent parts of Oklahoma (Davis et al., 2014).

Programmatic Agreement

In 2010, four parties signed a Programmatic Agreement (PA) regarding compliance with Section 106 of the National Historic Preservation Act (NHPA) of 1966 (as amended) concerning construction of the proposed Lower Bois d'Arc Creek Reservoir (NTMWD et al., 2010). The four parties were the NTMWD; USACE, Tulsa District; THC, the Executive Director of which serves as the State Historic Preservation Officer (SHPO); and the Caddo Nation of Oklahoma. This PA is still in effect and has governed all cultural resources investigations and analysis associated with this undertaking (i.e., the proposed reservoir). The purpose of the PA is to serve as a guidance document that will be relied upon by all parties identified above to ensure that Section 106 requirements are met throughout the life of the project. The PA will serve to guide the work and ensure compliance with Section 106 on a timeline separate from that of the EIS. The PA will be in place for a period of ten years from signing, and may be renewed as needed. An additional agreement document will be drafted and signed by the PA signatories that will outline mitigation or avoidance measures for all identified adverse effects.

The PA notes that Section 106 and its implementing regulation 36 CFR Part 800 require the Tulsa District to ensure both that historic properties are identified and documented, and that any adverse effects to those historic properties are evaluated and resolved prior to any issuance of a Section 404 permit. Because the effects of the Proposed Action on historic properties will not be fully determined prior to approval of the Proposed Action and issuance of the permit, the PA will serve to fulfill the legal requirements of Section 106 of the NHPA by ensuring that adverse effects are identified and resolved prior to any ground disturbance or construction. The development and execution of the PA solidifies the agreement between the Tulsa District, the Caddo Nation, and the SHPO to accomplish the Section 106 process by implementing the PA in accordance with 36 CFR 800.6 and 36 CFR 800.14(b)(3).

The PA also specifies that the Area of Potential Effects (APE) of this undertaking consists of the reservoir proposed footprint itself, up to the elevation of the planned top of flood pool (elevation 541 feet MSL at the crest of the emergency spillway), as well as, "the planned location of the dam and all associated construction and staging areas, the planned new water treatment facility at Leonard, Texas, the pipeline from the new water treatment facility to the discharge point into Pilot Grove Creek, all raw water pipelines between the reservoir and associated existing water treatment facilities, lands manipulated for impact mitigation, plus the full horizontal and vertical extent of any identified cultural or historic resources intersected by or adjacent to any of the above listed project component boundaries and associated impact areas" (NTMWD et al., 2010). This also would include the area of the downsized reservoir alternative, which is located within the Proposed Action's footprint. The discharge point into Pilot Grove Creek cited in the PA is no longer part of the project.

The PA further notes that, prior to contact with Europeans, the Bois d'Arc Creek and Red River drainages in northeastern Texas were occupied by ancestors of the Caddo Nation and thus may retain historic properties of importance to this Nation. The PA states that the four signatories agree that the proposed undertaking (i.e., dam, reservoir, pipeline, treatment plant, and all appurtenant facilities) shall be implemented and administered in accordance with a number of stipulations that would ensure the Tulsa District takes into account the effects of issuing a Section 404 permit on historic properties as required by Section 106 of the NHPA. The Tulsa District is tasked with ensuring that all stipulations and measures are implemented.

The initial and principal stipulation consisted of tasks to "accomplish identification, evaluation, effect determination, and resolution." The first task instructed NTMWD to prepare a research design (described below) to guide cultural resource investigations within the APE. This research design "will synthesize current knowledge about the prehistory and history of the project area using existing records on historic resources, including but not limited to archaeological sites and historic standing structures in the APE." The design proposed a survey methodology appropriate for the particular landscape encompassed by the APE and also developed research questions relevant to the APE that guided testing and data recovery efforts.

In keeping with the PA stipulations, a draft research design was prepared in 2010 by ARC and submitted on behalf of NTMWD to the SHPO, the Caddo Nation Tribal Historic Preservation Officer (THPO), and Tulsa District for review. The reviewing parties returned comments back to ARC, and a second revised draft was submitted and reviewed in the same manner.

The next steps specified in the PA were initial cultural resources investigations and eligibility determinations for the NRHP. Whenever historic or cultural resources were identified within the APE, their eligibility for inclusion in the NRHP was to be assessed using the criteria outlined in 36 CFR 60. Should USACE, SHPO, and Caddo Nation agree that a property is or is not eligible, this consensus would be deemed conclusive. However, if USACE, or SHPO, or Caddo Nation disagreed regarding the eligibility of a given property, the Tulsa District then would obtain a determination of eligibility from the Keeper of the NRHP pursuant to 36 CFR 63.

The term "Cultural Resources" is a broad category which includes historic and prehistoric archaeological sites, deposits and features; historic and prehistoric districts; and built environment resources, including, but not necessarily limited to, buildings, structures (e.g. bridges), and objects. Traditional cultural properties and sacred sites, including cemeteries, human remains, and features or sites associated with significant events or practices in the traditional culture of an ethnic group are also deemed cultural resources.

Consistent with terminology defined in 36 CFR 800.16, the term "historic property" is used to denote all cultural resources identified as eligible for listing in the NRHP. Cultural resources determined to be ineligible for inclusion in the NRHP would require no further protection or evaluation.

Subsequent steps in the first stipulation of the PA outline procedures for Findings of No Adverse Effect, Findings of Adverse Effect, and Resolution for Adverse Effects. Additional stipulations pertain to curation and disposition of recovered materials, treatment of human remains, inadvertent discoveries of historic properties, and dispute resolution.

Reservoir-Related Investigations – Archeological and Historical Architectural Investigations

ARC conducted extensive archeological and historical architectural field investigations during 2011 and 2013 to identify cultural resources within approximately 5,000 acres of the entire 16,641-acre proposed LBCR site. The 2011 and 2013 surveys focused on the dam and reservoir footprint APE for the project, which is all land upstream from the dam location and below an elevation of 541 feet MSL (Davis et al., 2014). The majority of the reservoir study area is in the floodplain or on the first and second terraces of Bois d'Arc Creek. However, the historical architectural fieldwork and survey were conducted on the valley slope, which is part of the prairie upland south of the creek. All fieldwork was conducted in accordance and consistent with the stipulations outlined in the PA above. Methodology information discussed in this section relies heavily on ARC's report (Davis et al., 2014).

Research Design

The ARC reservoir APE surveys conducted in 2011 and 2013 as described above were designed to address a series of 11 hypotheses developed to implement and direct a better understanding of the archeological record in the region as well as to guide interpretations from field survey findings.

1. Hypothesis 1 states that the valley contains stratified alluvial soils designated by the Natural Resource Conservation Service (NRCS) Soil Surveys as "frequently flooded." This would imply that stabilized depositional sequences have laid down well-stratified deposits in the area, providing an intact archeological record.
2. Hypothesis 2 says that the duration of habitation within the valley (seasonal versus permanent) directly reflects the types of resources being used and/or available to Native populations. Well stratified sediments from the floodplain would also reflect these changes in the local ecotone over time.
3. Hypothesis 3 addresses Paleoindian use-patterns in the area, and states that the region's earliest visitors used seasonal resources, using locally available resources to overwinter.
4. Hypothesis 4 states that, following climatic shifts associated with the end-Pleistocene, Archaic peoples settled into the region and established informal territories to support increasing populations based marginally on hunting bison.
5. Hypothesis 5 indicates that Middle and Late Archaic population increase in the region will be reflected in toolkit contents, artifact density, and site activity areas and settings.
6. Hypothesis 6 states that during the Woodland, or Fourche Maline period, populations continued increasing and permanent housing and ceramic technology make an appearance in the region associated with the arrival of agriculture.

7. Hypothesis 7 indicates that during the Formative-Middle Caddo period villages will be found on the terraces north of Bois d'Arc Creek where arable soil and year-round water are available. Fully sedentary culture should be apparent by the appearance of permanent buildings, mounds, and ceramic traditions.
8. Hypothesis 8 says that Late Caddo sites will be located in the same areas as before, but population will dwindle with a climatic shift toward drier conditions. Specialized toolkit items such as refined bow and arrow technology will also identify this period.
9. Hypothesis 9 addresses Historic Caddo occupations in the region. These sites will be in the same areas of arable land along the northern side of Bois d'Arc Creek and will be identifiable by the presence of European-manufactured trade goods and iron tools.
10. Hypothesis 10 states that Historic European settlers in the region prior to the Civil War would have occupied similar areas as Caddo populations but will be identifiable by collapsed rock chimneys on arable, tillable land above normal flooding zones.
11. Hypothesis 11 covers local populations from the Civil War to the present and is based largely on the presence of standing structures, many of which are expected to be located near the site of previous or older structures.

Sample Design Methodology

To develop the approach for the survey methods, it was assumed that certain areas are intrinsically more likely to have intact cultural resources and deposits. Subsequently, a stratified hierarchical approach was used. The assumption that certain areas may contain more resources is based on the knowledge that archeological site locations are usually associated with certain landforms, elevations, soil types, and proximity to existing resources. Sample design methods also involved the use and examination of historical maps and imagery to identify potential historical sites (Davis et al., 2014). In addition, Light Detection and Ranging (LiDAR) was used to identify elevations within the project area. Based on the evaluation of historical maps and imagery researched, combined with the use of the stratified hierarchical approach, ARC designated terraces and their associated slopes as the higher probability areas. The trends for prehistoric resources were anticipated to correspond to historic archeological resources, with the exceptions being infrastructural or non-occupational sites such as roads, bridges, trash piles, etc. (Davis et al., 2014).

Field Survey Methodology

The pedestrian survey began with two tasks, the first of which was a reconnaissance survey of the accessible parts of the present creek channels and the original channel sections that were bypassed by channelization. The second involved a geomorphological study of the terrace sediments (and floodplain) to preliminarily evaluate and assess the archaeological potential of the reservoir area. The geomorphological study focused on the recognition and correlation of buried soils and documentation of flood deposition and erosion episodes (Davis et al., 2014). The channel sections in the floodplain were considered lateral transects and were projected to locate areas that could be studied geomorphologically as a result of "representative profiles" created by erosion over time. In addition, these profiles would provide the opportunity to recover organic materials for radiocarbon dating and environmental reconstruction. Furthermore, these profiles provided the depth to the base of the exposed Late Pleistocene subsoil or the bedrock under it. Inspections completed when the creek level was at a seasonal low provided evidence of site deposits, levees, point-bars, and filled in channel profiles in the channel walls (Davis et al., 2014).

The initial reservoir sample area was recommended to be approximately 3,800 acres, which represented approximately a 20 percent sample of the reservoir area (Skinner et al., 2010). The initial survey and draft report were completed in 2011 and summarized the findings of the survey. After several meetings with the USACE and the THC, it was decided in 2011 that an additional 1,200 acres needed to be surveyed to more effectively and completely evaluate the potential impacts to resources. The additional 1,200 acres represented an additional 10 percent sample project area, bringing the total to 30 percent. The survey areas are shown on Figure 3.14-1 and summarized in Table 3.14-1 (Davis et al., 2014). Twenty-four survey areas were established, and field crew members walked within each individual transect to evenly cover all visible ground surfaces. Survey areas A through I, N through R, T, and U were ¼ mi wide (0.4 km); the survey area at the proposed dam location was ½ mi wide (0.8 km); and survey areas J, L, M, V, and W were ⅛ mi wide (0.2 km). Survey areas K and S were both 100 feet (30 m) wide. The most extensive impacts from construction activities are associated with the floodplains and the terraces which would be eroded by fluctuations in reservoir levels. Subsequently, the survey areas were selected so that they crossed a variety of settings, with a focus on the floodplains and terraces. The survey areas also incorporated parts of microenvironments within the proposed reservoir area with a focus on attaining a representative sample from both high and low potential areas (Davis et al., 2014).

Table 3.14-1 Quantitative Survey Descriptions

Transect/ Survey Area	Total Acres	Floodplain Acres	Terrace Acres	Upland Acres	Percent Floodplain	Percent Terrace	Percent Upland
Dam	645.40	427.30	160.80	57.30	66.21%	24.91%	8.88%
A	438.39	141.30	251.80	45.29	32.23%	57.44%	10.33%
B	657.00	209.00	448.00	0.00	31.81%	68.19%	0.00%
C	156.62	125.00	31.62	0.00	79.81%	20.19%	0.00%
D	175.00	163.00	11.00	1.00	93.14%	6.29%	0.57%
E	102.70	102.70	0.00	0.00	100.00%	0.00%	0.00%
F	100.07	19.35	40.94	39.78	19.34%	40.91%	39.75%
G	303.39	139.50	36.69	127.20	45.98%	12.09%	41.93%
H	309.10	244.60	0.00	64.50	79.13%	0.00%	20.87%
I	58.20	33.70	18.70	5.80	57.90%	32.13%	9.97%
J	110.73	6.33	101.40	3.00	5.72%	91.57%	2.71%
K	508.80	508.80	0.00	0.00	100.00%	0.00%	0.00%
L	105.79	38.69	67.10	0.00	36.57%	63.43%	0.00%
N	57.57	43.61	0.00	13.96	75.75%	0.00%	24.25%
O	29.31	0.00	24.61	4.70	0.00%	83.96%	16.04%
P	224.90	38.50	186.40	0.00	17.12%	82.88%	0.00%
Q	232.76	34.70	168.80	29.26	14.91%	72.52%	12.57%
R	28.75	6.80	0.00	21.95	23.65%	0.00%	76.35%
S	163.30	1.60	0.00	161.70	0.98%	0.00%	99.02%
T	164.80	129.46	0.00	35.34	78.56%	0.00%	21.44%
U	249.70	226.60	0.00	23.10	90.75%	0.00%	9.25%
V	11.86	1.19	9.66	1.01	10.03%	81.45%	8.52%
W	33.88	14.89	18.99	0.00	43.95%	56.05%	0.00%
Totals	**5004.32**	**2665.12**	**1704.31**	**634.89**	**53.26%**	**34.06%**	**12.69%**

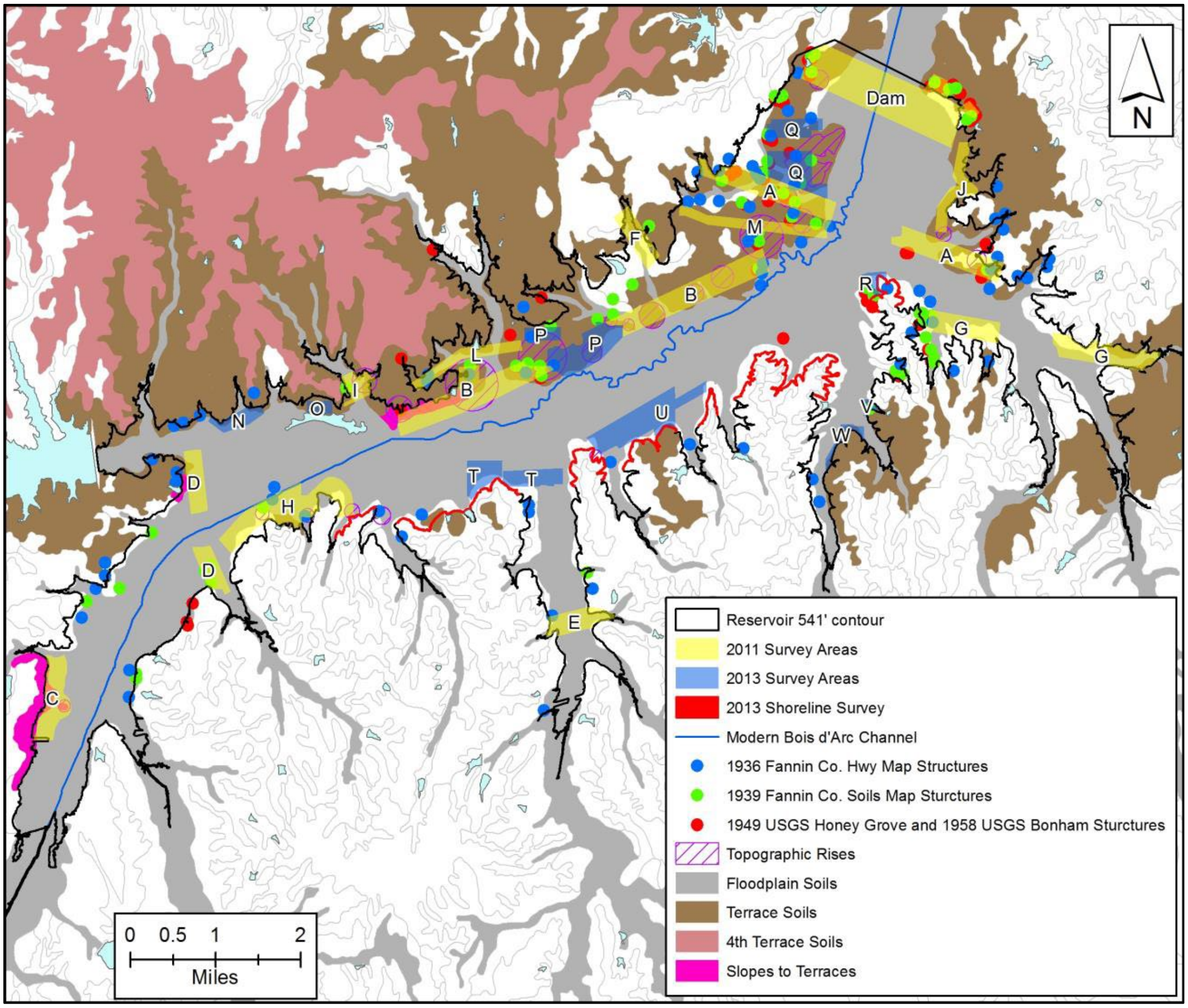


Figure 3.14-1. ARC Survey Transect Areas

Source: Davis et al., 2014

Field methods were designed to gather baseline information and data related to the location and recording of cultural resources within the survey areas for the purpose of making a preliminary assessment of NRHP eligibility. The inventory of recorded sites in the survey areas provides information related to site distribution and density, size and deposit depth, artifact groupings, ecofact conservancy, and dating potential (Davis et al., 2014). The information gathered as part of the field methods were used by ARC to develop recommendations for sites and areas that require or would benefit from additional or more extensive cultural resource investigations. This includes testing and mitigation of sites that are eligible for listing on the NRHP. Pedestrian survey data collection methods include conducting shovel testing, performing geomorphological assessments using trenches, and completing archival and oral history research (Davis et al., 2014).

As part of the terrace settings, the field crew walked parallel and individually numbered transects, spaced 20-30 m apart. The field crew excavated shovel tests along the transects in each survey area at approximately every 75 to 100 meters (69 to 91 yards) and took detailed notes on ground exposure, soil types, and topographic settings encountered. The excavation of shovel tests were concentrated where artifacts were present on the surface or on topographic rises, ridge tops, knolls, and on terrace edges, with an average of two to three shovel tests per acre excavated in the high potential terrace sediments. The dimensions of all shovel tests were approximately 30 cm (12 in.) in diameter, extended to 80 cm (31 in.) below surface (cmbs) or to the bottom of the Holocene deposit (THC, no date-a), and were performed at 10 cm levels (Davis et al., 2014).

The focus of the floodplain survey was centered at the floodplain edge, where it meets the first terrace, and the channel edge, where overbank levees might have been. The field crew made extensive notes on ground exposure and soil types for each survey area. Parallel transects were used to examine creek banks in the Bois d'Arc Creek channel. An average of one shovel test per acre was excavated in the floodplain, and the shovel tests were only performed in those settings where buried deposits were expected to be encountered within the top 60 to 80 cm (24 to 32 inches) of sediment below the present ground surface. The soils in the face of the bank were profiled at regular intervals using picks to examine the stratigraphy. Handheld GPS units were used to record profile locations, and *in situ* recordings of artifacts exposed in the bank were made. Shovel testing was also conducted on elevated rises within the floodplain and in areas where mussel shells, animal bones, and other artifacts were noted on the surface during the survey. In areas where buried cultural deposits were located beneath a meter or more of alluvium, trenching and shovel tests were conducted as described above (Davis et al., 2014).

To determine if cultural materials were present in the diversity of soil profiles, clay soils were broken apart, hand sorted, and visually inspected, while sandy soils were screened using a ¼ inch hardware cloth. The Munsell Soil Color Chart was used to compare the texture and color of soils gathered from the shovel test matrices to already categorized soils. A shovel test form was completed for each location, recording the number of artifacts and soil type. As noted above, handheld GPS units were used to record the locations of artifacts and soil types. All subsurface artifacts were collected in 10-cm (4-inch) levels for analysis and curation. Temporally and functionally diagnostic artifacts located on the surface were mapped and collected for analysis and curation, and all artifacts identified were photographed using digital cameras (Davis et al., 2014).

All sites were documented during the survey using a standard Texas State Site Form. Field sketch maps were drawn incorporating local landmarks, shovel tests locations, features, and site boundaries. Prehistoric sites were delineated using six or more shovel tests to determine the subsurface extent of cultural deposits, surface artifact scatters, and in the case of terrace and floodplain deposits, backhoe trenches. The standard methodology for determining the site edge/boundary was that shovel tests were excavated outward from the point of discovery until no evidence of a site deposit was present, as indicated by an absence of artifacts or cultural deposits. Data collected included the criteria necessary for making initial recommendations for a site's inclusion to the NRHP including: site integrity, features, cultural context, potential for intact buried deposits, and artifactual materials present.

Historic site horizontal and vertical site boundaries were defined using shovel tests, as well as surface scatters of artifacts, parcel and aerial maps, layout of structures, and structural remains. Vertical site boundaries (i.e., deposit depths) were specifically defined using shovel tests, supplemented by bucket augering and backhoe trenching in the terrace and floodplain sediments. Horizontal site boundaries were specifically defined using surface scatter and six or more shovel tests where ground visibility was less than 30 percent. Similar to the discussion of prehistoric sites above, shovel tests were excavated outward from the point of discovery until no evidence of a site deposit was present, as indicated by an absence of artifacts or cultural deposits. Historic site types were tentatively identified based on cultural context and cultural material present. An architectural historian evaluated and documented all standing structures to make NRHP eligibility evaluations. All structures built before 1970 were evaluated by the architectural historian. The NRHP potential of historic sites was evaluated on integrity of site deposits and structural remains, features and archaeological materials present, cultural context, and associated persons of significance to the area.

In the event cemeteries (prehistoric and historic burials of any type) were found, the cemeteries were to be carefully evaluated using typically non-invasive initial means to determine horizontal extent (e.g., scraping the surface to obtain a better initial evaluation on the perimeter of the cemetery and unmarked graves) prior to full-scale mechanical excavation. These activities were to be conducted in accordance with consultations and coordination with the THC and the Caddo Nation (depending on whether the site was determined to be historic or prehistoric) prior to excavation, and applicable notifications would be issued. The evaluation and determination of horizontal extent was to be conducted in accordance with Section 711 of the Texas Health and Safety Code (which requires mitigation and re-interment of human remains to be inundated or otherwise negatively impacted). Prehistoric burials and cemeteries were specifically addressed in accordance with and following the Treatment Plan and were excavated in consultation and coordination with the Caddo Nation. Historic cemeteries evaluation and identification utilized some minor mechanical equipment (to scrape the surface to identify individual unmarked graves as noted above) to identify the perimeter of the cemetery (e.g., the Wilks Cemetery).

Additionally, because the land is owned by NTMWD, a political entity of the State of Texas, it is subject to state burial laws, and all work was conducted as per the stipulations outlined in the "Treatment Plan for Caddo Culturally Affiliated Human Remains" and "Treatment Plan for Native American Human Remains or Unmarked Burials", which was performed in a manner consistent with the PA and with Title 13, Part II, Chapter 22, Cemeteries, and any other requirements under Chapter 711 Of The Texas Health And Safety Code, and The Antiquities Code of Texas (Title 9, Chapter 191 of The Texas Natural Resources Code). The Treatment Plans outline the steps to be taken in the event that human remains are encountered during archaeological survey, shovel testing, unit excavating, land clearing, construction activity and/or shoreline erosion, or any other unanticipated effects of the project for the duration specified in the individual plans.

An extensive geomorphology survey was conducted using a backhoe to provide cross sections of terraces throughout the project area and to provide a baseline for paleoenvironmental reconstruction. Trenches were used to define the vertical limits of deeply buried deposits within the sites, and geomorphologist, Ms. Stephanie Coffman, conducted four streambank profiles and nine backhoe trench profiles in the project area. All of the profiles were located along the creek, within the floodplain, or on the slope of the terraces adjacent to the floodplain. These data were used to establish floodplain and terrace development, which assists in creating a natural history of the region and enables archeologists to identify site creation processes and likely depositional sequences within sites in a variety of settings. Profile drawings were made, samples were screened, and carbon and soil samples were taken to establish age ranges.

Historic archive research was performed by ARC, who consulted numerous state and local resources including the THC online Atlas, Fannin County land abstracts and tax records, and Fannin County Clerk's Office deeds and titles. In addition, historical aerial photos and historic maps were also consulted. Personal interviews were carried out using a standardized questionnaire directed toward the project area to establish a local historical narrative, document private artifact collections, and to locate cultural resources.

All prehistoric artifacts were analyzed using a variety of methods to gain the maximum amount of information from the sampling. Lithic artifacts were defined by typology, stage of manufacture, function, and probable material source. Lithic tools were analyzed in an attempt to identify any discernable hunting and foraging patterns through time, in particular from Paleoindian through Archaic compared to Late Prehistoric/Caddo. Basic ceramic identification was conducted based on known typologies, with thickness, paste, slip, and visible decorations recorded. Other artifacts were used in a variety of manners: snails were used for paleoclimatic reconstruction, mussel shell for occupation patterns, and charcoal for direct dating of buried cultural deposits.

Historic artifacts, largely being of known source and age, were sorted into typologies and described by their diagnostic attributes. These attributes contribute to an understanding of historic-era cultural settlement and land-use patterns in the project area.

Concurrent to archeological investigations, ARC also conducted a historical architecture investigation for the proposed reservoir. The following discussion of this investigation relies entirely on ARC's report (Davis et al., 2014).

Historical Architectural Design Methodology

The historical architecture survey was carried out to identify any potential NRHP properties that could be negatively impacted by the construction of the Lower Bois d'Arc Creek Reservoir. One hundred percent of the proposed reservoir was examined in this effort. Structures dating to 1970 and prior were considered historic in age during this survey.

Four factors were used to determine NRHP eligibility during the investigations. These criteria, presented in 36 C.F.R § 60.4[a-d], are (Davis et al., 2014):

(a) association with events that have made a significant contribution to the broad patterns of our history; or

(b) association with the lives of persons significant in our past; or

(c) embodiment of the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) yielding, or may be likely to yield, information important in prehistory or history (primarily archaeological).

In addition to these criteria, a structure must possess some level of the seven characteristic aspects of integrity, as defined by the NRHP: location, design, setting, materials, workmanship, feeling, and association.

Birthplaces and graves of historic persons, cemeteries, religious institution-owned properties, moved structures, reconstructed buildings, commemorative properties, and properties which have gained historical significance in the last 50 years are not considered eligible for the NRHP unless they are a (Davis et al., 2014):

(a) religious property deriving primary significance from architectural or artistic distinction or historical importance; or

(b) building or structure removed from its original location but which is significant primarily for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or

(c) birthplace or grave of a historical figure of outstanding importance if there is no appropriate site or building directly associated with his or her productive life; or

(d) cemetery which derives its primary significance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or

(e) reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

(f) property primarily commemorative in intent of design, age, tradition, or symbolic value has invested it with its own exceptional significance; or

(g) property achieving significance within the past 50 years if it is of exceptional importance.

Background information for the project area was derived from the THC's Texas Historic Sites Atlas (THSA), Texas State Historical Association's "Handbook of Texas Online", Fannin County Chamber of Commerce, Fannin County Library, Fannin County Historical Society, Fannin County Historical Museum, the Portal to Texas History, and other available books and resources. Oral histories were gathered by ARC and previous interviews conducted by the Fannin County Historical Society were used as well. Historic aerial photographs and maps were also used in locating potential structures to visit during fieldwork.

Summary of Archaeological, Historical and Architectural Field Survey Results

Field Survey Results – Archaeological Sites

The sediments of the LBCR project area contain a variety of archaeological resources dating from the Middle Archaic to Historic periods. Most of the prehistoric sites seem to be temporary and seasonal occupations. As part of the initial 2011 survey, approximately 40 linear miles (500 acres) of creek channels were walked, along with the roughly 4,500 acres that were surveyed to identify the presence of historic properties. Roughly 30 percent (including the additional 10 percent of the proposed reservoir footprint agreed to be surveyed in 2013 to fulfill the obligation of the Texas Antiquities Permit) of the proposed reservoir was surface inspected, and areas that were not within the designated archeological survey areas (i.e., Bois d'Arc Creek and tributary stream channel areas) were also included in this number (Davis et al., 2014). A total of 61 archaeological sites and 26 Isolated Objects (IOs) (31 prehistoric, 26 historic, and four prehistoric/historic multi-component) were recorded (41FN95-142 and 41FN147-159). This represents an average of one archaeological site per 86 acres. Three of the archaeological sites (41FN139, 140, and 142) that were previously reported by local informants to ARC during the 2011 survey were tested in 2013 as part of the additional 30 percent identified above and were identified not to exist. Subsequently, these three sites have been removed/eliminated from the number of identified sites, resulting in a total of 58 sites. The site 41FN141 consisted of a prehistoric lithic scatter found and reported 1.1 km (0.7 mile) east of CR 2610. Due to its location outside the proposed reservoir on private property, it was not recorded, but its location was documented with a trinomial. The site needs to be delineated before a recommendation on its eligibility for listing in the NRHP can be made; however, it will not be impacted by this project. A tabular summary and individual descriptions of these archaeological sites are provided below and in Appendix S.

Most of the identified archaeological sites from the 2011 and 2013 surveys date to the 20th century, except for Wilks Cemetery (41FN96) and sites 129, 137, 138, 148, 154, 157, 158, and 159. The eight sites appear to represent the sparse remains of late 19th to early 20th century homesteads and farmsteads. Three of these sites could be linked to the same rural communities, and oral histories confirm that most 19th century residences were eliminated to increase the amount of farm and pasture land or were replaced by more modern structures that utilized space more efficiently. Based on the results of the archaeological and architectural investigations, ARC recommends that most of the prehistoric and historic site identified during the surveys in 2011 and 2013 were not eligible for listing on the NRHP or as State Antiquities Landmarks (SALs) (Davis et al., 2014). Although most of the identified sites are not eligible for listing on the NRHP or as SALs, 17 archaeological sites (both historic and prehistoric) are recommended for further testing and research to determine their eligibility for the NRHP: 41FN108, 109, 110, 113, 114, 118, 119, 120, 122, 136, 137, 138, 148, 151, 154, 156, and 159. These sites require further testing and research at a scale larger than the survey level to determine the full vertical and horizontal extent of the sites and to assist in recommending whether or not the site should be recommended as eligible for listing on the NRHP. The Wilks Cemetery has an undetermined eligibility for listing on the NRHP but will be relocated prior to the construction of the reservoir and will be evaluated for eligibility during that phase of the project (Davis et al., 2014).

Field Survey Results – Historic Structures/Buildings

Historic aerial photographs document a decrease in the number of buildings and structures within the project area through time, dropping from 81 structures in 1936, to 44 structures in 1976. At the time of ARC's survey, which included extensive archeological and historical architectural field investigations conducted during 2011 and 2013 to identify cultural resources within the entire 16,641-acre Lower Bois d'Arc Creek Reservoir survey, many more structures had disappeared and two had burned in wildfires. A total of three structures were not accessible due to right-of-entry issues. These structures were subsequently not evaluated by historians. ARC's historical architecture survey encompassed the entire proposed lake area (541 feet MSL and below) and identified a total of 38 architectural resources within the proposed Lower Bois d'Arc Creek Reservoir boundaries (Davis et al., 2014). Of these 38, ARC made a preliminary investigation of nine of the sites identified during the archeological survey to evaluate if it was appropriate to assign (archeological) site trinomials (assigned by the Texas Archeological Research Laboratory). Some of these architectural resources were associated with recorded archaeological sites, and most structures were conglomerations of styles and were not readily identified with any particular style of construction.

Agricultural outbuildings were the most numerous constituting 63 percent of the 38 historic architectural resources documented. Domestic structures (primary and secondary) composed 32 percent, while single commercial structures represented 2.5 percent of total as did the one religious structure documented. More than one-half of the structures recorded were built between 1939 and 1955, while most of the rest were built/constructed during the gaps in aerial photography from 1950 to 1976 with the exception of the New Jerusalem Baptist Church (41FN98) in Carson. Based on the appearance of 41FN98 on a Fannin County map in 1936, it is presumed the structure was built prior to 1936 and was moved to its present location, from two miles (3.2 km) north, in 1940 after its African-American congregation was displaced by formation of the Caddo National Grasslands (Davis et al., 2014). Of the 38 documented structures/buildings, none were found to have significant associations with events that made a contribution to the broad patterns of history (NRHP Criterion A) or persons important to the past (NRHP Criterion B). In addition, none of the resources evaluated were found to be an outstanding example of a type, period, or method of construction, nor were any found to be the work of a master (NRHP Criterion C), nor likely to yield information important to history or prehistory (NRHP Criterion D). Furthermore, no architectural resource was determined to meet any of the special requirements under Criteria Considerations A-G. For these reasons, ARC recommended that all 38 historic-age architectural resources evaluated are ineligible for listing in the NRHP (Davis et al., 2014). No further surveys will be conducted because the historical architecture survey encompassed the entire project area, and additional surveys are not required. A tabular summary and individual descriptions of these structures are provided in Table 3.14-2 in the following section.

Identified Historic Buildings and Structures at or Near the Reservoir

Within the Reservoir APE

Table 3.14-2 summarizes the site subtype and style for each of the known historic buildings and/or structures identified within the reservoir APE.

Table 3.14-2. Historic Buildings and Structures Within the Reservoir Basin

Resource ID	Subtype	Style	Constr. Date (ca.)
1a	Domestic, single-family dwelling	One-story, wood-frame house; L-shaped footprint; hipped roof with side gable; low-pitched roof clad with composite shingles	1950
1b	Agricultural, outbuilding	Front-gabled, rectangular shed clad with vertically placed sheets of corrugated metal	1950
2a	Domestic, single-family dwelling	Cross-gabled, wood-frame house; rectangular footprint with irregular projections	1940
2b	Agricultural, outbuilding	Rectangular outbuilding clad with corrugated metal; roof clad with corrugated metal with exposed rafters; double corrugated metal doors	pre-1976
3a	Domestic, single-family dwelling	One-story, rectangular, wood-frame house with full-width, extended roof porches on the facade and rear elevation	1970
3b	Agricultural, outbuilding	Wood-frame shed with corrugated metal cladding; roof no longer intact, but appears to have been a shed roof	1970
3c	Agricultural, outbuilding	Rectangular, side-gabled, wood-frame structure clad with sheets of metal	1970
4a	Domestic, single-family dwelling	Originally a rectangular, front-gabled dwelling, four rooms deep, with incised porch supported by square posts and containing two entry doors	1948
4b	Agricultural, outbuilding	Pole barn with rectangular footprint; barn and roof clad with sheets of corrugated metal	pre-1976
5a	Domestic, single-family dwelling	Rectangular, wood-frame dwelling resting on wood piers; 2 bays wide and 1.5 rooms deep	1939
5b	Agricultural, outbuilding	Two bay, rectangular, wood-frame structure clad with horizontal boards; front-gabled roof clad with corrugated metal; no doors intact	1939
5c	Agricultural, outbuilding	Rectangular, wood-frame structure; cladding consists of both horizontal and vertical boards	1939
5d	Agricultural, outbuilding	Rectangular, wood-frame structure clad with corrugated metal; shed roof clad with corrugated metal.	1939
5e	Agricultural, outbuilding	No style; wood-frame structure clad with corrugated metal	1939
6a	Domestic, single-family dwelling	Wood-frame dwelling clad with horizontal wood boards; side-gabled with ell and carport and storage room inserted in L	1950
6b	Domestic, secondary structure	Freestanding metal roof supported by metal poles on one side and wood poles on the other	pre-1976
6c	Agricultural, outbuilding	Rectangular pole barn clad with corrugated metal; side-gabled roof clad with corrugated metal; three bays in width	pre-1976
7a	Domestic, secondary structure	Long, rectangular pole shed 5-6 bays in width measuring 15'9" by 86'2	pre-1976
7b	Agricultural, outbuilding	Long, rectangular pole shed clad with composite shingles resembling yellow brick over horizontal boards	pre-1976
8a	Domestic, single-family dwelling	Minimal Traditional; wood-framed, cross-gabled dwelling clad with composite shingles resembling yellow brick over rabbeted horizontal boards	1950

Resource ID	Subtype	Style	Constr. Date (ca.)
8b	Agricultural, outbuilding	Rectangular, wood-frame shed; clad with salvaged materials including wood planks and corrugated metal	pre-1976
8c	Agricultural, outbuilding	Three-bay shed; front-gabled center section with a shed addition on east and west elevations	pre-1976
8d	Agricultural, outbuilding	Rectangular, pole shed; clad with variety of sheet metal including corrugated, crimped and V-channel; shed roof clad with crimped metal	pre-1976
9	Agricultural, outbuilding	Side-gabled pole barn with shed attachments on both sides forming a broken-roof; structure and roof clad with corrugated metal	pre-1976
10	Religious	New Jerusalem Baptist Church; T-shaped footprint with intersecting gable roof; wood frame building clad with horizontal composite siding with limited corrugated metal skirting remaining; front-gabled facade with drop-roofed entry porch supported by square cut-lumber supports with side balustrades	Prior to 1940; additions: 1984.
11	Commerce, community store	Wood framed, rectangular building with board and batten cladding; side-gabled roof with crimped-metal cladding and exposed rafters	1940
12a	Domestic, single family dwelling	1 ½ story, wood frame house clad with composite siding and with later lean-to addition on the east elevation	1955
12b	Agricultural, outbuilding	Rectangular, wood-frame shed clad with corrugated metal; roof clad with corrugated metal	pre-1976
13	Agricultural, outbuilding	Rectangular pole barn with side-gabled roof	1946
14a	Domestic, single-family dwelling	Rectangular, wood frame house with side-gabled roof; horizontal wood planks clad with Insulbrick siding; roof clad with metal over framing	1950
14b	Agricultural, outbuilding	Small, wood-frame shed clad with horizontal wood planks; side-gabled roof clad with corrugated metal roof and exposed rafters	pre-1976
15a	Domestic, single-family dwelling	Craftsman; wood-frame dwelling clad with metal siding; front-gabled roof with exposed rafters and braces; roof clad with crimped metal	1942
15b	Agricultural, outbuilding	Front-gabled pole barn; clad with wood planks; roof covered with various types of metal	1950, addition 1960
16	Agricultural, outbuilding	Front gabled storage shed with lean-to garage with shed roof; shed clad with vertical board-and-batten wood planks	1940
17a	Agricultural, outbuilding	Large, front-gabled, hay barn with mangers on both sides; approximately 75 feet wide x 110 feet long; framing consists of both Bois d'Arc and metal poles; walls and roof clad with sheets of corrugated metal; exposed rafters	1950
17b	Agricultural, outbuilding	Front-gabled, rectangular pole barn with lean-to shed on west elevation; cladding is wide wood planks covered with metal sheets	1950
18	Agricultural, outbuilding	Small open-front pole shed; approximately 20 feet wide by 17 feet long; board-and-batten cladding on three sides; open facade; roof clad with corrugated metal sheets	1950
19	Agricultural, outbuilding	Barn with rectangular footprint; gabled roof clad with sheet metal	pre-1976

Outside of the APE

No survey data are available of historical architecture outside the physical APE for the project.

Identified Historic Cemeteries at or Near the Reservoir

Within the Reservoir APE

The cemetery located within the area that would be inundated as a result of the Proposed Action is the Wilks Cemetery (FN-C020 and 41FN96) (TASA). This cemetery was used until 1932 and contains burials dating back to 1852, which is considered early for the region (Davis et al., 2014). The Wilks Cemetery (Site 41FN96) is located at an elevation of 533 feet MSL. approximately one mile (1.6 km) south of Coffee Mill Lake and 0.8 mile (1.3 km) west of Bois d'Arc Creek on the north shore of the proposed reservoir basin. It encompasses about 0.3 acres (80 by 180 feet) but extends an additional 595 feet west to an outlying grave marker belonging to Charity Bonham (died 1865) and Louisa A. Bonham (died 1866). The cemetery was used from 1852 (M.G. Gagle) to 1927 (Milton Wilks) and includes 39 marked graves within its physical boundaries as summarized in Table 3.14-3 below. To test for additional graves, exploratory shovel tests were conducted outside of the cemetery; all shovel tests were negative and did not identify any additional graves. Because the site would be impacted by the project and subsequently relocated, it has an undetermined status for the NRHP until it can be fully evaluated during the relocation phase (Davis et al., 2014).

Table 3.14-3. Known Interments in the Wilks Cemetery, Fannin County, Texas

Number	Name	Birth Year	Death Year	Notes
1	-	-	-	Wood Head Marker
2	-	-	-	Wood Head Marker
3	Wilks, Newton	1855	1901	-
4	Wilks, Charles Jefferson	1888	1896	Son of Newton & Mary
5	Wilks, Eliza N.	1886	1888	Son of N.& M.H.
6	Wilks, Frederick B.	1884	1885	Son of Newton & Mary
7	Wilks, Margaret J.	1814	1869	wife of Thomas A.
8	Wilks, Thomas A.	1800	1871	-
9	Wilks, Infant	1881	1881	child of Milton & Betty
10	Wilks, Noah	1882	1883	son of Milton and Betty
11	Wilks, Emsy E.	1884	1885	Son of M.& B.
12	Wilks, Betty	1853	1887	Wife of Milton
13	Wilks, Milton	1857	1927	-
14	Wilks, Florence E.	1872	1901	2nd wife of Milton Wilks
15	Wilks, Cora	1889	1889	Daughter. of Milton & F.E.
16	N.W.	-	-	Footstone
17	C.J.	-	-	Footstone
18	E.N.W.	-	-	Footstone
19	F.B.W.	-	-	Footstone
20	M.A.W.	-	-	Footstone
21	T.A.W.	-	-	Footstone
22	None	-	-	Footstone
23	N.W.	-	-	Footstone
24	E.E.W.	-	-	Footstone
25	B.W.	-	-	Footstone
26	M.W.	-	-	Footstone

Number	Name	Birth Year	Death Year	Notes
27	F.E.W.	-	-	Footstone
28	C.W.	-	-	Footstone
29	Cagle, M.G./S.C. Cagle	1809/1814	1852/1861	
30	M.V.C.	-	-	Footstone
31	E.C.C.	-	-	Footstone
32	S.H.H.	-	-	Footstone
33	M.S.C	-	-	Footstone
34	M.G.C	-	-	Footstone
35	S.C.C	-	-	Footstone
36	J.H.C	-	-	Footstone
37	-/Louisa A. Bonham	1812/1864	1865/1866	Charity Wife of David Bonham/Daughter of J. and P.E. Bonham
38	C.B.	-	-	Footstone
39	L.A.B	-	-	Footstone

Source: Davis et al., 2014

Outside of the APE

Outside the flood pool of the proposed reservoir, 19 other historic cemeteries are located within the general vicinity. These cemeteries have not been formally recorded as archaeological sites.

1. Historic Russell Cemetery (Site 41FN58) is located on the outskirts of Bonham and north of Pig Branch. The site is at an elevation of 580 feet MSL and covers an area of 30 x 30 m (33 x 33 yds.). The cemetery contains an estimated 22 interments dating from 1853 to 1967.
2. The Gum Springs Cemetery (FN-C068) is located about 1.6 miles (2.6 km) northwest of Bois d'Arc Creek at an elevation of about 550 feet MSL elevation. The cemetery is occasionally referred to as the Carson Cemetery because of its proximity to the town of Carson. The cemetery has an estimated 250 burials ranging from 1880 through the present.
3. The White Family Cemetery #2 (FN-C085 is one of two White Family Cemeteries in Fannin County) is about 1.1 miles (1.8 km) northwest of Bois d'Arc Creek at an elevation of about 545 feet MSL elevation. Records suggest this cemetery contains an estimated 15 interments ranging from 1870 to 1940.
4. The Center Grove Cemetery (FN-C067) is located about 2.2 miles (3.5 km) northwest of Bois d'Arc Creek at an elevation of about 580 feet MSL. The cemetery contains an estimated 95 interments ranging from 1877 to 1963.
5. The Owens Chapel Cemetery (FN-C086) is located about 2.2 miles (3.5 km) northwest of Bois d'Arc Creek at an elevation of about 590 feet MSL. The cemetery is sometimes called the Old Danner Cemetery. It contains more than 250 interments ranging from the 1880s to the present.
6. The Stancel Cemetery (FN-C066) is located about 1.1 miles (1.8 km) north of Bois d'Arc Creek and about 2.5 km east of Lake Bonham at an elevation of about 550 feet MSL. It contains four interments dating to the 1870s.
7. The Shiloh Cemetery is located about 1.4 miles (2.2 km) east of Honey Grove Creek at an elevation of about 590 feet MSL. More than 250 interments are present, ranging from 1860 to the present.
8. The Vineyard Grove Cemetery is located about 2.9 miles (4.6 km) southeast of Bois d'Arc Creek at an elevation of about 590 feet MSL. It contains an estimated 155 interments ranging from the 1840s to the present.

9. The Humble Family Cemetery (FN-C064) (marked as "Umble" on the USGS topographic map) is located about 1.7 miles (2.8 km) southeast of Bois d'Arc Creek at an elevation of about 600 feet MSL. It contains an estimated four interments dating from 1871 through 1893.
10. The Smith Family Cemetery (FN 084) is located about 1.9 miles (3.1 km) southeast of Bois d'Arc Creek at an elevation of about 612 feet MSL. It contains nine recorded interments dating from 1854 to 1908.
11. The Onstott-Stewart Cemetery (FN-C046) is located about 2.4 miles (3.9 km) southeast of Bois d'Arc Creek and about 0.6 miles (0.9 km) east of Bullard Creek at an elevation of about 560 feet MSL. Records indicate it contains seven interments dating from 1846 to 1993.
12. The Smyrna Cemetery (FN-C045) is located about 3.2 miles (5.1 km) southeast of Bois d'Arc Creek on the high ground between Cottonwood and Bullard Creeks at an elevation of about 570 feet MSL. The cemetery contains an estimated 500 interments dating from 1866 to the present.
13. The Cross Family Cemetery (FN-C065) is located approximately 1.1 miles (1.8 km) southeast of Bois d'Arc Creek at an elevation of about 590 feet MSL. It contains four known interments dating 1855 to 1911.
14. The Wolfe and Carlisle Family Cemetery (FN-C044) is located about 2.9 miles (4.6 km) southeast of Bois d'Arc Creek and about 820 feet (250 m) east of Burns Branch at an elevation of about 610 feet MSL. It contains 15 recorded interments dating from 1855 to 1925.
15. An unnamed cemetery is located about 3.4 miles (5.5 km) northwest of Bois d'Arc Creek and immediately west of the community of Hudsonville at an elevation of about 590 feet MSL.
16. An unnamed cemetery is located about 2.9 miles (4.6 km) northwest of Bois d'Arc Creek and immediately south of the community of Lamasco at an elevation of about 580 feet MSL.
17. An unnamed cemetery is located about 3.5 miles (5.6 km) southeast of Bois d'Arc Creek and west of the community of Allen's Chapel at an elevation of about 590 feet MSL.
18. An unnamed cemetery is located about 1.4 miles (2.2 km) southeast of Bois d'Arc Creek between Ward Creek and Pettigrew Branch at an elevation of about 600 feet MSL.
19. An unnamed cemetery is located about 1.7 miles (2.8 km) southeast of Bois d'Arc Creek and immediately north of Onstott Branch at an elevation of about 565 feet MSL.

Identified Archaeological Sites at or Near the Reservoir

Within the Reservoir APE

Table 3.14-4 summarizes the age and site type for each of the known archaeological sites identified within the APE, as well as whether or not it is recommended as eligible to be listed on the NRHP. Site descriptions discussed in this section rely heavily on ARC's report (Davis et al., 2014) and others referenced within their report.

Table 3.14-4. Archaeological Sites Identified During Current Investigations

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN95	Historic	Undefined	Barn	No
41FN96	Historic	1852 - 1927	Cemetery	Unknown – will be relocated during construction phase and would be evaluated during the mitigation phase.

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN97	Historic	Undefined	Shed	No
41FN98	Historic	Undefined	Church	No
41FN99	Historic	Undefined	House & Shed	No
41FN100	Historic	Mid-20th Century	House & Outbuildings	No
41FN101	Historic	Undefined	House & Shed	No
41FN102	Historic	1930s-1940s	House	No
41FN103	Historic	Undefined	Structure Foundation	No
41FN104	Historic	Undefined	Store	No
41FN105	Historic	Undefined	House, Barn, & Sheds	No
41FN106	Historic	Mid-20th Century	Trash Scatter	No
41FN107	Historic	Mid-20th Century	Trash Scatter	No
41FN108	Historic	Early 20th Century	Well or Cistern	Further testing is needed to determine NRHP eligibility
41FN109	Historic	Mid-20th Century	Well or Cistern & Trash Scatter	Further testing is needed to determine NRHP eligibility
41FN110	Prehistoric	Unknown	Buried Artifact Scatter (historic camp site)	Further testing is needed to determine NRHP eligibility
41FN111	Prehistoric	Late Prehistoric	Artifact Scatter	No
41FN112	Prehistoric	Unknown	Surface Artifact Scatter	No
41FN113	Prehistoric	Archaic	Buried Stratified Artifact Scatter	Further testing is needed to determine NRHP eligibility
41FN114	Prehistoric	Late Prehistoric	Buried Artifact Scatter	Further testing is needed to determine NRHP eligibility
41FN115	Prehistoric	Unknown	Thin Artifact Scatter	No
41FN116	Prehistoric	Unknown	Thin Artifact Scatter	No
41FN117	Prehistoric	Archaic	Surface Artifact Scatter	No
41FN118	Prehistoric	Late Prehistoric	Unstratified Buried Artifact Scatter	Further testing is needed to determine NRHP eligibility
41FN119	Prehistoric	Late Prehistoric	Buried Unstratified artifact scatter	Further testing is needed to determine NRHP eligibility
41FN120	Prehistoric	Archaic - Late Caddo	Stratified Alluvial Terrace Site	Further testing is needed to determine NRHP eligibility
41FN121	Prehistoric	Unknown	Buried Unstratified artifact scatter	No
41FN122	Prehistoric	Archaic - Late Prehistoric	Unstratified Artifact Scatter	Further testing is needed to determine NRHP eligibility
41FN123	Prehistoric	Late Prehistoric	Thin Artifact Scatter	No
41FN124	Prehistoric	Archaic	Artifact Scatter	No
41FN125	Prehistoric	Unknown	Possible Hearth Features	No
41FN126	Prehistoric	Unknown	FCR Concentration	No

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN127	Prehistoric	Archaic	Shell Lens and Dart points	No
41FN128	Historic	Undefined 20th Century	Well	No
41FN129	Multi-component	Unknown PH & Late 19th Century	Trash, Lithic Scatter and Well	No
41FN130	Prehistoric	Unknown	Campsite - Shell Lens in Creek Bank	No
41FN131	Multi-component	Archaic & Undefined Historic	Historic Ash Lens and PH Lithic Scatter	No
41FN132	Historic	Undefined 20th Century	Bridge Remains	No
41FN133	Historic	Undefined 20th Century	Bridge Remains	No
41FN134	Prehistoric	Late Prehistoric	Campsite in Creek bank	No
41FN135	Prehistoric	Unknown	Campsite in Creek bank	No
41FN136	Prehistoric	Late Prehistoric	Campsite	Further testing is needed to determine NRHP eligibility
41FN137	Multi-component	Undefined 20th Century	Site with a Well	Further testing is needed to determine NRHP eligibility
41FN138	Multi-component	Undefined 20th Century	Site with a Cistern	Further testing is needed to determine NRHP eligibility
41FN139*	Prehistoric	Late Prehistoric	Artifact Scatter	No longer considered a site
41FN140*	Prehistoric	Archaic - Late Prehistoric	Artifact Scatter	No longer considered a site
41FN141	Prehistoric	Unknown	Artifact Scatter	Further testing is needed to determine NRHP eligibility – site located on private property and is outside of APE; no impacts
41FN142 *	Prehistoric	Unknown	Lithic Quarry	No longer considered a site
41FN147	Prehistoric	Unknown	Artifact Scatter	No
41FN148	Historic	Undefined Late 19th to Early 20th century	Buried Artifact Scatter and Cistern	Further testing is needed to determine NRHP eligibility
41FN149	Prehistoric	Unknown	Campsite	No
41FN150	Prehistoric	Unknown	Campsite	No
41FN151	Prehistoric	Unknown	Occupation Site	Further testing is needed to determine NRHP eligibility
41FN152	Prehistoric	Unknown	Buried Lithic Deposit	No
41FN153	Historic	Undefined 20th Century	Homestead Artifact Scatter	No
41FN154	Historic	Undefined Late 19th to Early 20th century	Shallowly-buried Artifact Scatter	Further testing is needed to determine NRHP eligibility
41FN155	Historic	Undefined 20th Century	Dumping Ground	No

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN156	Historic	Undefined 20th Century	Homestead Ephemeral Remains	Further testing is needed to determine NRHP eligibility
41FN157	Historic	Undefined Late 19th to Early 20th century	Cistern	No
41FN158	Historic	Undefined Late 19th to Early 20th century	Cistern, foundation piers, trash and burn piles	No
41FN159	Historic	Undefined Late 19th to Early 20th century	Cluster of Buildings including a Capped Well/Cistern	Further testing is needed to determine NRHP eligibility

* Sites tested in 2013, found not to exist, and have been removed from the sites atlas.

Individual site descriptions for each of the archeological sites listed in Table 3.14-4 are located in Appendix S.

Outside of the APE

Within one mile (1.6 km) of the proposed Lower Bois d'Arc Creek Reservoir, four previously recorded archeological sites were known prior to ARC's 2011 and 2013 surveys, none of which were recommended for listing as eligible for the NRHP.

- **Site 41FN16** was discovered as a result of 1968 Texas Building Commission and Texas State Water Development Board surveys in advance of Timber Creek Lake (later named Lake Bonham). The site is located on the first terrace above Timber Creek and dates to Woodland/Early Caddoan, containing a lithic scatter and a single Scallorn point.
- **Site 41FN30** is a lithic scatter of undetermined age, documented in 1973. The site was badly eroded at the time of recording and has most likely further deteriorated since.
- **Site 41FN57** is a lithic surface scatter of undetermined age documented in 2001 by Horizon Environmental Services, Inc.
- **Site 41FN58**, the historic Russell Cemetery, is located west of the southern extent of the proposed reservoir on the west side of Pig Branch. This cemetery contains the remains of 22 people, including early settlers to the region and Revolutionary War veterans. Most marker dates were noted to be from the 1880s.

3.14.4 Raw Water Pipeline Route and Associated Facilities

ARC conducted a pedestrian survey and intensive investigation of approximately 1,033 acres of the proposed LBCR pipeline route and associated facilities in 2013 (Figure 3.14-2). ARC also surveyed the proposed Leonard Water Treatment Plant (WTP), the proposed terminal storage reservoir (TSR) adjacent to the WTP, and a proposed rail spur that would transport materials to the new WTP both during construction and operation. All of the surveys conducted for these areas were negative for cultural resources. Seven historic archaeological sites were documented during the LBCR pipeline survey, and only one prehistoric artifact was found during the survey. An interior chert flake was discovered in the terrace sediments near the proposed dam site. A summary of the archaeological sites documented during the LBCR pipeline survey are summarized in Table 3.14-5 below. Individual site descriptions are provided following the table (Davis et al., 2013).

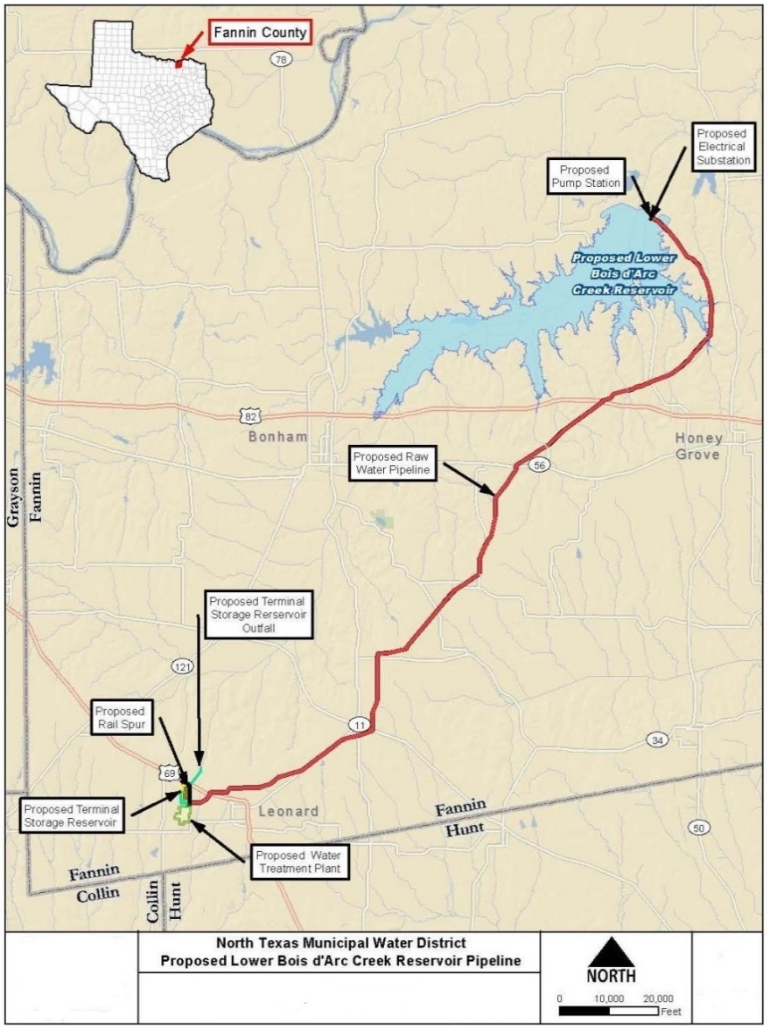


Figure 3.14-2. Raw Water Pipeline, North WTP, and Related Facilities Surveyed for Cultural Resources in 2013

Table 3.14-5. Known Archeological Sites within the Pipeline Route and Associated Facilities

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN169	Historic	Late 19th to Early 20th Century	Cistern or Well with Associated Artifacts	No
41FN170	Historic	20th Century	Cistern and Pump House with Associated Artifacts	No
41FN171	Historic	Late 19th to Early 20th Century	Artifact Scatter	No
41FN172	Historic	Early 20th Century	Farmstead	No
41FN173	Historic	Late 19th to Early 20th Century	Cistern	No
41FN174	Historic	Late 19th to Early 20th Century	Cistern	No

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN175	Historic	Early to Mid-20th Century	Farmstead	Unknown – further archival research is required to establish NRHP eligibility.

Individual Site Descriptions for each of the archeological sites listed in Table 3.14-5 are located in Appendix S.

Sites 41FN137 and 41FN159 were identified during the Reservoir APE investigations and are discussed in this section because the proposed pipeline route is located very close them. Further testing at these sites within the Reservoir APE is warranted to determine NRHP eligibility. Because these sites are in close proximity to the pipeline route, the site boundaries must be fenced with construction fencing at the direction of a project archaeologist to avoid impacts. The construction of this portion of the pipeline should be monitored by a professional archaeologist to ensure that sites 41FN137 and 41FN159 are not impacted (Davis et al., 2013). The monitor would possess the knowledge and expertise necessary to identify any materials exposed during the trenching and would be responsible for recording any identified materials (Davis et al., 2013). Open trench inspection and monitoring by archaeologists should be conducted from the pump station to CR 2715.

The portion of the pipeline route north of US 82 was initially thought to have potential for buried prehistoric site deposits in the floodplain sediments, and sites might have been found on elevations in the narrow floodplains. The survey found no prehistoric archaeological sites, and subsequently, no sites were recorded. Previous investigations of uplands in the surrounding region corroborated the findings of the survey (Davis et al., 2013).

Another type of prehistoric site initially thought to be located on the drainage divides where Ogallala Gravels were deposited in Late Pliocene times were lithic procurement sites. The survey found no evidence of major gravel fields containing quartzite and chert cobbles or other knappable material (Davis et al., 2013). Knapping is the shaping of flint, chert, obsidian or other appropriate rocks to manufacture stone tools. The knappable material that could have potentially been found at these locations would have provided a primary potential source of resources that could have been used during the process of cooking plant or animal foods.

All of the seven historic sites (41FN169-41FN175 as noted in Table 3.15-5 above) recorded during the pipeline and associated features study represents the remains of either late 19th or 20th century farmsteads or homesteads found on upland divides. Only one site contained historic-age structures. The historic aged structures at this one site have been modified and updated over the years, diminishing their integrity. In addition, the areas surrounding the structures consisted of maintained degrading upland surface and subsequently contained no artifacts (Davis et al., 2013). Only one of the six remaining sites did not have any associated features. This one site was associated with a farmstead which was demolished prior to 1995, according to Google Earth aerials, and consists of historic artifacts found on the surface and worked into the plow zone. The remaining five sites likely represent the remains of homesteads and farmsteads but are only represented by historic artifacts and water related features. These five sites showcase a diverse collection of late 19th or early 20th century cisterns, wells, or well-cisterns (Davis et al., 2013).

The results of the 2013 LBCR pipeline route survey correspond with others conducted in Fannin County. Prehistoric sites appear to be very ephemeral on the south side of Bois d'Arc Creek, while historic sites are common on the upland divide. Nearly all traces of mid-19th century sites have been eliminated by farming and urban growth, and only sparse remains of late 19th and early 20th century sites remain. In most cases, these sites contain no structures and are only represented by cistern or well features and associated artifacts. Because the historic sites identified in this study have been heavily impacted by farming, they provide little to no information about the early history of Fannin County (Davis et al., 2013).

3.14.5 FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

NTMWD has proposed a new bridge to be built over the planned Lower Bois d'Arc Creek Reservoir as well as extend FM 897 from U.S. Highway 82 to FM 1396. A cultural resource survey was conducted by AmaTerra Environmental in March, April, and June of 2016 under Antiquities Permit No. 7570 to determine the impact of this proposed bridge to cultural resources in the area. The survey encompassed a 6.4 mile (10.2 km) stretch of a new and existing Right-of-Way (ROW) for the Farm-to-Market Road (FM) 897 in Fannin County, Texas. The APE was measured by systematic shovel tests and pedestrian cultural resources surveys. A total of 151 shovel tests were conducted along two survey transects within a 120 foot (36.5 meter) wide ROW for a rate of one test per 328 feet (100 meters) along each transect. The archeologists discovered two historic period sites, one historic debris scatter, and two historic-age bridges. None of the sites described are eligible for listing in the NRHP or as a SAL. In addition, because the design of the two bridges is basic, and because the bridges were likely built in the mid-20th century, neither bridge is eligible for listing on the NRHP or as a SAL. Subsequently, no additional archeological work for the proposed FM 897 road and bridge project is recommended (Sitters and Feit, 2016).

Other areas that were explored during this investigation included the APE South, APE North, APE Central, and a Historic Debris Scatter on the side of the road. APE South measures 2.84 miles (4.5 km) and contains two family cemeteries, the two sites described below (41FN251 and 41FN252), and the Historic Debris Scatter. The Carlisle-Wolf Family Cemetery is a 50 feet by 50 feet plot of land marked by a chain-link fence that contains mostly junipers and dates back to the mid-19th century. This cemetery contains 23 aboveground features including headstones, footstones, and remnants of boxed graves, though it is not expected to be affected by the proposed project. The Cross Family Cemetery contains two fenced-in areas, 11 feet by 25 feet, and one fenced in tree, which contains no grave sites. Only eight graves marked by headstones, footstones, and an outline of cut limestone are located within the cemetery. The Historic Debris Scatter is located in a roadside drainage ditch next to a pipe culvert on the west side of CR 2945 and measures 13 feet in length. The site contains mid-late 20th century Acme Ferris bricks, mortar, clear vessels, glass, metal fragments and whiteware ceramic sherds and does not warrant a NRHP or SAL designation. APE Central contains 1.1 miles of the Bois d'Arc floodplain along with thick vegetation and standing water; the site may potentially hold two historic age bridges within the floodplain. APE North is located on the north edge of the floodplain, measures 2.5 miles, and consists of forested areas and open pastures. Sixty-eight shovel tests were performed at the site, none of which were positive for cultural materials (Sitters and Feit, 2016). A summary of the archaeological sites documented during the survey are summarized in Table 3.14-6 below.

Table 3.14-6. Known Archeological Sites within the FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN251	Historic	19^{th} to 20^{th} Century	Associated Artifacts	No
41FN252	Historic	19^{th} to 20^{th} Century	Dairy Farm, Cistern and Associated Artifacts	No

Individual site descriptions for each of the archeological sites listed in Table 3.14-6 are located in Appendix S.

3.14.6 Fannin County Bridges Survey

A Phase I intensive pedestrian survey of twelve bridge locations within Fannin County is taking place for the construction of the Lower Bois d'Arc Creek Reservoir project. At each bridge, shovel tests will be excavated on either side of the existing road or drainage area, and notes describing the surface visibility, land disturbances, drainage channels and vegetation will be taken at each site. Pictures of all the bridges or culverts will be taken and researched thoroughly, along with any artifacts found, to determine if they contain historic elements. The PA will guide the process of site identification, eligibility determination, and mitigation measures should those be necessary, and a draft report will be prepared on the findings and recommendations on the historical eligibility. No construction will take place until any impacts to historic properties are identified and any adverse impacts are mitigated.

3.14.7 Ongoing Investigations at the Riverby Ranch Mitigation Site

As a whole, the Riverby Ranch and its surrounding properties have primarily been used for agricultural purposes for approximately 170 years. Two prominent families owned most of the land from the late-19th to mid-20th century – Goss and Morgan. The two farms, sometimes referred to as plantations, were located in the small towns of Newt and Riverby (now inside the Riverby Ranch property). The town of Newt existed during the early 1900s and was the home of the Goss Farm. Newt had a post office from 1902 to 1907 and reported a population of 25 during the 1930s and 1940s until it faded from the landscape. The main businesses located in Riverby were the Morgan Farm, a local store, and the Riverby School. In the 1930s, Riverby had a population of 20, but by the mid 1940's the two villages had dissolved.

Joseph Ray Goss began his farm in 1885 on 50 acres, though over the course of his life this grew to approximately 16,000 acres. The farm employed hundreds of people who assisted with the production of corn, cotton, and peanuts. The Goss Farm contained a store, cotton gin, blacksmith, church, and school. When Gross died in 1947, the farm was split amongst the heirs and transformed into a cattle operation. George William Morgan inherited 200 acres in the late 1800s and grew his farm to 12,000 acres. His farm employed hundreds of people for the production of corn, cotton, and peanuts. The farm also contained a large store, a cotton gin, and a church. The Morgan Farm was sold in 1954 to Lloyd Smith and H. W. Frances, Jr. and was renamed the Riverby Ranch. The two prominent families competed for land regularly but set differences aside to create the Riverby School in 1913 to combine the smaller schools of Newt, Riverby, and the small town school of Ragsdale. The school enrolled up to 200 children at its peak but closed in the 1960s due to low enrollment (Davis et al., 2016).

Protocols set forth in the PA will be implemented during the continuing Investigations on the Riverby Ranch mitigation site in accordance with Section 106 and the PA. The PA guides the work and ensures compliance with Section 106 on a timeline separate from that of the EIS. A brief summary of the workplan and a description of the work that has been completed to date are outlined below.

As discussed in section 3.14.3.3 above, the overall LBCR Research Design outlined three major research contexts and eleven testable hypotheses dealing with the geomorphology, prehistoric natural environment, and human settlement over time in Fannin County (Skinner et al., 2010). The floodplains were classified as having a generally low archaeological potential while the upland and Pleistocene terrace edges have a high potential for both historic and prehistoric archaeological sites. In order to define and refine the proposed land modifying mitigation activities, a two part archaeological survey was needed for the development of the Mitigation Plan. The 14,959-acre mitigation property extends south from the Red River, down the Fannin and Lamar county line. The first step in the process consisted of acquiring a Texas Antiquities Permit, which was necessary since NTMWD is a political entity of the State of Texas. Investigation of the ranch was done in two phases. Phase 1 included extensive archival research on the history of Riverby Ranch as well as the collection of oral history interviews. In addition to this research, all previously recorded archaeological sites on the property were researched and revisited when possible.

Based on the results of the Phase 1 investigation, the archaeological potential of Riverby Ranch was identified (Davis et al., 2016). The initial geomorphologic definition of the property was used as the foundation but was refined with historic maps and aerial photos, soil data, and LiDAR. There were seven described alluvial geomorphic surfaces on the ranch. Only five of these geomorphic surfaces had been previously described as having potential for containing archaeological sites. These five areas were identified for survey and defined as High Potential Areas (HPAs) as depicted Figure 3.14-3 below. The areas shown as Prehistoric HPAs represent the mapped NRCS terrace soils that corresponded to the locations and settings of significant sites like 41FN1, 41FN9, 41FN12, 41FN86, and 41LR2 (Davis et al., 2016). It was expected that any locations on the leading edge of T2 and T3 could contain Paleoindian and Archaic artifacts, but they would likely be mixed with later Woodland and Caddo occupations. These HPAs have potential to contain buried site deposits, as well as human remains, especially below the plow zone. Temporary or seasonal prehistoric campsites might be found on the T3 and T4 deposits along Bois d'Arc Creek. The areas highlighted as Historic HPAs were selected because they contained the largest concentrations of structures on historic maps as well as overlapping the three rural communities of Ragsdale, Riverby, and Newt. Areas where the Historic HPA and wooded areas on the T2, T3, and T4 overlap were surveyed for intact features such as collapsed structures, foundations, and other features.

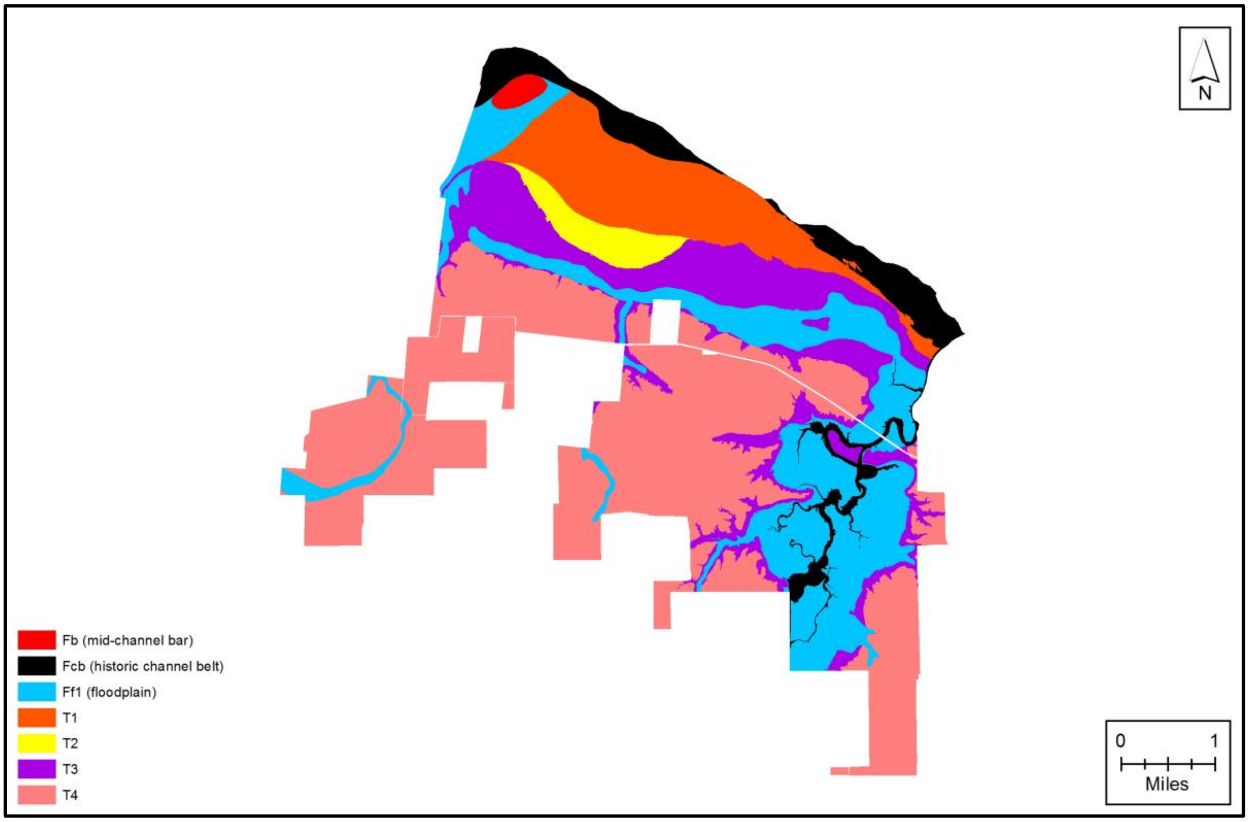


Figure 3.14-3. Estimated Geomorphology of the Red River

Note: Adapted from Hajic and Mandel (2009) and derived from NRCS Soil Data and LiDAR
Source: Davis et al., 2016

Following the completion of the Phase I investigation which helped define the HPAs, the Phase 2 study was conducted between March and August of 2015 and consisted of an intensive pedestrian survey of 3,670 acres of HPAs for prehistoric and historic archaeological sites. The survey included collecting, washing, labeling, and analyzing artifacts, as well as preparing a written report. Overall, a total of 86 sites (20 prehistoric, 52 historic, and 14 multicomponent) are recorded on the property as a result of the Phase I and II surveys (Davis et al., 2016). In addition, a total of 28 architectural resources were found to meet the historic-age guideline as established for this project and therefore were evaluated for their integrity and potential eligibility in the NRHP. Twenty five of these structures did not fulfill Criterion A, B, or C. In addition, none of these 25 structures maintained the level of integrity required to be considered for listing in the NRHP. Furthermore, none of the 28 structures were found to meet any of the special requirements under Criteria Considerations A-G. Three structures (structures 11, 21, and 25) met the historic age requirement and exhibited a potential for historical significance under Criteria A, B, and/or C. However, after careful evaluation and consideration, none of these structures were found to maintain the significant association and/or integrity required by the NRHP. As a result, Structures 11, 21, and 25 are recommended not eligible for listing in the NRHP. A summary of the 86 archaeological sites (both new and previously discovered) identified during the survey of the Riverby Ranch mitigation area is provided in Tables 3.14-7 and 3.14-8 below and individual site descriptions are included in Appendix S. A summary of the known interments for the Whitten (41FN228), Liberty (41FN229), Greenlee (41FN230), and Friendship (41FN239) cemeteries are provided in Tables 3.14-8 through 3.14-11.

Table 3.14-7. Newly Recorded Archaeological Sites Within the Riverby Ranch Mitigation Site

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligibility Recommendation
41FN180	Historic	Late 19th to Mid-20th Century	Historic artifact scatter	Not eligible
41FN181	Historic	Late 19th to Mid-20th Century	Historic artifact scatter	Not eligible
41FN182	Historic	Late 19th to 20th Century	Harling house and artifact Scatter	Not eligible
41FN183	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN184	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN185	Multi-component	Late 19th to 20th Century	Multi-component artifact scatter	Not eligible
41FN186	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN187	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN188	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible, outside of WRP
41FN189	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN190	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN191	Multi-component	Unknown Prehistoric/Late-19th to 20th century	Multi-component artifact scatter	Not eligible, outside of WRP
41FN192	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN193	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN194	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN195	Multi-component	Unknown Prehistoric/Late-19th to 20th century	Multi-component artifact scatter	Not eligible
41FN196	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN197	Multi-component	Unknown Prehistoric/Late-19th to 20th century	Multi-component artifact scatter	Not eligible
41FN198	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN199	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible
41FN200	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN201	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible
41FN202	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN203	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN204	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN205	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN206	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN207	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN208	Prehistoric	Unknown Prehistoric/Late-19th to 20th century	Prehistoric artifact scatter	Not eligible
41FN209	Multi-component	Late 19th to 20th Century	Multi-component artifact scatter	Not eligible

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligibility Recommendation
41FN210	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN211	Multi-component	Woodland to Middle Caddo	Multi-component artifact scatter	Further testing is needed to determine NRHP eligibility or avoid
41FN212	Prehistoric	Middle to Late Caddo	Prehistoric artifact scatter	Not eligible
41FN213	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN214	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible
41FN215	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN216	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN217	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible
41FN218	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN219	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN220	Historic	Mid-20th Century	Historic artifact scatter	Not eligible
41FN221	Historic	Late 19th to 20th Century	Historic artifact scatter	Not eligible
41FN222	Historic	20th Century	Historic artifact scatter	Not eligible
41FN223	Historic	Unknown	Historic artifact scatter	Not eligible
41FN224	Historic	Early to mid-20th Century	Historic artifact scatter	Not eligible
41FN225	Historic	20th Century	Historic artifact scatter	Not eligible
41FN226	Historic	Late-19th Century to Present	Historic artifact scatter	Not eligible
41FN227	Historic	Late-19th to mid-20th Century	Historic artifact scatter	Not eligible
41FN228	Historic	1876-1917	Historic Cemetery	Undetermined-protected in place
41FN229	Historic	1872-1951	Historic Cemetery	Undetermined-protected in place
41FN230	Historic	1894-1895	Historic Cemetery	Undetermined-protected in place
41FN231	Prehistoric	Unknown	Prehistoric artifact scatter	Not eligible
41FN232	Historic	1920-1965	Historic artifact scatter	Not eligible
41FN233	Historic	Late-19th to mid-20th Century	Historic artifact scatter	Not eligible
41FN234	Historic	19th Century	Historic artifact scatter	Not eligible
41FN235	Prehistoric	Late or historic Caddo components	Prehistoric artifact scatter	Yes eligible—Needs additional testing if deeper than plow zone
41FN236	Historic	Unknown	Historic artifact scatter	Not eligible
41FN237	Historic	Unknown	Historic artifact scatter	Not eligible
41FN238	Historic	Unknown	Historic artifact scatter	Not eligible
41FN239	Historic	1899-1944	Historic Cemetery	Undetermined-protected in place
41FN240	Historic	Unknown	Historic artifact scatter	Not eligible
41FN241	Prehistoric	Unknown	Prehistoric artifact scatter	Not eligible
41FN242	Historic	Unknown	Historic artifact scatter	Not eligible

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligibility Recommendation
41FN243	Historic	20th Century	Historic artifact scatter	Yes eligible
41FN248	Prehistoric	Late Archaic or Woodland periods	Prehistoric artifact scatter	Not eligible
41FN249	Prehistoric	Late Archaic or Woodland periods	Prehistoric artifact scatter	Further testing is needed to determine NRHP eligibility
41FN250	Prehistoric	Unknown	Prehistoric artifact scatter	Not eligible

Table 3.14-8. Previously Recorded Archaeological Sites within the Riverby Ranch Mitigation Site

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligibility Recommendation
41FN1	Multi-component	Woodland/Middle and Historic Caddo/Mid-19th century cemetery	Multi-component Cemetery	Not eligible
41LR2	Prehistoric	Late Archaic/Woodland/Middle and Historic Caddo	Prehistoric artifact scatter	Yes, eligible–Need to Avoid and Protect
41FN9	Prehistoric	Woodland/Early to Late Caddo	Prehistoric artifact scatter	Further testing is needed to determine NRHP eligibility or must be avoided if impacts are deeper than 30 cmbs
41FN12	Multi-component	Paleoindian/Woodland/Middle and Historic Caddo	Multi-component artifact scatter	Unknown-Protected within WRP
41FN39	Prehistoric	Woodland/Middle Caddo	Prehistoric artifact scatter	Unknown-Protected within WRP
41FN40	Historic	Late-19th to 20th century	Historic artifact scatter	Not eligible
41FN41/41FN88	Multi-component	Woodland/Early to Late Caddo	Multi-component artifact scatter	Further testing is needed to determine NRHP eligibility or must be avoided if impacts are deeper than 30 cmbs
41FN42	Historic	Late-19th to 20th century	Historic artifact scatter	Not eligible
41FN51	Multi-component	Archaic/Late-19th to 20th century	Multi-component artifact scatter	Not eligible – outside of WRP
41FN82	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible
41FN83	Historic	Late-19th to 20th century	Historic artifact scatter	Not eligible
41FN84	Historic	Late-19th to 20th century	Historic artifact scatter	Not eligible
41FN85	Prehistoric	Unknown Prehistoric	Prehistoric artifact scatter	Not eligible
41FN86	Multi-component	Archaic/Woodland/Late-19th to 20th century	Multi-component artifact scatter	Yes, eligible–Need to Avoid and Protect

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligibility Recommendation
41FN87, 41FN91	Multi-component	Unknown Prehistoric/Late-19th to 20th century	Multi-component artifact scatter	Not eligible
41FN89	Prehistoric	Woodland/Caddo	Prehistoric artifact scatter	Not eligible
41FN94	Historic	Late-19th to 20th century	Historic artifact scatter	Not eligible
41FN144	Prehistoric	Woodland/Middle Caddo	Prehistoric artifact scatter	Further testing is needed to determine NRHP eligibility or must be avoided if impacts are deeper than 30 cmbs

Table 3.14-9. Known Interments in the Whitten Cemetery, 41FN228

Number	Name	Birth Date	Death Date
1	Hawley, Doss Robert	18 Jan 1898	26 Aug 1899
2	Hawley, Gillie Belle	21 Mar 1901	15 Feb 1902
3	Hawley, John Newton	19 Jul 1890	18 Oct 1895
4	Hawley, Tommie	2 Jul 1905	12 Oct 1906
5	Robinson, Joseph A.	25 Feb 1887	2 May 1904
6	Robinson, Olivian	22 Nov 1902	3 Jul 1903
7	Titus, Isaac W.	28 Dec 1860	19 Feb 1929
8	Titus, Martha Jane Mullens	07 Mar 1859	19 Oct 1917
9	Whitten, Francis M.	28 Dec 1839	07 Jan 1876

Sources: Davis et al., 2016; TXGenWeb Project, 2014d

Table 3.14-10. Known Interments in the Liberty Cemetery, 41FN229

Number	Name	Birth Date	Death Date
1	Allen, Prof Isaac	NBD	NDD
2	Arnold, Lela	8 Aug 1905	17 Jun 1919
3	Bradley, Tinnie	Jul 1863	20 Sep 1881
4	Briggs, A. B.	31 Aug 1912	10 Feb 1914
5	Briggs, Adolphus D.	28 Oct 1877	7 May 1948
6	Briggs, Alberta	01 Apr 1896	8 Sep 1919
7	Briggs, Clara Sims	30 Aug 1878	10 Dec 1945
8	Briggs, Iola	12 Jun 1939	13 Jun 1939
9	Briggs, Joe	ca 1895	23 Jun 1928
10	Briggs, John	22 Dec 1861	18 Apr 1888
11	Briggs, Lela Harris	6 May 1906	28 Jun 1944
12	Briggs, Lucinda Brown	29 Oct 1835	10 Nov 1903
13	Briggs, M. A. B.	15 Mar 1905	15 Mar 1905
14	Briggs, Mary	22 Dec 1861	13 Aug 1872
15	Briggs, Pink	14 May 1910	15 Dec 1910
16	Briggs, Samuel Davie	09 Apr 1890	24 Jul 1939

Number	Name	Birth Date	Death Date
17	Briggs, Spencer	NBD	12 Dec 1904
18	Briggs, Stephen	12 Oct 1862	24 Oct 1948
19	Bush, Estella	18 Aug 1898	19 Jul 1899
20	Bush, Rosco	07 Oct 1896	Aug 1900
21	Bush, Walter	28 May 1889	12 Oct 1889
22	Carson, Charllote	ca 1879	20 Apr 1908
23	Carson, Lillier	16 Jun 1890	17 Jun 1927
24	Cole, Mozita Green	ca 1921	16 Aug 1936
25	Cooper, Luisa	5 Nov 1928	16 Aug 1929
26	Cozine, Buford	09 Nov 1896	28 Jan 1897
27	Cozine, Dovie Nancy	31 Dec 1897	31 Dec 1897
28	Cozine, Earnest	22 Sep 1900	13 Dec 1900
29	Cozine, Ervin	23 Jun 1899	25 Aug 1899
30	Cozine, Wade	16 Sep 1894	18 Apr 1896
31	Dotson, Sam	ca 1873	11 Jan 1938
32	Fields, Dallas	1853	4 May 1928
33	Garrett, Sallie	1843	27 Dec 1886
34	Gilbreath, Aron	13 Oct 1891	24 Mar 1942
35	Gilbreath, Daisy Gates	29 Apr 1901	15 May 1936
36	Gilbreath, George M.	15 Jun 1933	20 Jun 1936
37	Gilbreath, Gussie	20 Apr 1919	8 May 1936
38	Gilbreath, Henry	15 Aug 1855	30 Nov 1935
39	Gilbreath, Lou	NBD	NDD
40	Gilbreath, Lucille	Nov 1919	14 Nov 1929
41	Gilbreath, Riley	01 Jul 1855	03 Jul 1919
42	Gilbreath, Rodie	ca 1864	1 Dec 1900
43	Gilbreath, Tom	1869	May 1899
44	Gilbreath, William	1869	11 Dec 1939
45	Golden, Willie May	23 Dec 1889	4 Jan 1900
46	Harris, Roxie Briggs	15 Aug 1892	13 Jun 1932
47	Haywood, Hilliard	Aug 1860	16 Aug 1892
48	Jackson, Versa Mae Jones	14 Mar 1914	9 Oct 1939
49	Jewett, Hattie	1871	30 Mar 1899
50	Jones, Mattie	NBD	NDD
51	Jones, Willie	10 Aug 1887	17 Oct 1891
52	Langs, Marie Hicks	15 Sep 1886	9 Mar 1930
53	Lee, David	07 Sep 1888	14 Jan 1907
54	Lee, James	04 May 1820	29 May 1914
55	Lee, James Arthur	10 Oct 1897	8 Dec 1944
56	McDade, Anthony	28 Nov 1864	10 Apr 1899
57	McDade, Mima	ca 1836	26 Feb 1907
58	McKnight, Frank	14 Feb 1870	23 Nov 1950
59	McKnight, John	01 Nov 1878	8 Nov 1948
60	McKnight, Margret	12 Oct 1840	12 Oct 1936
61	McKnight, Perry M.	05 May 1887	25 Mar 1940
62	McKnight, Robert Louis	5 May 1947	24 May 1954
63	Merphey, James Abner	24 Mar 1912	2 Feb 1913

Number	Name	Birth Date	Death Date
64	Mills, Defecer	22 Mar 1887	24 May 1901
65	Mills, Frances	ca 1876	8 Dec 1931
66	Mills, Gethero	16 Jul 1894	4 Oct 1903
67	Mills, Martin	22 Mar 1862	8 Jan 1945
68	Moore, Eli	03 Jun 1842	28 Sep 1898
69	Moore, Franklin	Mar 1892	Mar 1892
70	Moore, Matthew Thomas	27 Jun 1884	11 Nov 1885
71	Morle, Mattie Dirks	18 Dec 1899	15 Jan 1941
72	Myres, F. B.	11 Nov 1871	24 May 1901
73	Nash, John	ca 1892	22 Aug 1937
74	Nash, Lula	20 Feb 1888	9 Dec 1954
75	Perkins, Dan	15 Jan 1899	7 Mar 1944
76	Perkins, Elijah	NBD	NDD
77	Perkins, James 'Jim'	10 Jun 1867	21 May 1930
78	Pittis, Jane	ca 1900	25 Mar 1931
79	Railback, Wiley	15 Jan 1849	2 Aug 1916
80	Rayford, Joe Earl	3 May 1947	15 Aug 1951
81	Rodgers, Jim	1874	14 Jun 1939
82	Rose, Texanna	18 Jul 1876	29 Jun 1902
83	Ruffin, Florence Burnett	15 Jul 1894	4 Jan 1944
84	S., L.	NBD	NDD
85	Thomas, Renda Garrett	22 Jan 1877	28 Jun 1949
86	Toson, Elbert	18 Mar 1883	16 Jun 1903
87	Walker, Bud	NBD	10 Nov 1918
88	Walker, J. W.	1863	19 Dec 1902
89	Williams, Nora Thomas	ca 1864	13 Nov 1931
90	Williams, Willie	03 Mar 1893	04 Mar 1893

Source: Davis et al., 2016

Table 3.14-11. Known interments in the Greenlee Cemetery, 41FN230

Number	Name	Birth Date	Death Date
1	Greenlee, Mary M.	May 1855	Aug 1895
2	Greenlee, Willis S.	14 Oct 1849	10 Aug 1894

Source: Davis et al., 2016

Table 3.14-12. Known Interments in the Friendship Cemetery, 41FN239

Number	Name	Birth Year	Death Year
1	Anderson, Barbara Cox	29 Oct 1871	2 Sep 1936
2	Baker, Jessie	25 Feb 1897	21 Sep 1932
3	Carter, Burnice	22 Oct 1932	2 Nov 1932
4	Cobb, Florence	ca 1893	22 Feb 1933
5	Glover Sr., John	10 Aug 1836	17 Jun 1919
6	Haywood, Mollie	12 Apr 1873	27 Apr 1901
7	Jackson, Annie Barron	ca 1871	22 Dec 1936

Number	Name	Birth Year	Death Year
8	Jackson, Morse 'Morris, March'	04 Mar 1869	6 Jan 1947
9	Jackson, O P	12 Aug 1904	1 Dec 1944
10	Mills, Tenie	NBD	25 Dec 1915
11	Stone, Elizabeth	08 Dec 1842	17 Aug 1905
12	Whidbey, Eliza	08 Mar 1868	15 Mar 1899

Source: Davis et al., 2016

Individual Site Descriptions for each of the archeological sites listed in Table 3.14-7 and 3.14-8 are located in Appendix S.

Based on the results of the archaeological and architectural investigations, ARC recommends that the majority of the 86 sites are not eligible for listing on the NRHP or as a SAL. The eligibility of sites 41FN12 and 41FN39 is undetermined; however, these sites are within the Wetland Reserve Program (WRP) portion of the ranch, and they would not be impacted. The portion of 41FN51 that is outside the WRP is ineligible; however, the eastern portion inside the WRP is undetermined but would not be impacted. Additionally, the four known cemeteries on the property (41FN228-41FN230, 41FN239) are undetermined, but these would not be impacted and are protected within large buffers. Two sites (41LR2 and 41FN86) are considered eligible for listing on the NRHP and as SALs. Further testing is recommended for seven sites (41FN9, 41FN41/41FN88, 41FN144, 41FN211, 41FN235, and 41FN249) to determine eligibility for listing on the NRHP or as a SAL. The eligibility recommendations and report of investigations are currently under review by the USACE, Caddo Nation, and THC. Official determinations of eligibility would be coordinated among the USACE, Caddo Nation, and THC once reviews are completed. As per the terms of the PA, avoidance and mitigation measures would be coordinated and agreed upon by the USACE, Caddo Nation, and THC once eligibility determinations are completed.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

Chapter 4 assesses the potential environmental consequences associated with the No Action Alternative, Alternative 1, and Alternative 2. The terms "consequences," "impacts," and "effects" are used interchangeably in this chapter.

Potential environmental consequences can be direct or indirect, on-site and/or off-site. According to the Council on Environmental Quality's (CEQ) NEPA Regulations at 40 CFR 1500-1508, **direct effects**, "…are caused by the action and occur at the same time and place" (1508.8(a)). **Indirect effects** "…are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable." Indirect effects also include "induced changes" in the human and natural environments (1508.8(b)). In other words, direct impacts are those that are caused directly by the proposed action or connected actions, such as conversion of bottomland hardwood forest habitat to open water habitat in the reservoir. Indirect impacts are those follow-on effects induced by the initial impact, such as effects of this habitat conversion on wildlife species in the project area. Indirect impacts also include growth-inducing effects, that is, the potential for an action, such as development of a new water supply or a new water treatment plant, to facilitate population growth, economic growth and physical development in a region, which then may cause secondary effects on the environment. Growth-inducing effects are addressed primarily in Chapter 5 (Cumulative Impacts) of this EIS.

Potential environmental consequences are discussed under each resource topic for three possible alternatives: 1) No Action, in which the dam, reservoir, and ancillary facilities would not be built. Under the No Action Alternative, NTMWD would have to develop another water supply source which would have its own impacts, although these are not addressed to any extent in this chapter; 2) Alternative 1, or the Applicant's Proposed Action and Preferred Alternative, which is the construction and operation of the full-scale Lower Bois d'Arc Creek dam and reservoir and ancillary facilities at the proposed site on Bois d'Arc Creek in Fannin County, TX; and 3) Alternative 2, the downsized (smaller-scale) LBCR with Lake Texoma Blending Alternative, a smaller version of the LBCR project at the same location as Alternative 1 that would include blending of LBCR water with water from Lake Texoma, as described in Section 2.3.

This DEIS necessarily relies upon research, surveys, analyses and literature from a number of sources, including scientists, planners and engineers associated with the official State of Texas water planning process conducted by the TWDB and its sub-entities, and in particular with the permit applicant and project proponent, NTMWD. The USACE independently reviewed and evaluated all pertinent information and data with the help of its third-party contractor, Solv LLC and subcontractors. All qualitative and quantitative conclusions and findings in this chapter as to types and levels of impact are those of the USACE Tulsa District Regulatory Program alone.

4.2 METHODOLOGY

The interdisciplinary study team (see Chapter 7, List of Preparers) followed a structured process to analyze the potential environmental impacts, or effects, resulting from the No Action Alternative, Alternative 1, and Alternative 2. This procedure, called the cause-effects-questions (C-E-Q) process, is described in the text box below.

Using this process, both direct and indirect effects that could potentially occur as a result of implementing the alternatives were identified.

**Causes-Effects-Questions:
A Structured Analytic Process**

Step 1: Identify the specific activities, tasks, and subtasks involved in the proposed action(s) and alternative(s).

Step 2: For each specific activity, task and subtask, determine the full range of direct effects that each could have on any environmental resource. For example, removing vegetation could cause soil erosion.

Step 3: For each conceivable direct effect, identify which further effects could be caused by the direct effects. For example, soil erosion could cause stream sedimentation, which could harm or kill aquatic macroinvertebrates, which could diminish the food supply for fish, leading to decreased fish populations. This inquiry can identify multi-stepped chains of potential causes-and-effects.

Step 4: Starting at the beginning of each chain of causes-and-effects, work through a series of questions for each potential effect:

- Would this effect actually occur from this project?
- If not, why not?
- What would preclude it from happening?
- If the effect cannot be ruled out, characterize which types of data, other information, and analyses are needed to determine the parameters of the effect, including its extent, duration, and intensity.
- Identify the sources from which the data are to be obtained.

Step 5: Gather the data and conduct the analyses identified by the above steps, utilizing only relevant information.

Step 6: Document the results of this study process.

Figure 4.2-1 presents the several of the preliminary C-E-Q diagrams that the study team prepared at the outset of the analysis. This visual aid helped organize the investigation and focus it on relevant issues. The team also used this C-E-Q diagram in the scoping meeting in Bonham on December 8, 2009 to solicit input from the public.

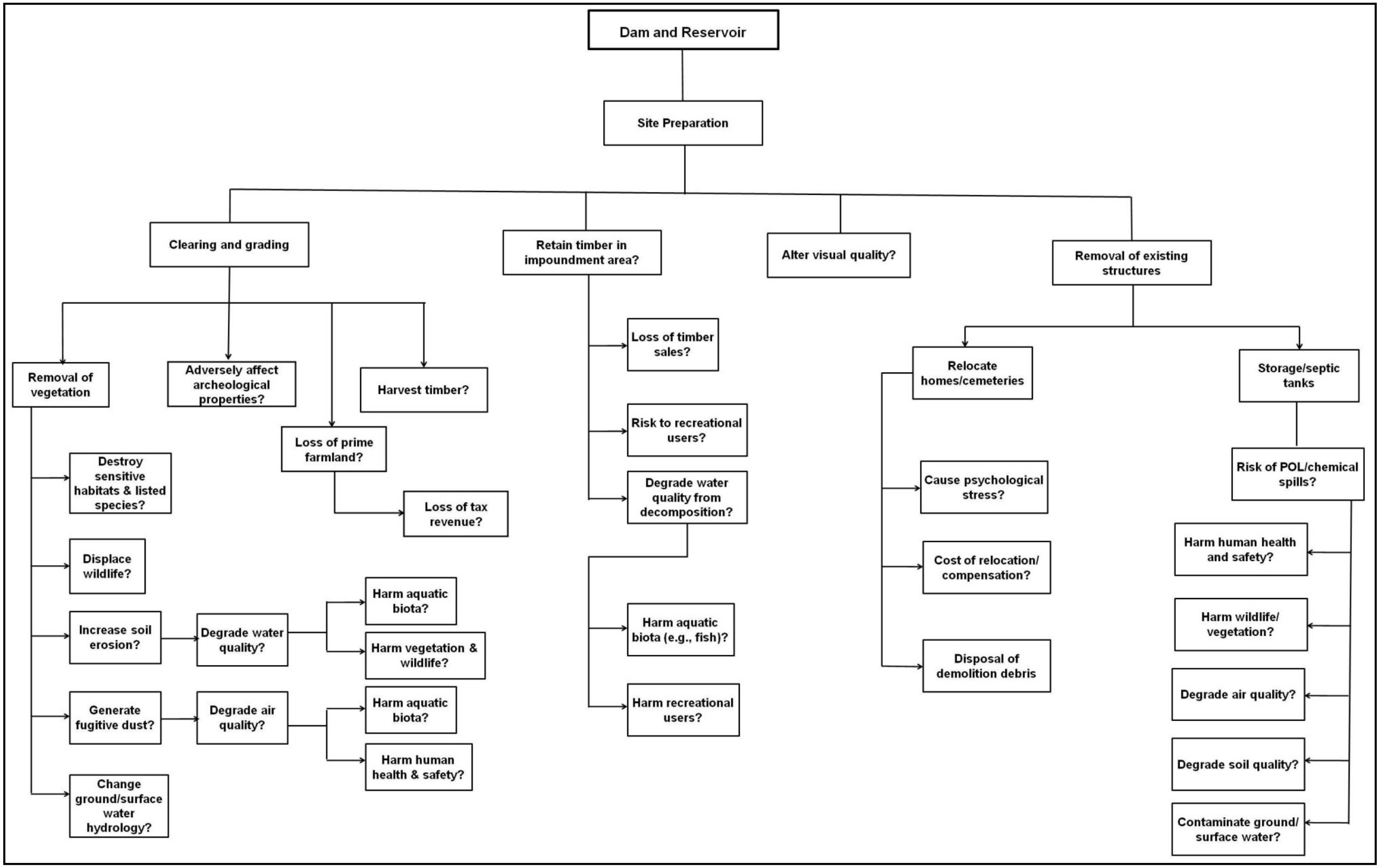


Figure 4.2-1a. Sample Preliminary Causes-Effects-Questions (C-E-Q) for LBCR

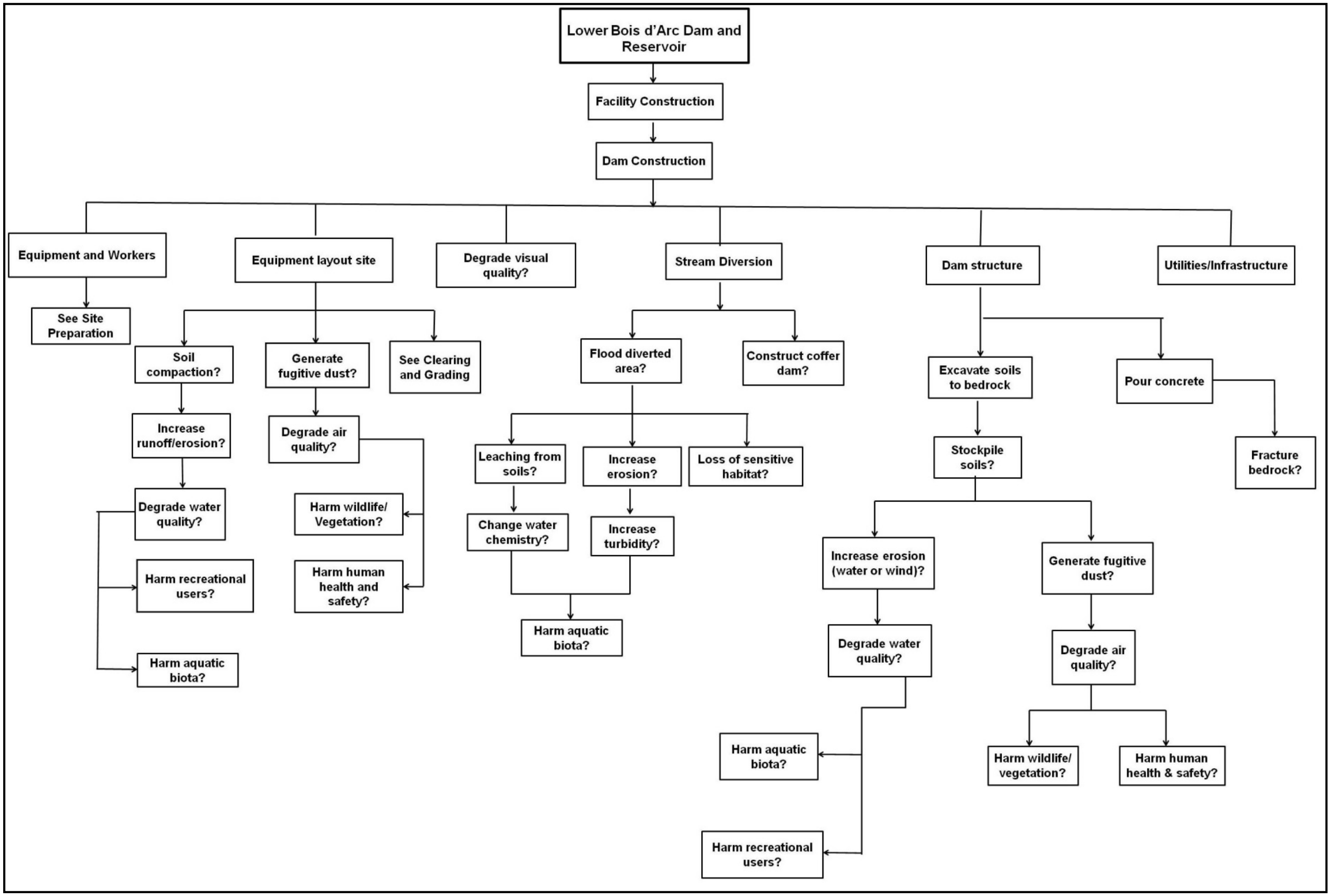


Figure 4.2-1b. Sample Preliminary Causes-Effects-Questions (C-E-Q) for LBCR (cont.)

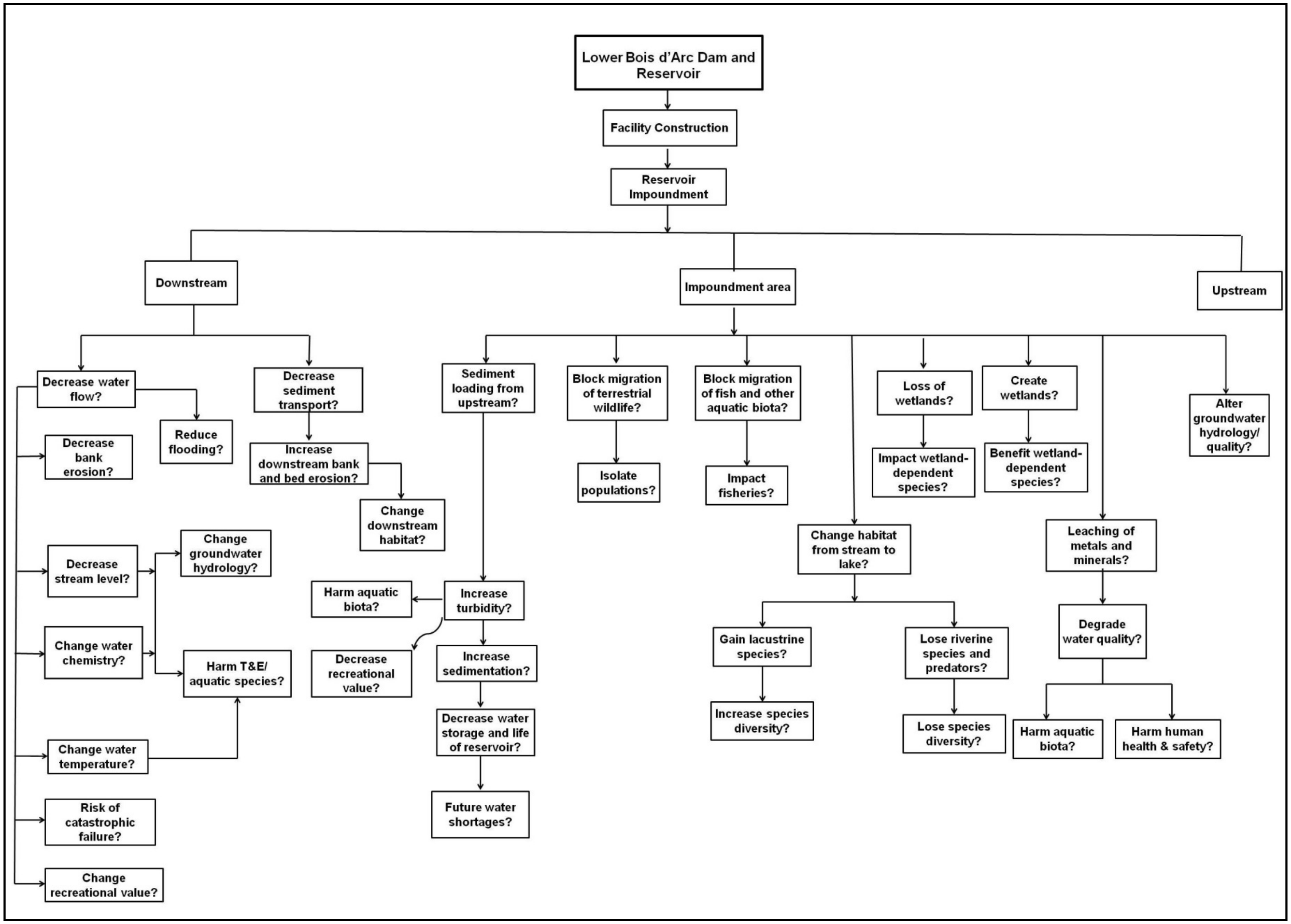


Figure 4.2-1c. Preliminary Causes-Effects-Questions (C-E-Q) for LBCR (cont.)

4.2.1 Assessment Factors

A project like the proposed reservoir can have a wide variety of impacts on different components of the environment. The importance, magnitude, or "significance," of each of these diverse impacts depends on various factors. Some of these factors can be evaluated objectively. Other factors affecting significance must be evaluated subjectively, such as the importance of losing some amount of wildlife habitat. The CEQ's NEPA regulations at 40 CFR 1508.27 provide a list of factors to be considered in determining impact significance. The primary purpose of significance ratings in the NEPA process is to ascertain whether a lead agency should prepare an EIS, as opposed to a less time-consuming and less in-depth Environmental Assessment (EA) and Finding of No Significant Impact (FONSI). In the present case, the USACE determined early in the Section 404 permit application process that an EIS would be prepared for the proposed LBCR because of the high potential for significant impacts. Because the determination has already been made that the potential for overall significant impacts exists, this Revised Draft EIS does not set significance thresholds or make findings of significance for specific resources.

During the planning stage of the EIS study, the study team reviewed documentation for similar projects to ascertain activities that would be associated with the proposed action and the types of impacts they could cause. This research was supplemented by professional judgment concerning typical activities and impacts of concern for any large construction project. A preliminary environmental evaluation diagram (i.e., the C-E-Q diagram, Figure 4.2-1), was developed for each activity associated with the proposed action, listing the potential impacts for that activity.

The study team then identified the following major factors by which the effects associated with the three alternatives can be predicted, characterized, and where possible, quantified:

- Size of the disturbance or footprint;
- Duration or frequency of the impact (how long or how often);
- Likelihood of the impact occurring (probability): high, medium, low, none; and
- Severity of the impact: severe, moderate, slight or none.

With this structure established, the team then conducted the EIS study. The study team obtained information used to predict the size, duration, likelihood, and severity of the impacts for each of the resources described in the Affected Environment (Chapter 3).

4.2.2 Definitions

Discussions of environmental consequences in the following sections will include the following terms and definitions:

Types of Impact

Beneficial – A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.

Adverse – A change that moves the resource away from a desired condition or detracts from its appearance or condition.

Direct – An effect that is caused by an action and occurs in the same time and place.

Indirect – An effect that is caused by an action but is later in time or farther removed in distance, but is still reasonably foreseeable.

Size of Impact

The size or physical extent of the impact in question is quantified to the extent feasible.

Duration or Frequency of Impact:

The duration or frequency of the impact in question is quantified to the extent feasible in terms of months, years, or decades.

Likelihood of Impact:

High – The impact is more likely to occur than not, i.e., approximately 50% likelihood or higher.

Medium – The impact has some chance of occurring, but probably below 50% likelihood.

Low – The impact has a non-zero but very small likelihood of occurrence.

None – The impact has zero probability of occurring.

Severity of Impact:

Severe – Substantial impact or change in a resource that is easily defined, noticeable and measurable, or exceeds a standard.

Moderate – Noticeable change in a resource occurs, but the integrity of the resource remains intact.

Slight – Change in a resource occurs, but no substantial resource impact results.

None – The impact is below the threshold of detection and with no perceptible consequences.

For each resource analyzed, the impacts are divided into two phases: construction and operation. Some types of impacts may of course occur both during the construction and long-term operational phases of the alternative.

4.3 LAND USE

This section discusses environmental consequences, or impacts, to land use under the No Action Alternative, Alternative 1, and Alternative 2. Table 4.3-1 summarizes the impacts for both the construction and operation phases of the proposed dam project for all alternatives.

Table 4.3-1. Summary of Impacts to Land Use Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Construction Phase			
Size	Combined area of dam and reservoir (17,068 acres), flood pool (5,574 acres), pipeline, WTP and TSR	Combined area of dam and reservoir (9,305 acres), flood pool (3,800 acres), pipelines, WTP and TSR	No change from current condition
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Severe	Severe	

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Operation Phase			
Size	Long-term change of land uses at and in the vicinity of the reservoir	Long-term change of land uses at and in the vicinity of the reservoir	Changes in land use may occur but none of those changes would be attributable to not building LBCR. Rather, they may occur as a result of other planned developments due to Fannin County's projected population growth.
Duration	100+ years (long-term)	100+ years (long-term)	
Likelihood	High	High	
Severity	Severe	Moderate to Severe (less than Alternative 1)	

4.3.1 No Action Alternative

Under the No Action Alternative, Lower Bois d'Arc Creek Reservoir would not be constructed. The present trends in land use at the project site would continue. The project area would be expected to remain predominantly rural and undeveloped for the foreseeable future. Some increased urbanization in nearby cities and towns would be expected as the population of the Dallas-Fort Worth Metroplex and Fannin County increases over the decades. This urbanization would be at a slower pace than what would occur in the remainder of the state as a whole due to slower population growth projected for Fannin County.

Changes in land use due to increased urbanization in nearby cities and towns would likely occur within and in proximity to the City of Bonham, located approximately one mile to the west-southwest of the north end of the project site. There may be some additional development in the project area as the result of suburban sprawl which would be dependent on general development trends in north Texas. Some agricultural lands may convert to grasslands or undeveloped lands as family farms are passed down to future generations or sold. This would conversely increase demand for agricultural products and/or pastures. The No Action Alternative would not impact the Caddo National Grasslands.

4.3.2 Alternative 1

This section discusses the environmental consequences on land use during both the construction and operation phases of the proposed dam, reservoir, raw water transmission facilities, water treatment plant, terminal storage reservoir, and related facilities and roadways in Alternative 1. Impacts of this alternative are expected to be moderate to severe in magnitude. Whether these long-term changes in land use of moderate to severe magnitude are considered adverse or beneficial – or both – depends on the particular interests and values of the observer.

Dam and Reservoir

Under Alternative 1, the proposed dam and LBCR would take an estimated 3 to 4 years to construct and would impact 17,068 acres of forest, crop, and ranch land. An additional 5,574 acres of land around the perimeter of the proposed reservoir would be obtained for the flood pool for a total impacted area of 22,640 acres. All of the 22,640 acres would be rendered unusable for current or future agricultural use. The total area of 22,640 acres of land does not include the proposed water treatment plant, terminal storage reservoir, and pipeline. The 5,574 acres of flood pool land is permanently designated as a flood easement and would be only infrequently and temporarily inundated. Thus, 5,574 acres would be suitable for their predominant land use and 17,068 acres would be unusable for their predominant land use. There are approximately 20 single family homes located within the footprint of the proposed reservoir that would be demolished prior to inundation. The majority of these homes have already been acquired by the NTMWD. All remaining units would have to be purchased before construction could begin (McCarthy, 2011a). These residential areas are only a minor portion of the proposed reservoir site. Overall, the effects of the proposed LBCR associated with Alternative 1 on land use would be severe.

Raw Water Transmission Facilities

Pipelines associated with the proposed raw water transmission facilities would parallel county and farm-to-market roads and existing electrical transmission line easements to minimize environmental and infrastructural disturbances. While future construction would be limited within the right-of-way easement, land uses such as farming could continue directly above the buried pipeline. The pipeline would have to be constructed across local streams; however, adverse impacts associated with this could be minimized through a variety of mitigation measures and BMPs that are common to pipeline construction projects, and in any case, would be short-term and localized.

Overall, the effects of the raw water transmission facilities associated with Alternative 1 on land use would be minor.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

The construction and operation of the proposed WTP (including plant access and parking areas) and TSR near Leonard are unlikely to cause any further changes in land use in that area as compared to the No Action Alternative because the area has already been developed. The construction area of the WTP, TSR, and related facilities would cover approximately 351.5 acres, which would no longer be available for the current predominant land use of agricultural hay and pasture land.

FM 1396 Relocation and New Bridge Construction

Relocating FM 1396 and constructing a new bridge over the proposed reservoir would represent a minor, long-term, localized change in land use in the vicinity of the proposed LBCR.

Reservoir Operations

Impacts to land use from the operational phase of Alternative 1 are expected to be severe. Once construction of the proposed dam was completed, this alternative could possibly serve as a catalyst leading indirectly to additional development and population growth within Fannin County, where population density is presently low and agricultural land use now predominates.

This potential effect would be especially prominent in areas with relative proximity to the new lake. Surrounding land values would likely increase, encouraging local land owners to sell their properties to developers or speculators, which would possibly result in the subdivision of agricultural lands for conversion to higher value land use types such as residential and commercial. Over time, this process would change the current appearance and "feel" of the county from low-density rural to higher-density rural, exurban, or even suburban, due to leapfrog development. This is often referred to as sprawl, which is new development separated from existing development by substantial vacant land (Greenbelt Alliance, 2017). Development in these areas would likely include single family dwelling residential areas that are suburban in nature, commercial uses such as community facilities, and retail and consumer services that serve local and nonlocal residents, as well as water-related land use types such as marinas or private campgrounds.

In the Draft Comprehensive Plan, a zoning commission was formed to guide the long-term development of the area surrounding the proposed LBCR. Through a series of public and stakeholder meetings, the commission created the following recommendations regarding the lake area development:

- Desirable home, commercial, and tourist destinations;
- Primarily rural feel, with some areas of greater development;
- Large and small lot residential development should be located on the southern half of the lake;
- Nonresidential uses in designated area (Fannin County, 2016).

The Fannin County Draft Comprehensive Plan has not been finalized as additional public meetings have yet to occur.

It should be emphasized that as the Dallas Metroplex grows in population and development spreads northward – which official demographic projections indicate will occur for decades to come – pressures for growth and development within Fannin County would occur even without the implementation of Alternative 1, that is, without the new reservoir. However, the presence of the reservoir is likely to accelerate this background trend, especially if it is developed for its recreational and high-value real estate potential.

Recreational land use such as parks and golf courses could result from the construction of the proposed reservoir. This development, in turn, would create a demand for increased "hard" infrastructure, such as additional improved roads and utilities and "soft" infrastructure such as schools, churches and other amenities. The proposed reservoir could lead to leapfrog development in surrounding counties through the construction of infrastructure to support development that might occur in Fannin County. This development could change the makeup of current land use in these counties from predominantly agricultural and rural to more developed, rural residential, and suburban in nature. These changes would take place mostly along the border of these counties as development moves out along the periphery of Fannin County.

Neither the NTMWD nor the USACE have land use planning authority in the vicinity of the proposed LBCR. However, Senate Bill 525 in the 82nd Texas Legislature, passed in 2011, granted the Fannin County government land use planning jurisdiction over "the area within 5,000 feet of where the shoreline of the Lower Bois d'Arc Creek Reservoir would be if the reservoir were filled to its storage capacity" (McCarthy, 2013). This authority, under Local Government Code Section 231.133, allows the County to regulate land use features such as:

- Height, number of stories, and size of buildings and other structures;
- Percentage of a lot that may be occupied;
- Size of yards, courts, and other open spaces;
- Population density;
- Location and use of buildings, other structures, and land for business, industrial, residential, or other purposes; and
- Placement of water and sewage facilities, parks, and other public requirements.

If Alternative 1 is selected and the LBCR is constructed, the Fannin County government would possess the authority to regulate land use for almost a mile around the reservoir perimeter in the public interest. The County has recently created a Draft Comprehensive Plan addressing land use and zoning regulations for the area surrounding the project site (Fannin County, 2016). The Draft Comprehensive plan follows the process outlined in the Texas Local Government Code, Chapter 231 - Subchapter G (TLGC 231.131-231.141) (Fannin County, 2016).

Mitigation

Land at Riverby Ranch and lands in the floodplain upstream of the LBCR would be designated for mitigation for the wetland impacts caused by Alternative 1. The land use would be changed from ranching agriculture and undesignated open space to conservation and habitat restoration.

4.3.3 Alternative 2

This section discusses the environmental consequences on land use of the construction and operation of the proposed dam and reservoir in Alternative 2. Impacts of this alternative are expected to be moderate to severe in magnitude, but less than Alternative 1. As with Alternative 1, whether these long-term changes in land use of moderate to severe magnitude are considered adverse or beneficial – or both – depends on the particular interests and values of the observer.

Dam and Reservoir

Under Alternative 2, construction of the proposed dam and LBCR would require an estimated 3 to 4 years and would impact approximately 9,305 acres of forest, crop, and ranchland, all within the footprint of the proposed full-sized LBCR of Alternative 1. An additional 3,800 acres of land around the perimeter of the proposed reservoir would be obtained for the flood pool for a total impacted area of 13,105 acres. All of the 13,105 acres would be rendered unusable for current or future agricultural use. The total area of 13,105 acres of land does not include the proposed water treatment plant, terminal storage reservoir, raw water pipeline, and blending water pipeline. The 3,800 acres of flood pool land is permanently designated as a flood easement and would be only infrequently and temporarily inundated. Thus, 3,800 acres would be suitable for their predominant land use and 9,305 acres would be unusable for their predominant land use. There are approximately 20 single family homes located within the footprint of the proposed reservoir that would be demolished prior to inundation. The majority of these homes have already been acquired by NTMWD. All remaining units would have to be purchased before construction could begin (McCarthy, 2011a). These residential areas are only a minor portion of the proposed reservoir site. Overall, the effects of the proposed LBCR associated with Alternative 2 on land use would be severe.

Raw Water Transmission Facilities

As under Alternative 1, pipelines associated with the proposed raw water transmission facilities would generally run parallel to county and farm-to-market roads and existing electrical transmission line easements to minimize environmental and infrastructural disturbances. The necessary infrastructure and facilities construction and improvements associated with conveying water from Lake Texoma to the proposed Leonard WTP are relatively small, and include a new pipeline and improvements at the Texoma pump station.

The pipelines would have to be constructed across local streams; however, adverse impacts associated with this could be minimized through a variety of mitigation measures and BMPs common to pipeline construction projects and, in any case, would likely be short-term and localized. While future construction would be limited within the right-of-way easement, land uses such as farming could continue directly above the buried pipelines. Overall, the effects of the raw water transmission facilities associated with Alternative 2 on land use would be minor.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

The construction and operation of the proposed WTP (including plant access and parking areas) and TSR near Leonard are unlikely to precipitate any further changes in land use in that area as compared to the No Action Alternative because the area has already been developed. The lands occupied by construction of the WTP, TSR, and related facilities would no longer be suitable for the current predominant land use of agricultural hay and pasture land.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

As under Alternative 1, Alternative 2 would also involve relocating FM 1396 and constructing a new bridge over the proposed reservoir. Impacts would be essentially the same as under Alternative 1 and would constitute a minor, long-term, localized change in land use in the vicinity of the proposed LBCR.

Reservoir Operations

Effects on land use from the operational phase of Alternative 2 are expected to be moderate to severe, though less than from Alternative 1. Though less acreage would be impacted than under Alternative 1, once construction of the proposed dam was completed this alternative could still possibly serve as a catalyst leading indirectly to additional development and population growth within Fannin County, especially in areas with relative proximity to the new lake. Even on a reduced scale, this trend could change the current appearance and "feel" of the county from low-density rural to higher-density rural, exurban, or even suburban, due to leapfrog development and suburban or exurban sprawl.

As described under Alternative 1, the Fannin County government now possesses the authority to regulate land use in the public interest in the vicinity of the proposed LBCR for almost a mile around the reservoir perimeter. This would not change under any alternative.

Recreational land use such as parks and golf courses could result from the construction of the proposed reservoir; however, under the downsized LBCR alternative, the development of such amenities would likely occur on a smaller scale (with both less adverse and less beneficial impacts) since the reservoir would be half the size of that which is proposed under Alternative 1. Thus, the further development of both hard and soft infrastructure resulting from the development of recreational amenities would also occur on a smaller scale. However, land use changes associated with development that would potentially occur would be similar in nature to those described under Alternative 1.

Mitigation

As under Alternative 1, land at Riverby Ranch and lands in the floodplain upstream of the LBCR would be designated for mitigation for the wetland impacts caused by Alternative 2. The land use would be changed from ranching agriculture and undesignated open space to conservation and habitat restoration.

4.4 TOPOGRAPHY, GEOLOGY, AND SOILS

This section discusses the environmental impacts on topography, geology, and soils from Alternatives 1and 2 and the No Action Alternative. Table 4.4-1 provides a summary of the environmental impacts for both the construction and operation phases of the proposed dam project for all alternatives.

Table 4.4-1. Summary of Impacts to Topography, Geology, and Soils Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Construction Phase			
Size	Combined area of dam and reservoir (17,068 acres), flood pool (5,574 acres), pipeline, WTP and TSR	Combined area of dam and reservoir (9,305 acres), flood pool (3,800 acres), pipelines, WTP and TSR	No change from current condition
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Moderate	Moderate	Geology – No change from current condition Topography and soils – slight to moderate
Operation Phase			
Size	Combined area of dam and reservoir (17,068 acres), flood pool (5,574 acres), pipeline, WTP and TSR	Combined area of dam and reservoir (9,305 acres), flood pool (3,800 acres), pipelines, WTP and TSR	No change from current condition
Duration	100+ years (long-term)	100+ years (long-term)	
Likelihood	High	High	
Severity	Moderate	Moderate	Geology – No change from current condition Topography and soils – slight to moderate

4.4.1 No Action Alternative

Under the No Action Alternative, the proposed dam and reservoir, raw water pipeline, water treatment plant, new bridge and FM 1396 relocation, and other related facilities would not be built. Under this alternative, over the short term topographic features, geological formations, and soils in the project area would remain essentially in their present condition. Ongoing erosion and downcutting associated with channelization of Bois d'Arc Creek would continue for the foreseeable future, eroding soils along the creek's banks and transporting them downstream. This would adversely affect topography in the immediate vicinity of the creek by causing additional widening and deepening of the channel, as well as steeper, unstable banks.

Overall, there would be no short- or long-term effects from the No Action Alternative on geology. With regard to topography and soils, adverse impacts from ongoing erosion would be long-term and slight to moderate.

4.4.2 Alternative 1

Alternative 1 includes a proposed reservoir and dam that would cover a total of 22,640 acres of various soils including 13 Prime Farmland soils. It also includes water treatment and transmission facilities. Environmental impacts on topography, geology, and soils during both the construction and operation phases of Alternative 1 are discussed below.

Construction Phase

Construction of the Proposed LBCR Dam and Reservoir Clearing

The impacts of dam and reservoir construction to topography and geology would be expected to be moderate. The dam would be constructed to a length of 10,400 feet with a maximum height of 90 feet. The reservoir embankment would be built to a height of 553.5 feet MSL. The proposed LBCR would cover over 16,641 acres of forest, crop, and ranch land. An additional 5,574 acres around the perimeter would be obtained for the flood pool. Construction is expected to take 3 to 4 years.

Dam construction would involve excavating a slurry trench of variable depth in the ground surface to create an impervious barrier along the length of the dam foundation. Reservoir construction upstream of the dam site would not be expected to impact subsurface geology, as no deep excavation and minimal grading would occur. Two spillways would be constructed along the right abutment of the dam. Soils and earth removed during excavation would be used to construct the core of the dam, potentially exposing the underlying shale formations. The bedrock includes weathered shale followed by clayey shale, which is further followed by unweathered shale. Given the depth to bedrock as well as its composition, general impacts to geology would be expected to be minor. The construction of both the service spillway and the emergency spillway would be anticipated to have negligible to minor effects on geology.

The impacts of dam and reservoir construction to soils would be expected to be moderate. Use of heavy construction equipment often results in soil compaction, which can lead to decreased infiltration rates and increased runoff and erosion rates. The magnitude, extent, and duration of construction-related impacts depend on the erodibility rates of the soil; proximity of the construction activity to receiving waters; and the construction methodologies, duration, and season. Most of the soils at the site of the proposed LBCR are clayey with a low erosional potential. Soil compaction is not expected to appreciably change the character of the existing soils. Mitigation measures such as standard Best Management Practices (BMPs) could reduce these impacts to soil resources. The project would be subject to CWA construction stormwater permitting requirements, which impose a host of specific erosion and sediment control measures.

Construction activities have the potential to disturb soils within the entire footprint of the dam and certain other areas within the reservoir. Some erosion is likely to occur from vehicle use and vegetation removal. The Draft Reservoir Clearing Plan (NTMWD, no date-b), as prepared by the applicant, guides the process of vegetation removal within the footprint of the reservoir. Vegetation clearing would also be expected along the proposed shoreline, as needed for emergency access. The selective clearing of vegetation detailed in the construction drawings would address potential impacts such as shoreline instability and erosion. These impacts could be minimized by considering the specific character of the soils, slope, and underlying strata at a particular location.

Overall, the effects on topography, geology, and soils of constructing the proposed LBCR would be adverse and moderate.

FM 1396 Relocation and New Bridge Construction

As described in Section 3.10 of this DEIS, FM 1396 is an existing two-lane, TxDOT asphalt road that crosses through the proposed reservoir footprint. Construction of the proposed LBCR would directly cause the inundation and closure of a segment of the existing FM 1396 within the reservoir footprint and the existing FM 1396 bridge over Bois d'Arc Creek. NTMWD has investigated options for replacing this road and bridge with the relevant TxDOT and Fannin County authorities. The preferred option of those considered by all three parties is to replace FM 1396 by extending FM 897 North out of Lannius with a new bridge over the proposed reservoir. This option would require building approximately four miles of new roadway that would run from north to south across the proposed reservoir. While existing County

Road ROW may be utilized, this construction would still result in temporary and long-term impacts to soils within the ROW from grading and excavation by heavy road construction equipment and paving with asphalt. Up to approximately 20 acres of soils may be lost or converted permanently as a result of paving with asphalt, which would be considered a minor impact. The replacement of FM 1396 by an extension of FM 897 would have a temporary, minor effect on topography and geology due to the use of heavy road construction equipment and paving with asphalt.

Raw Water Pipeline

Under Alternative 1, 35 miles of raw water pipeline would be constructed from the proposed reservoir to the site of the proposed new water treatment plant near Leonard. As noted in Section 3.2.2.2, the main soil groups crossed by the pipeline route include the Fairlie-Dalco complex, Houston Black clay, and Howe-Whitewright complex. The Fairlie-Dalco complex and Houston Black clay are deep soils which are well-suited for use as cropland, while the Howe-Whitewright complex is more suited to be used as rangeland or pastureland.

Construction of the pipeline would temporarily impact these soils by the use of heavy machinery to excavate a trench and lay the pipeline. The raw water pipeline would not have a permanent effect on the topography, geology, or soil. Overall, impacts of pipeline construction on soils along the proposed raw water pipeline route would be temporary and minor with no permanent effects.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

The proposed Water Treatment Plant and Terminal Storage Reservoir would be located at a site near Leonard. The grading limits or footprint of the WTP are 186.2 acres, while the grading limits/footprint of the TSR to the north are 153.5 acres. These connected actions would permanently impact soils within the grading limits by covering them with facilities or removing them from agricultural production. The predominant soil type at this site is the Fairlie-Dalco complex, which consists of deep, moderately alkaline, clayey soils on low slopes of 3-5 percent.

Overall, developing the proposed water treatment plant and terminal storage reservoir would have a slight effect on soils and no permanent effect on the topography or geology.

Operation Phase

The only potential effects on topography, geology, and soils from operation of the components of Alternative 1 are from operation of the proposed reservoir. The relocated road and new bridge, raw water pipeline, WTP, and TSR would not have effects on topography, geology, or soils during the operation phase.

Lower Bois d'Arc Creek Reservoir

The dam would operate as a structure 10,400 feet in length at the terminus of the reservoir, which would have a total footprint of 17,068 acres (including the dam). Reservoir operations are not anticipated to impact topographical or geological resources unless slope stability were to become an issue along the embankment and shoreline. Fluctuating water levels have the potential to create unstable slopes, thus increasing the potential for small slides, which would impact both the topography and geology of the slopes, especially if erosion during slides were to occur. However, in most places bank slopes would be relatively low, given the relatively gentle topography of the area. Best management practices, such as using riprap to stabilize banks and monitoring shoreline conditions would be implemented to decrease the potential of these impacts. Impacts from reservoir operations on topography and geology would thus be considered slight.

Impacts to soils from the operation of the proposed dam and reservoir are expected to be moderate. The soils within the footprint of the reservoir would be permanently altered once inundated by water. These soils would become anaerobic with altered chemical and biological processes. Sediment would also be expected to gradually accumulate within the reservoir and may collect ahead of the dam discharge area.

Operating the proposed dam and reservoir would have a long-term adverse impact on Prime Farmland Soils by eliminating these soils from potential use in agriculture. There are 13 soils listed at the site of the proposed dam and reservoir that are considered potential Prime, Unique, and Important Farmland by the NRCS. These soils would no longer be available for agricultural use once the land conversion to a reservoir occurs. However, the NRCS considers Prime Farmland soils found in areas of proposed water supply reservoirs to be exempt from restrictions under the Farmland Protection Policy Act (FPPA). The NRCS office in Temple, TX reviewed information concerning the proposed project and completed a Farmland Conversion Impact Rating Form (AD-1006). Because the rating fell below 160 (the combined score for the LBCR site was 115), USACE does not need to consider other alternatives (see Appendix P).

4.4.3 Alternative 2

This section describes the effects on topography, geology, and soils from construction and operation of Alternative 2. The Alternative 2 reservoir operations area covers a total area of 13,105 acres including the area of the dam and reservoir (9,305 acres) and flood pool (3,800 acres). Alternative 2 is smaller than Alternative 1, which has a total area of 22,642 acres including the area of the dam and reservoir (17,068 acres) and flood pool (5,574 acres). Alternative 2 also includes the construction of approximately 25 miles of new underground water pipeline from Lake Texoma to the Texoma Balancing Reservoir.

Construction Phase

Construction of the LBCR Dam and Reservoir Clearing

The impacts of dam and reservoir construction to topography and geology for Alternative 2 would be expected to be similar to those for Alternative 1. However, the impacts from the downsized dam would be somewhat less in scale and proportion because of the reduction in dam height and corresponding reservoir footprint (estimated at 46 percent less than the full-scale dam) in this alternative. Under Alternative 2, approximately 9,305 acres of waters, wetlands, and uplands would be impacted by the dam and reservoir. An additional 3,800 acres around the perimeter would be obtained for the flood pool. Construction is expected to take 3 to 4 years.

The impacts of dam and reservoir construction to soils would be expected to be moderate. Again, the impacts from the downsized dam would be somewhat less in scale and proportion because of the reduction in dam height and corresponding reservoir footprint in Alternative 2. The project would be subject to CWA construction stormwater permitting requirements, which impose a host of specific erosion and sediment control measures.

Overall, the effects on topography, geology, and soils of Alternative 2 would be minor. Overall impacts of Alternative 2 would be slightly less than those of Alternative 1.

FM 1396 Relocation and New Bridge Construction

As described in Section 3.10 of this DEIS, FM 1396 is an existing two-lane, TxDOT asphalt road situated within the proposed reservoir. Construction of the proposed LBCR would directly cause the inundation and closure of a segment of the existing FM 1396 within the reservoir footprint and the existing FM 1396 bridge over Bois d'Arc Creek. NTMWD has investigated options for replacing this road and bridge with the relevant TxDOT and Fannin County authorities. The preferred option of those considered by all three parties is to replace FM 1396 by extending FM 897 North out of Lannius with a new bridge over the proposed reservoir. This option would require building approximately four miles of new roadway that would run from north to south over the new reservoir. While existing County Road ROW may be utilized, this construction would still result in temporary and long-term impacts to soils within the ROW from grading and excavation by heavy road construction equipment and paving with asphalt. Up to approximately 20 acres of soils may be lost or converted permanently as a result of paving with asphalt, which would be considered a minor impact. The replacement of FM 1396 by an extension of FM 897 would have a temporary, minor effect on the topography and geology due to the heavy road construction equipment and paving with asphalt.

Raw Water Pipeline

Under Alternative 2, 35 miles of raw water pipeline would be constructed from the proposed reservoir to the site of the proposed new water treatment plant near Leonard, as would be done for Alternative 1. As noted in Section 3.2.2.2, the main soil groups crossed by the pipeline route include the Fairlie-Dalco complex, Houston Black clay, and Howe-Whitewright complex. The Fairlie-Dalco complex and Houston Black clay are deep soils which are well-suited for use as cropland, while the Howe-Whitewright complex is more suited to be used as rangeland or pastureland.

As in the case of Alternative 1, Alternative 2 would temporarily impact these soils by the use of heavy machinery to excavate a trench and lay the pipeline. The raw water pipeline would not have a permanent effect on the topography, geology or soil. Overall, impacts of Alternative 2 on soils along the proposed raw water pipeline route would be temporary and minor with no permanent effects.

Texoma 72-inch blending pipeline

Alternative 2 would entail the construction of approximately 25 miles of a new, 72-inch underground pipeline to transport water from Lake Texoma to the Texoma Balancing Reservoir to blend with water supplied by the downsized LBCR. This new proposed pipeline would parallel the existing NTMWD pipeline from Lake Texoma and there would be temporary and short-term, negligible to slight impacts to soils during construction. The right-of-way corridor is already a disturbed site from the original Lake Texoma pipeline construction and ongoing maintenance. Although disruption to topography and geology may occur during construction, no permanent impacts are expected.

Texoma 84-inch blending pipeline

Alternative 2 would also include the construction of a new eight-mile spur underground pipeline from the existing NTMWD 96-inch raw water pipeline carrying Lake Texoma water to the WTP at Wylie. For the purpose of this analysis, it is assumed that the soil types that would be disturbed during the construction phase are similar to those for the raw water pipeline. Alternative 2 would temporarily impact soils by the use of heavy machinery to excavate a trench, and lay the 84-inch blending pipeline Overall, impacts of Alternative 2 on soils along the proposed raw water pipeline route would be temporary and minor with no permanent effects on the topography, geology, or soil.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

For construction of the WTP, TSR, and related facilities, Alternative 2 would have the same impacts and occur in the same location as Alternative 1. The proposed Water Treatment Plant and Terminal Storage Reservoir would be located at a site near Leonard. The grading limits or footprint of the WTP is 186.2 acres, while the grading limits/footprint of the TSR to the north is 153.5 acres. These connected actions would permanently impact soils within the grading limits by covering them with facilities or removing them from agricultural production. The predominant soil type at this site is the Fairlie-Dalco complex, which consists of deep, moderately alkaline, clayey soils on low slopes of 3-5 percent.

Overall, developing the proposed water treatment plant and terminal storage reservoir would have a slight effect on soils and no permanent effect on topography or geology

Operation Phase

The only potential effects on topography, geology, or soils from operation of the components of Alternative 2 are from operation of the proposed reservoir. The relocated road and new bridge, raw water pipelines, WTP, and TSR would not have effects on topography, geology, or soils during the operation phase.

Lower Bois d'Arc Creek Reservoir

With regard to topography, the reservoir would have a conservation pool elevation 515 feet MSL, and would have a storage capacity of 135,200 AF, for a total footprint of 9,305 acres (including the dam) approximately half the acreage of Alternative 1. Reservoir operations are not expected to adversely impact geological resources unless slope stability was to become an issue along the embankment and shoreline. Fluctuating water levels, which might be more pronounced for this alternative than for Alternative 1, have the potential to create unstable slopes, thus increasing the potential for small slides, which would impact both the topography and geology of the slopes, especially if erosion during slides were to occur. However, in most places bank slopes would not be relatively low, given the relatively gentle topography of the area. Best management practices, such as using riprap to stabilize banks, and monitoring shoreline conditions would be implemented to decrease the potential of these impacts. Impacts from operations under Alternative 2 on geology would thus be considered slight.

Impacts to soils from the operation of the dam and reservoir are expected to be moderate. The soils within the footprint of the reservoir would be permanently altered once inundated by water. These soils would become anaerobic with altered chemical and biological processes. Sediment would also be expected to gradually accumulate within the reservoir and may collect ahead of the dam discharge area.

As with Alternative 1, operating the downsized dam and reservoir would have a long-term adverse impact on Prime Farmland Soils within the reservoir footprint by eliminating these soils from potential use in agriculture. The acreage of Prime Farmland Soils directly affected would be slightly less than under Alternative 1. However, as discussed above, the NRCS considers Prime Farmland soils found in areas of proposed water supply reservoirs to be exempt from FPPA restrictions. While the total Prime Farmland acreage would be unavailable for agriculture, impacts from the smaller LBCR are exempt from consideration and protection under the FPPA, as indicated in Appendix P.

Table 4.4-2, compiled by Coffman (2013), contains estimated and measured sediment yield values from seven locations with similar climate, soils, geology, land use/land cover, and topography to the LBCR watershed. These estimates assume a total contributing drainage area for LBCR of 297 square miles at the proposed dam site, and that the proposed reservoir is not yet present. The sediment yields in Column 2 of Table 4.4-2 were multiplied by the LBCR watershed drainage area to calculate estimated average annual sedimentation rates (Column 3). Sedimentation rates with the proposed reservoir in place would be lower by a factor of approximately 0.09. Actual sedimentation rates in the proposed LBCR would depend on land use and land cover around the reservoir, the erodibility of the soils not inundated by the reservoir, potential future erosion control measures, thickness of soils, and the climate.

The calculated sedimentation rates for the LBCR in Table 4.4-2 vary by a factor of almost five, from 107 AFY to 475 AFY. Coffman (2013) considers those rates based on volumetric surveys of Lake Bonham and Pat Mayse Lake (near Paris) conducted by TWDB to be the most representative for the proposed reservoir.

Table 4.4-2. Measured and Modeled Sediment Yields from Similar Areas and Calculated LBCR Sedimentation Rates

Data Source	Sediment Yield ($AF/mi^2/year$)[a]	Corresponding LBCR Sedimentation Rate (AFY)[b]
Bois d'Arc Creek (Texas Dept. of Water Resources, 1982)	0.36	106.9

Data Source	Sediment Yield (AF/mi^2/year)[a]	Corresponding LBCR Sedimentation Rate (AFY)[b]
George Parkhouse Res. No. 2 (proposed) (Texas Dept. of Water Resources, 1982)	0.91	270.3
Lake Crook (Texas Dept. of Water Resources, 1982)	0.77	228.7
Report on New Bonham Reservoir (FNI [1984] from Texas Board of Water Engineers [1959])	1.60	475.2
Lake Bonham Volumetric Survey (TWDB, 2005)	0.94	279.2
Jim Chapman Lake Volumetric Survey (TWDB, 2008a)	1.50	445.5
Pat Mayse Lake Volumetric Survey (TWDB, 2008b)	0.93	276.2

[a] acre-feet per square mile per year.

[b] acre-feet per year

Source: Coffman, 2013

These surveys used a type of sonar to measure the bathymetry (underwater topography) and depth of waters throughout the reservoirs surveyed at a given water surface elevation (typically the conservation or normal pool elevation). Bathymetry and depth data were then combined to calculate reservoir storage at that water surface elevation. The current storage was then compared to the initial storage of the reservoir at the same elevation. Any reduction in storage was thus attributed to sedimentation, although it is still possible that some of the difference may be attributed to the different methods used to measure or calculate the storage volume.

Assuming a sedimentation rate of 0.94 AF/mi^2/year (the same as for the 2005 Lake Bonham Volumetric Survey), the proposed LBCR would lose approximately 11,167 AF of storage capacity at the normal pool elevation (534 feet) after its initial 40 years; this represents approximately three percent of the initial reservoir capacity of 367,609 AF. After 100 years of sedimentation at this rate, LBCR would have lost approximately 7.5 percent of its capacity. These predictions may over-estimate the sedimentation rate slightly, because they include the total contributing LBCR drainage area of 297 square miles, and do not account for the reduction in contributing drainage area resulting from land surface inundation from the reservoir itself; that is, lands which would be submerged so that they would no longer erode and contribute sediment.

As noted earlier, sediment accumulation in reservoirs and lakes is a natural and predictable process. Based on the calculations and estimates above, sedimentation in the proposed LBCR is not anticipated to be a significant issue. If at some point in the future, sedimentation is deemed to be a problem for the reservoir, sedimentation rates in the upstream watershed could be reduced by implementing a sediment management program. Such a program could include an educational component: instructing land owners and farmers about the benefits of sediment BMPs such as increased productivity through decreased loss of soil and nutrients. It could also include incentives or support for additional sediment yield reduction actions such as stream channel erosion protection measures, changes to agricultural practices (e.g., contour farming, terracing, filter strips, critical pasture planting and converting crop land to pasture land), and construction of sediment control structures in the watershed upstream.

4.5 WATER RESOURCES

The following sections address the potential environmental consequences of the No Action Alternative, as well as potential impacts associated with the construction and operational phases for the full-sized LBCR (Alternative 1) or smaller LBCR (Alternative 2) on surface water resources, groundwater resources, existing water rights and inter-basin water transfers within the affected environment. In the main body of Section 4.5, analysis of the effects on water resources during construction and operation is presented jointly because a clear separation of construction and operational impacts has not been fully quantified. Table 4.5-1 is a summary of the water resource impacts that were identified Alternatives 1 and 2.

Table 4.5-1. Summary of Impacts to Water Resources Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Surface Hydrology			
Size	Likely less than 1 mile of stream channel in Bois d'Arc Creek and Honey Grove Creek will be impacted within the 427 acre dam and spillway construction footprint	Likely less than 1 mile of stream channel in Bois d'Arc Creek and Honey Grove Creek will be impacted within the 427 acre dam and spillway construction footprint	No change from current condition.
Duration	50 – 100+ years (long-term)	50 – 100+ years (long-term)	
Likelihood	High	High	
Severity	Severe	Severe	
Stream Channels (Fluvial Geomorphology)			
Size	Likely less than 1 mile of stream channel in Bois d'Arc Creek and Honey Grove Creek will be impacted within the 427 acre dam and spillway construction footprint	Likely less than 1 mile of stream channel in Bois d'Arc Creek and Honey Grove Creek will be impacted within the 427 acre dam and spillway construction footprint	No change from current condition.
Duration	50 – 100+ years (long-term)	50 – 100+ years (long-term)	
Likelihood	High	High	
Severity	Severe	Severe	
Surface Water Quality			
Size	Likely less than 1 mile of stream channel in Bois d'Arc Creek and Honey Grove Creek will be impacted within the 427 acre dam and spillway construction footprint	Likely less than 1 mile of stream channel in Bois d'Arc Creek and Honey Grove Creek will be impacted within the 427 acre dam and spillway construction footprint.	No change from current condition.
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Slight	Slight	
Groundwater Resources	No change	No change	No change from current condition
Existing Reservoirs	No change	No change	No change from current condition.

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Operation Phase			
Surface Hydrology			
Size	Reservoir footprint only 16,641 acres; 120,000 AFY firm yield provided by the full sized LBCR reservoir Sedimentation rate of 0.94 AF/mi2/year, loss of 11,167 AF of storage capacity at the normal pool elevation (534 feet) 7.5 percent loss of storage capacity over 100 years	Reservoir footprint only 8,600 acres; 86,100 AFY firm yield provided by smaller LBCR reservoir. Sedimentation rate of 0.94 AF/mi2/year, loss of 11,167 AF of storage capacity at the normal pool elevation (515 feet) 21percent loss of storage capacity over 100 years	No change from current condition.
Duration	>50 - 100+ years (long-term)	>50 - 100+ years (long-term)	
Likelihood	High	High	
Severity	Moderate	Moderate	
Stream Channels (Fluvial Geomorphology)			
Size	Total = 651,140 LF (123.3 miles): Intermittent 286,139 LF (54.2 miles or 120 acres); Intermittent/Ephemeral 365,001 LF (69.1 miles or 99 acres)	Total = 348,928 LF (66.1 miles): Intermittent 166,286 LF (31.5 miles); Intermittent/Ephemeral 182,642 LF (34.6 miles)	No change from current condition.
Duration	>50 - 100+ years (long-term)	>50 - 100+ years (long-term)	
Likelihood	High	High	
Severity	Moderate	Moderate (less than Alternative 1)	
Surface Water Quality			
Size	Reservoir footprint 16,641 acres; Total Streams = 651,140 LF (123.3 miles) Total Dissolved Solids 221 – 330 mg/L	Reservoir footprint 8,600 acres; Total Streams= 348,928 LF (66.1 miles) Total Dissolved Solids <250 mg/L	Slight impact if development in the area continues.
Duration	>50 - 100+ years (long-term)	>50 - 100+ years (long-term)	
Likelihood	High	High	
Severity	Moderate	Moderate	
Groundwater Resources			
Size	0	0	Moderate impact on groundwater due to increased groundwater withdrawals if development continues
Duration	>50 - 100+ years (long-term)	>50 - 100+ years (long-term)	
Likelihood	None	None	
Severity	None	None	
Existing Reservoirs	No change if mitigation measures are performed on Lake Bonham Dam.	Lake Texoma withdrawal of 28,700 AFY	No change from current condition.

4.5.1 No Action Alternative

Under the No Action Alternative, there would be no change from current conditions for surface hydrology, stream channels, or existing reservoirs. Impacts on surface water and groundwater from ongoing and new development that may still occur under the No Action Alternative are discussed below.

Surface Water Resources

The No Action Alternative is expected to result in continuing minor changes to the hydrology and hydraulics of Bois d'Arc Creek and affected tributaries over time, as these channelized streams continue to evolve towards a state of dynamic equilibrium. The *Final Environmental Report Supporting an Application for a 404 Permit for Lower Bois d'Arc Creek Reservoir* prepared for North Texas Municipal Water District (NTMWD) discusses potential impacts that could result from increased runoff due to ongoing and future development and urbanization, particularly in the nearby City of Bonham. The report is included as Appendix Q of this Revised DEIS. Potential impacts may include changes to temperature, dissolved oxygen, suspended sediment, and other water quality parameters. The most severe flooding in the watershed is caused by constrictions created at the point where bridges cross watercourses. These crossings may restrict streamflow and increase the magnitude and duration of flooding events. The Highway 82 and Highway 65 crossings of Bois d' Arc Creek have been identified as crossings that restrict stream flow during high water events. The greatest hydrologic impact expected to result from the No Action Alternative would be the potential for continued flooding, which may be worsened due to development in the Bois d'Arc Creek watershed, including the construction of new roads and bridges. Development of new roads and bridges, parking lots, and residential and commercial areas would include land disturbance and the construction of impervious surfaces, which could lead to a temporary increase in erosion and permanent increase in runoff that may reach surface waterbodies.

Surface water quality would remain similar to the existing conditions under the No Action Alternative. Development in the project area could affect water quality through increases in turbidity from erosion and sedimentation. Increased channelization could also result from development, which could lead to the disturbance or removal of vegetation, increased flows and reduced freshwater availability, and accelerated delivery of pollutants, all of which would affect surface water quality.

Based on past land use in the area, lands within the proposed reservoir footprint under the No Action Alternative could be subject to timber harvesting, which would require the clearing of wetlands (i.e., forested wetlands) and construction of new stock ponds. These activities could lead to effects on surface water quality of waters of the U.S., including wetlands, primarily in the form of increased turbidity and sedimentation.

Under the No Action Alternative, ongoing and new development may still occur. Federal, State or local permits are required for development projects and typically include surface water discharge restrictions and water quality protection measures. Under the No Action Alternative, it is assumed that there would be slight additional adverse impacts on surface waters because of permitted development. Effects on surface waters would not change considerably and Bois d'Arc Creek water quality would continue to support all of its current instream uses.

Ongoing and new development could influence surface water resources in other ways through increases in the occurrence and magnitude of floods from changes or increases in flows; increases in erosion and runoff from land disturbance and new impervious surfaces; increases in turbidity from erosion and sedimentation; and changes in or removal of vegetation, reductions in freshwater availability, and the acceleration of the delivery of pollutants from channelization. There would be an overall increase in the amount of non-point source surface water pollution. These potential direct and indirect adverse impacts on surface water resources under the No Action Alternative would likely be slight to moderate compared to existing conditions.

Groundwater Resources

The population in Fannin County is projected to steadily increase over the next several decades (Region C Water Planning Group, 2015). Due to the increase in population, water demands would also increase. To meet increasing water demands, additional pumping of groundwater from the major aquifers in the region, including the Woodbine and Northern Trinity, could occur. Areas of Fannin County that have limited well production capacity could potentially experience groundwater supply shortages and decreased production rates. The need for deeper groundwater wells could also potentially result in decreased water quality, as groundwater of lesser quality is pumped from the deeper wells. As a result, the No Action Alternative could have a moderate adverse impact on local aquifers.

4.5.2 Alternative 1

LBCR Reservoir Water Storage

The drainage area above the proposed dam site is 327 square miles or approximately 77 percent of the entire Bois d'Arc Creek watershed. The total storage volume of the proposed Lower Bois d'Arc Creek Reservoir is 367,609 acre-feet. The reservoir water depth would range between 72 feet at the dam and approximately four feet at the upstream extent of the reservoir, under normal pool conditions, as shown in the reservoir profile in Figure 4.5-1. The profile also indicates that water depth under normal pool conditions would be 19 feet at reservoir mile 12, and 11 feet at reservoir mile 13 (Appendix M). Water depth would be approximately four feet at reservoir mile 15, a depth that would occur for over three miles on the upstream end of the reservoir under normal pool conditions. At 75 percent capacity, the reservoir pool elevation would be 529.9 feet, 4.1 feet less than the normal pool elevation. At 50 percent capacity, the reservoir pool elevation would be at 520.3 feet, 13.7 feet less than the normal pool elevation. Figure 4.5-2 presents a plan view map of the fill levels of the proposed LBCR based on the elevation profile previously discussed and shows the lateral extent and reaches of the reservoir at the various given elevations and capacities, including the extent at normal pool elevation (534.0 feet MSL), 75 percent capacity, 50 percent capacity, and flood easement elevation (545.0 feet MSL).

Operation of the proposed LBCR will be conducted in compliance with Texas water law and the Water Permit. Some of the specific operational considerations NTMWD will implement, including requirements of the Water Permit, are included in the proposed operations plan (Appendix D):

- Storage – LBCR is authorized to impound 367,609 acre-feet of State water for municipal, industrial, agricultural and recreational use.
- Diversions – NTMWD is authorized to divert up to 175,000 acre-feet per year at a maximum diversion rate of 365.15 cfs from any point on the perimeter of the reservoir.
- Pass-Throughs - Pass-throughs are inflows that are released through (or "passed through") the LBCR Dam to Bois d'Arc Creek. Pass-throughs do not include releases of stored water. For purposes of the proposed operation plan, the terms "pass-through" and "release" are used interchangeably.)
    - Downstream senior water rights - In compliance with State water law, NTMWD will pass inflows through the dam for existing water right holders. There are two existing water rights on Bois d'Arc Creek between the LBCR and the confluence with the Red River and thirteen Texas water rights on the Red River downstream of the confluence with Bois d'Arc Creek.

- Environmental flows – NTMWD will pass inflows through the dam in compliance with the environmental flow requirements in the Water Permit. The environmental flow regime is based on the Texas Instream Flow Program and requires seasonal base flow and pulse flow releases.
- Wastewater discharges – The NTMWD will also pass the effluent return flow of the City of Bonham that is discharged upstream of LBCR for environmental flow purposes downstream of the dam. The City's discharges have historically ranged from <1 cfs to 3.5 cfs, with an average of 1.8 cfs over the last three years. (Note: All effluent return flows to the LBCR are considered as inflow to the reservoir and will be considered for environmental flow purposes. NTMWD has control over the City of Bonham's effluent return flows and has committed to pass these flows for environmental purposes during subsistence conditions.)

Reservoir storage capacity could be reduced over time by the sediment that accumulates within the reservoir. Sediment yield is the total quantity of silt and sediment deposited in a reservoir by surface runoff and erosion from the surrounding drainage area. Excess sedimentation in a reservoir causes reduced storage capacity.

Sedimentation in reservoirs and natural water bodies, such as ponds and lakes, occurs naturally as a result of erosion of the land surface by flowing water within an upstream watershed, as well as erosion from stream channel banks and sediment transport along stream beds. Erosion and sedimentation rates vary throughout the year as well as from year to year due to climatic conditions, land use/land cover, and existing conditions (e.g., soil types, topography). The sedimentation rate is the rate at which sediment accumulates, typically measured in units of mass per unit time or units of volume per unit time. Reservoir sedimentation is correlated directly with the upstream watershed sediment yield. Several methods are available to estimate the potential sedimentation rate for a proposed reservoir, including the production of sediment discharge rating curves using measured sediment concentrations in stream water; estimations of watershed sediment yields using available erosion prediction equations such as the Modified Universal Soil Loss Equation; and comparisons to measured sedimentation rates in existing reservoirs with similar climate, soils, land use/land cover and topography (Coffman, 2013).

Table 4.5-2 contains estimated and measured sediment yield values from seven locations with similar climate, soils, geology, land use/land cover, and topography as the LBCR watershed. These estimates assume a total contributing drainage area for LBCR of 327 square miles at the proposed dam site, and that the proposed reservoir is not yet constructed. The sediment yields in Column 2 of Table 4.5-2 were multiplied by the LBCR watershed drainage area to calculate estimated average annual sedimentation rates (Column 3). (Sedimentation rates with the proposed reservoir in place would be lower by a factor of approximately 0.09). Actual sedimentation rates in the proposed LBCR would depend on land use and

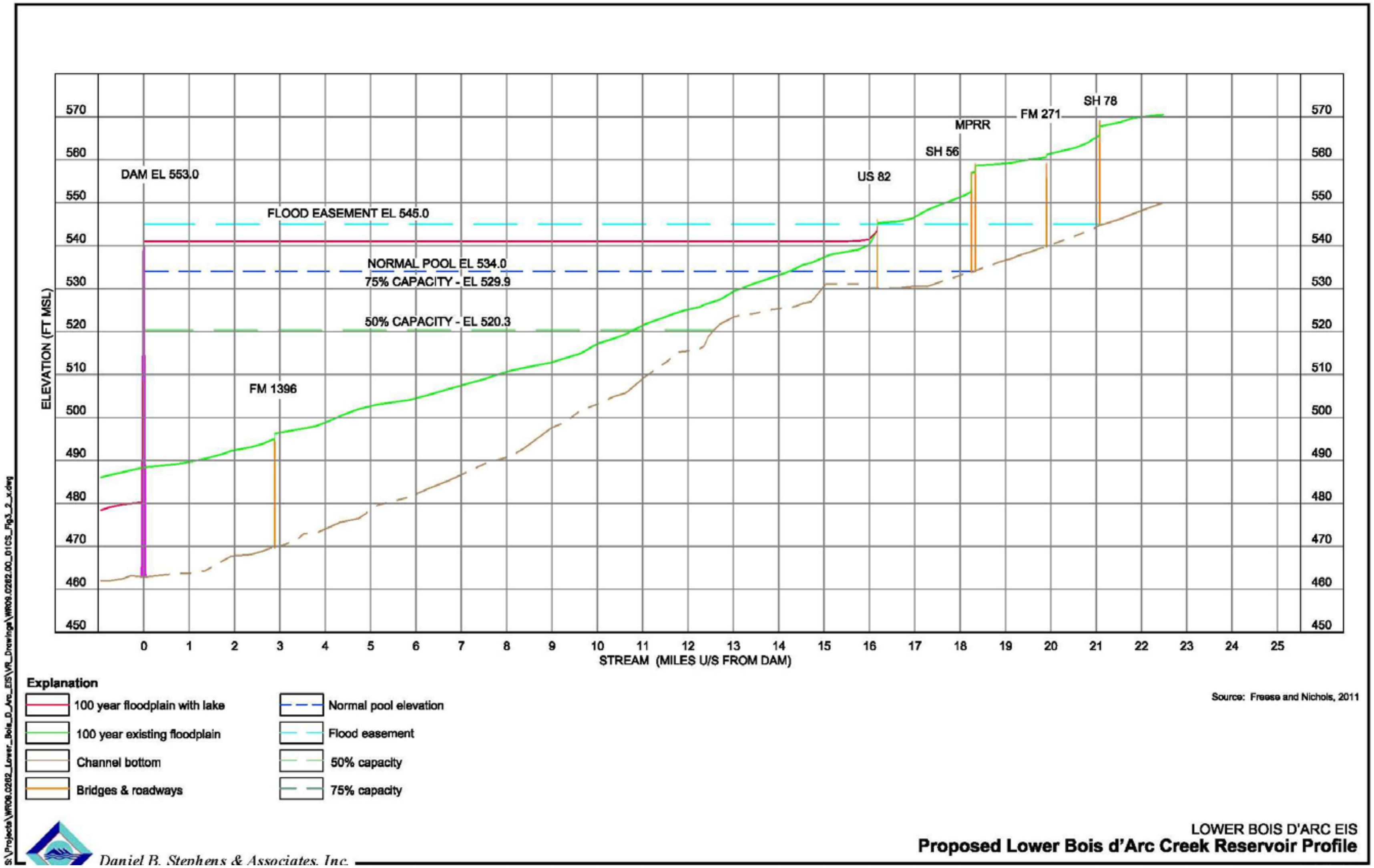


Figure 4.5-1. Profile of Proposed LBCR for Alternative 1

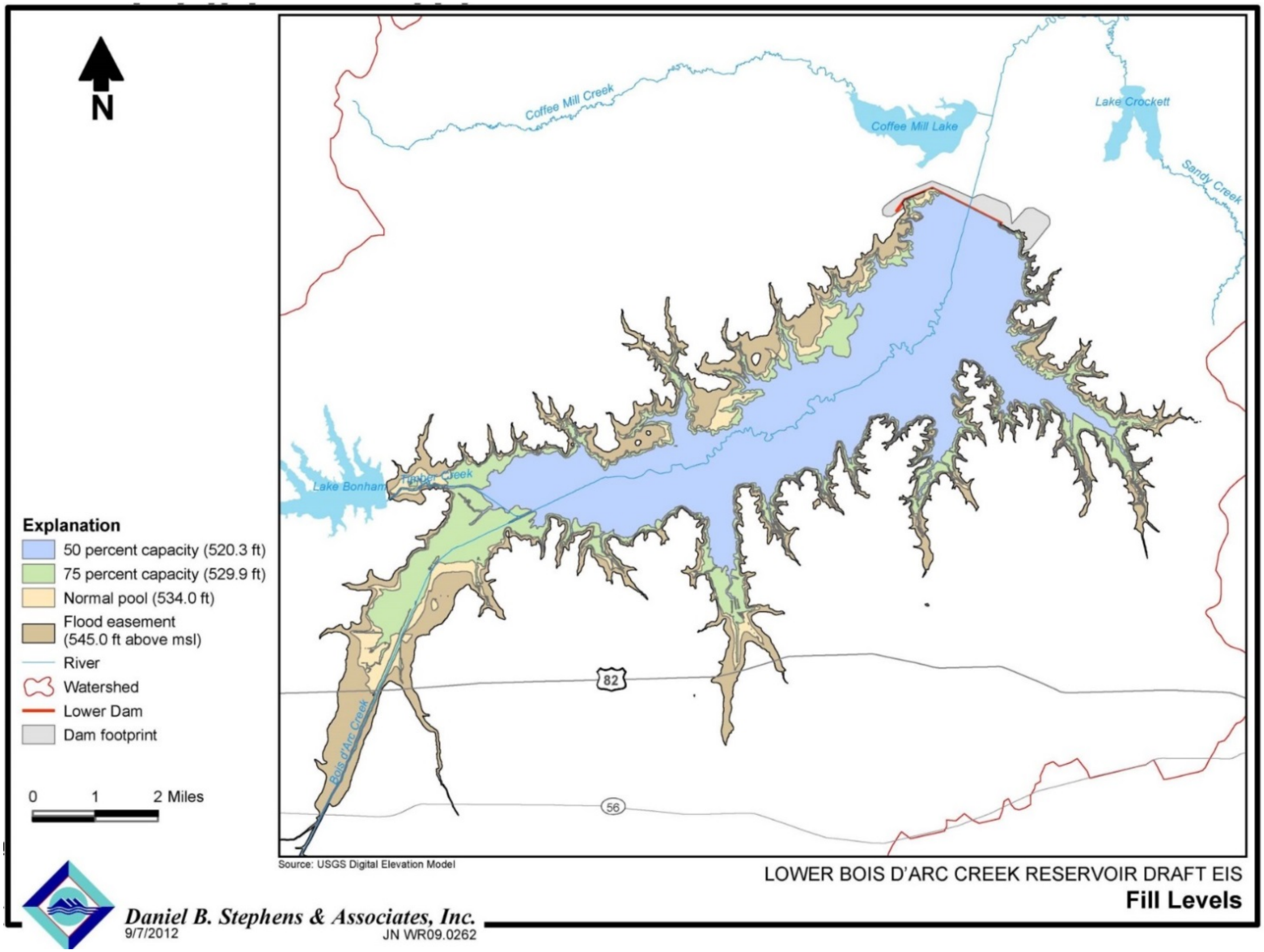


Figure 4.5-2. Proposed LBCR fill levels for Alternative 1

land cover around the reservoir, the erodibility of the soils not inundated by the reservoir, potential future erosion control measures, thickness of soils, and the climate.

Table 4.5-2. Measured and Modeled Sediment Yields from Similar Areas and Calculated LBCR Sedimentation Rates

Data Source	Sediment Yield ($AF/mi^2/yr$)	Corresponding LBCR Sedimentation Rate (AFY)
Bois d'Arc Creek (Texas Dept. of Water Resources, 1982)	0.36	106.9
George Parkhouse Res. No. 2 (proposed) (Texas Dept. of Water Resources, 1982)	0.91	270.3
Lake Crook (Texas Dept. of Water Resources, 1982)	0.77	228.7
Report on New Bonham Reservoir (FNI [1984] from Texas Board of Water Engineers [1959])	1.60	475.2
Lake Bonham Volumetric Survey (TWDB, 2005)	0.94	279.2
Jim Chapman Lake Volumetric Survey (TWDB, 2008a)	1.50	445.5
Pat Mayse Lake Volumetric Survey (TWDB, 2008b)	0.93	276.2

AF/mi2/yr = acre-feet per square mile per year; AFY = acre-feet per year; TWDB = Texas Water Development Board.

Source: Coffman, 2013

The most representative sedimentation rates for the proposed LBCR shown in Table 4.5-2 are the rates based on volumetric surveys of Lake Bonham and Pat Mayse Lake (near Paris) conducted by TWDB. Lake Bonham is upstream in the same watershed and Pat Mayse Lake is nearby. The calculated sedimentation rates for the LBCR vary by a factor of almost five, from 107 AFY to 475 AFY.

The reservoir sedimentation surveys used a type of sonar to measure the bathymetry (underwater topography), and the depth of waters throughout the reservoirs was surveyed at a given water surface elevation (typically the conservation or normal pool elevation). Bathymetry and depth data were then combined to calculate reservoir storage at that water surface elevation. The current storage was then compared to the initial storage of the reservoir at the same elevation. Any reduction in storage was thus attributed to sedimentation, although it is still possible that some of the difference may be attributed to the different methods used to measure or calculate the storage volume.

Assuming a sedimentation rate of 0.94 $AF/mi^2/year$ (the same as for the 2005 Lake Bonham Volumetric Survey), the proposed LBCR would lose approximately 11,167 AF of storage capacity at the normal pool elevation (534 feet) 40 years after construction, which represents approximately three percent of the initial reservoir capacity of 367,609 AF. Sedimentation at this rate would result in a loss of approximately 7.5 percent of the LBCR's capacity 100 years after construction. These predictions are conservative because they include the total contributing LBCR drainage area of 327 square miles and do not account for the reduction in contributing drainage area resulting from land surface inundation for the reservoir (lands which would be submerged so that they would no longer erode and contribute sediment).

As noted earlier, sediment accumulation in reservoirs and lakes is a natural and predictable process. Based on the above calculations and estimates, sedimentation in the proposed LBCR is not anticipated to be a severe impact. If sedimentation is deemed to be a problem for the reservoir at some point in the future, sedimentation rates in the upstream watershed could be reduced by implementing a sediment management program. Examples of sediment management strategies include 1) educating land owners and farmers about the benefits of sediment BMPs such as increased productivity through decreased loss of soil and nutrients, and 2) incentives or support for additional sediment yield reduction actions such as stream channel erosion protection measures, changes to agricultural practices (e.g., contour farming, terracing, filter strips, critical pasture planting and converting crop land to pasture land), and construction of sediment control structures in the watershed upstream.

Stream Channels and Open Water Features within the Bois d'Arc Creek Watershed

Under Alternative 1, the constructed dam and spillways would cover approximately 427 acres, and the reservoir would inundate approximately 16,641 acres. As such, the combined construction and inundation footprint of the proposed reservoir would be 17, 068 acres or only about 6 percent of the entire Bois d'Arc Creek watershed (272,000 acres). Approximately 120 acres (286,139 linear feet) of existing intermittent streams, 99 acres (365,002 linear feet) of intermittent/ephemeral streams and 78 acres of open water features occur within the total area associated with the combined construction and inundation footprint of the reservoir (Table 4.5-3 and Appendix C).

Table 4.5-3. Potential Project Impact Area Within the Combined Construction and Inundation Footprint of Alternative 1

Project Component and Affected Water Resource	Temporary Impact (linear feet)	Permanent Impact (linear feet)	Temporary Impact (acres)	Permanent Impact (acres)
Dam and reservoir				
Streams	--	651,140	--	219
Open waters	--	--	--	78
Raw water pipeline, WTP & TSR				
Streams	4,355	0	0.44	0
Open waters	0	0	0.10	0
Combined distance/acreage	**4,355**	**651,140**	**0.54**	**297**

-- = not applicable; TSR = terminal storage reservoir; WTP = water treatment plant

The operational phase of the project will have the largest potential impact on streams and open water features. Following construction of the proposed LBCR, areas within the project footprint would be inundated to an elevation of 534 feet above mean sea level under normal operating conditions. As a result, approximately 651,024 linear feet (123.3 miles) of intermittent and intermittent/ephemeral streams located within the proposed project site would be affected by inundation. In contrast, construction of the dam and spillways would likely impact less than 1 mile of stream channel within the 427 acre area construction footprint.

Stream Channel Form (Fluvial Geomorphological Processes)

The majority of streams within the proposed reservoir footprint, including Bois d'Arc Creek and its major tributaries, were extensively modified in the 20th century by channelization and other human actions (e.g., widespread deforestation and agricultural development in the watershed). The Rapid Geomorphic Assessment (RGA) and Instream Flow Study documented that contemporary stream conditions in Bois d'Arc Creek are generally poor. Table 4.5-4 shows the existing stream length and Stream Quality Units (SQUs) within the reservoir footprint that would be directly impacted by Alternative 1. Waters from these streams could be permanently converted from a flowing (lotic) to a still (lentic) state from construction of the reservoir.

Table 4.5-4. Impacts Proposed LBCR on Streams as Measured by Length in Feet and SQUs

Stream Quality Factor (SQF)	Existing Length (ft)	Existing Stream Quality Units (SQU's)
0.0 - 0.09	39,597	2,729
0.1 - 0.19	116,842	15,512
0.2 - 0.29	164,786	37,535
0.3 - 0.39	125,191	40,463
0.4 - 0.49	145,736	64,159
0.5 - 0.59	58,872	31,519
0.6 - 0.69	0	0
0.7 - 0.79	0	0
0.8 - 0.89	0	0
0.9 - 0.99	0	0
1.0	0	0
Total	**651,024**	**191,917**

ft = feet

Source: Modified from Table 2, Coffman and Cardenas (2016)

Surface Hydrology

This section describes impacts on existing surface waters in the project area, including Lake Bonham, waters of the U.S., and water rights and interbasin transfers. This section evaluates the potential impacts related to hydrology, drainage, and flooding that could result from implementation of Alternative 1.

Flood Flows

A detailed 100-year floodplain was delineated as a part of the Environmental Report prepared in support of the 404 Permit application, concluding that the 2-year and 100-year floodplains cover approximately 43 percent and 55 percent, respectively, of the proposed Lower Bois d'Arc Creek Reservoir project site Figure 4.5-3 shows the existing and proposed 100-year floodplains at the proposed reservoir site. Figure 4.5-4 displays the existing and proposed two-year floodplains on Bois d'Arc Creek downstream of the proposed dam site. Flooding within the City of Bonham was also evaluated because the city has experienced frequent flooding in the past and concern has been raised over the potential for the proposed reservoir to exacerbate the problem. Water surface profiles for 10-, 50-, 100-, and 500-year floods were developed using the USACE HEC-RAS model to analyze any potential flooding impacts to the City of Bonham. The profiles prepared highlighted the existing floodplain restrictions that occur as a result of two bridges, located at Highways 82 and 56. The study indicated that the historic flooding upstream of the Highway 82 and 56 bridges is due to the constriction of the floodplain in these two areas. The analysis concluded that building the proposed Lower Bois d'Arc Creek Reservoir would not increase flooding upstream of Highway 82, including at Highway 56, and the present analysis concurs with this conclusion. Figure 4.5-1, the profile of the proposed LBCR, shows US 82 and SH 56 in relation to the existing 100-year floodplain and the 100-year floodplain after the lake is in place if the project were built.

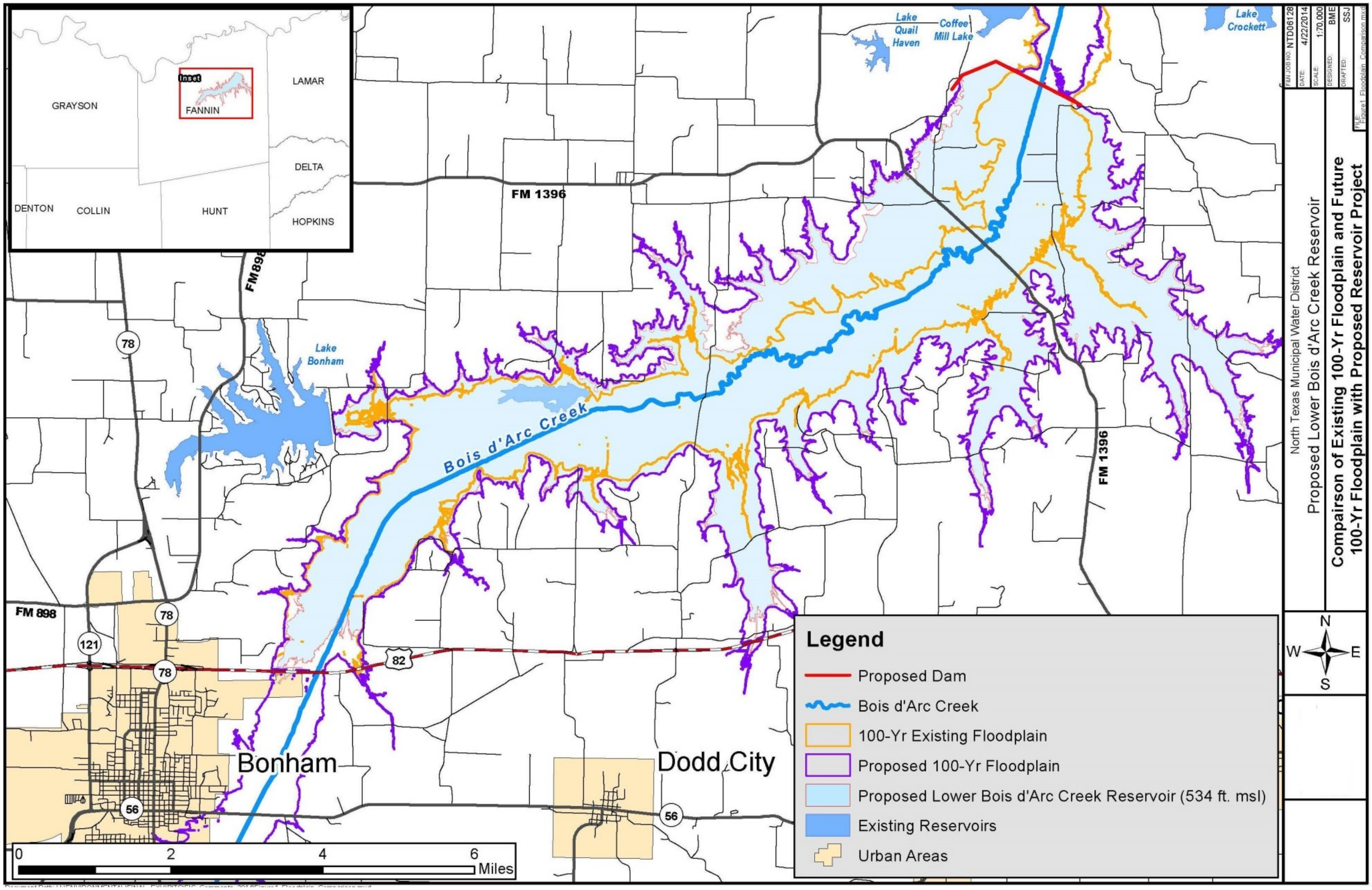


Figure 4.5-3. Existing and Proposed 100-year Floodplains at the Lower Bois d'Arc Creek Reservoir Site

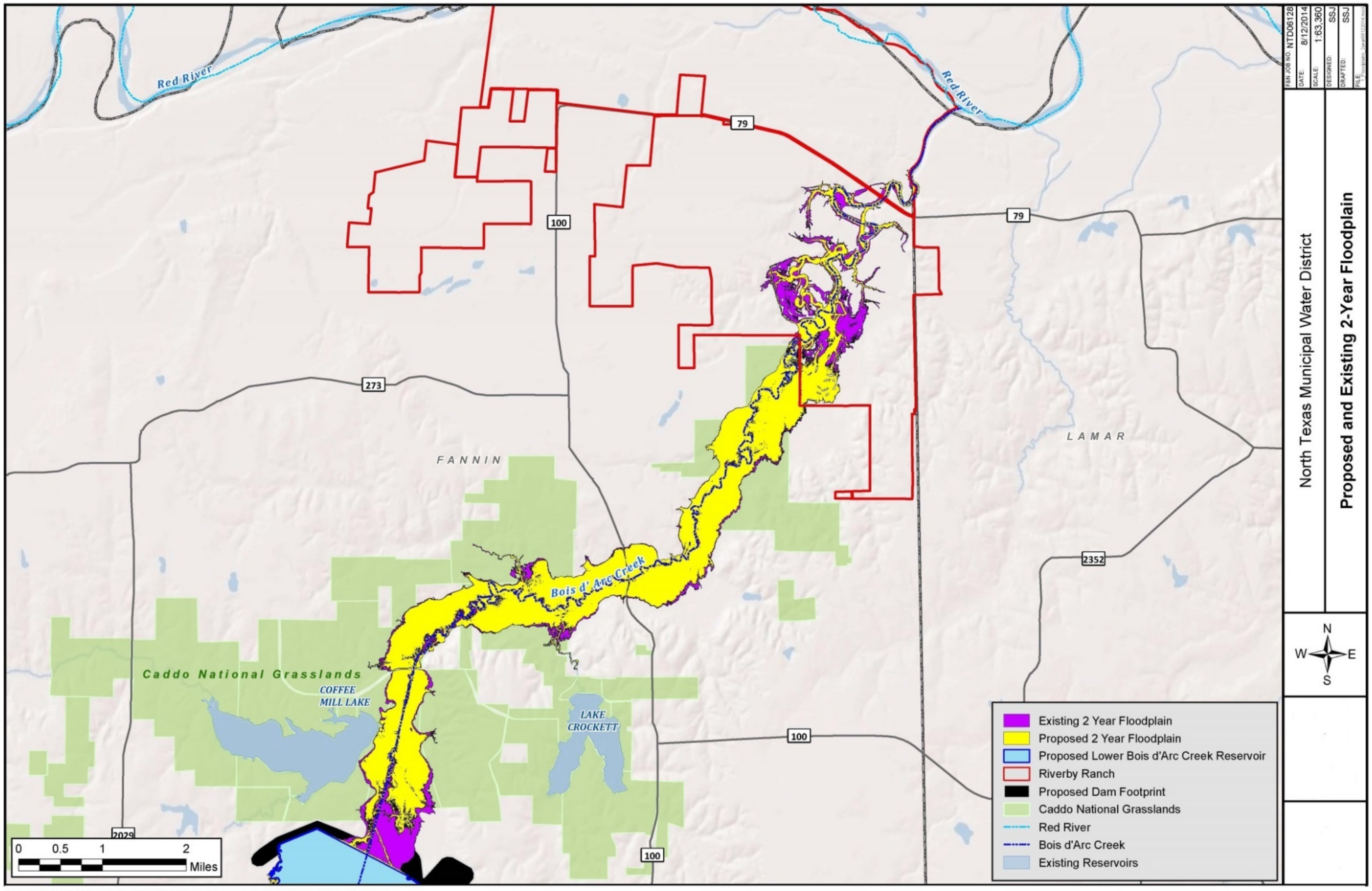


Figure 4.5-4. Existing and Proposed Two-year Floodplains on Bois d'Arc Creek Downstream of the LBCR Dam Site

An analysis conducted in 2016 of the potential impacts of the proposed LBCR on flood events used two hydrologic/hydraulic models developed by the USACE: HEC-HMS and HEC-RAS 2D. The HEC-HMS model applies specific rainfall events to the watershed and calculates the runoff hydrographs which are then utilized by the HEC-RAS 2D model. HEC-RAS delineates the geographic boundaries of the floodplain from a specific rain event. The HEC-RAS 2D (Version 5.0) is an updated model that permits a more precise delineation of floodplain hydrology over the entire watershed. It better portrays the hydraulic flows of tributaries to Bois d'Arc Creek (Watters and Kiel, 2016).

The 2016 study analyzed four hypothetical flood events with the LBCR dam in place to predict potential effects on overbanking flows into the downstream wetlands within the Bois d'Arc Creek floodplain:

1. Two-year flood event with the LBCR dam in place and no spills from the reservoir
2. Two-year flood event with the LBCR dam in place and spills from the reservoir
3. Five-year flood event with the LBCR dam in place and no spills from the reservoir
4. Five-year flood event with the LBCR dam in place and spills from the reservoir

The two-year event was selected because it represents the flood conditions prevailing in at least half of the years. The five-year rainfall event was also selected for analysis because the HGM model for forested wetlands considers the five-year floodplain in the functional assessment of riverine wetlands. For those conditions with no spills from the reservoir, it was assumed that the only water released through the dam would be the 3 cfs base flow required by the LBCR water right permit. Bois d'Arc Creek was modeled as if only the 3 cfs flow was in the creek before the two-year event was applied. This was a conservative assumption, especially during the rainy season in May and June. For those conditions with the reservoir spilling, it was assumed that it was full prior to the storm event and that upstream flood waters were routed through the reservoir before spilling downstream. This allowed for some attenuation of the flood hydrograph (Watters and Kiel, 2016).

Under the two-year flood event with the LBCR dam in place and no spills, flows in Bois d'Arc Creek and associated tributaries would continue to provide overbanking flows to the adjacent floodplain and wetland areas. As shown in Figure 4.5-5, overbanking flows would inundate low-lying areas within the floodplain. The areas that would not be inundated tend to be those immediately adjacent to the creek bank, which may be from spoils that were deposited next to the creek bank when it was channelized and/or from sediment deposition from previous overbank floods. Other areas might be flooded and/or retain water from direct precipitation but may not be differentiated in the model simply due to the one-foot resolution of the Light Detection and Ranging (LiDAR) data. When the dam spills during a two-year flood event, additional areas within the existing two-year floodplain would also be inundated as shown in Figure 4.5-6.

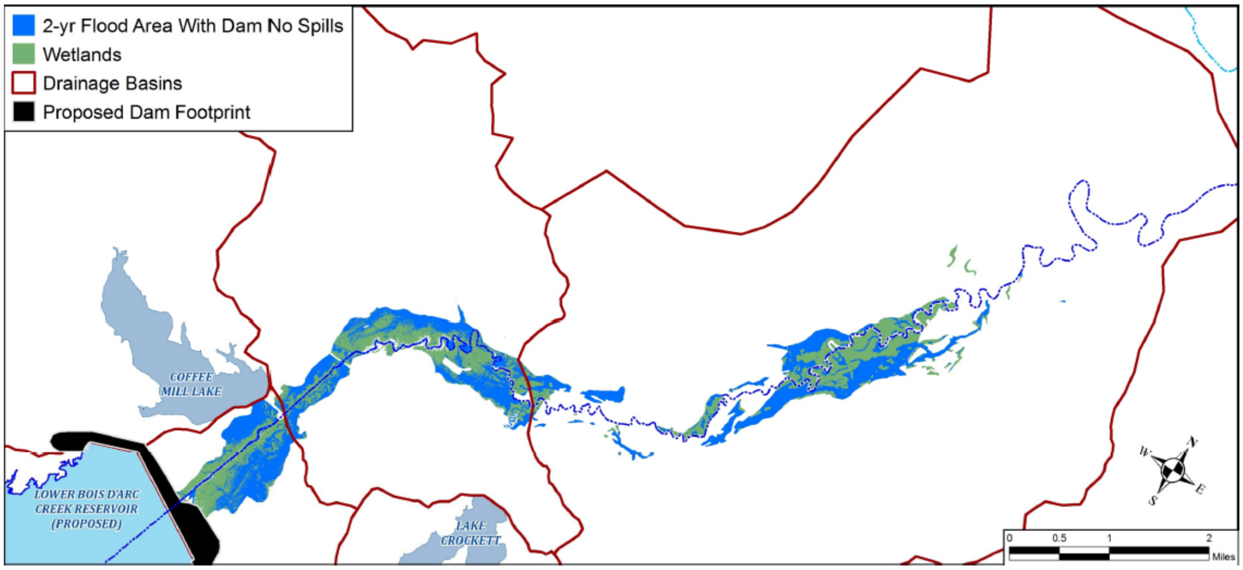


Figure 4.5-5. Two-year Flood Event on Bois d'Arc Creek with LBCR Dam and No Spills, Showing Inundation Area

Source: Figure 4.3-6 in Watters and Kiel, 2016

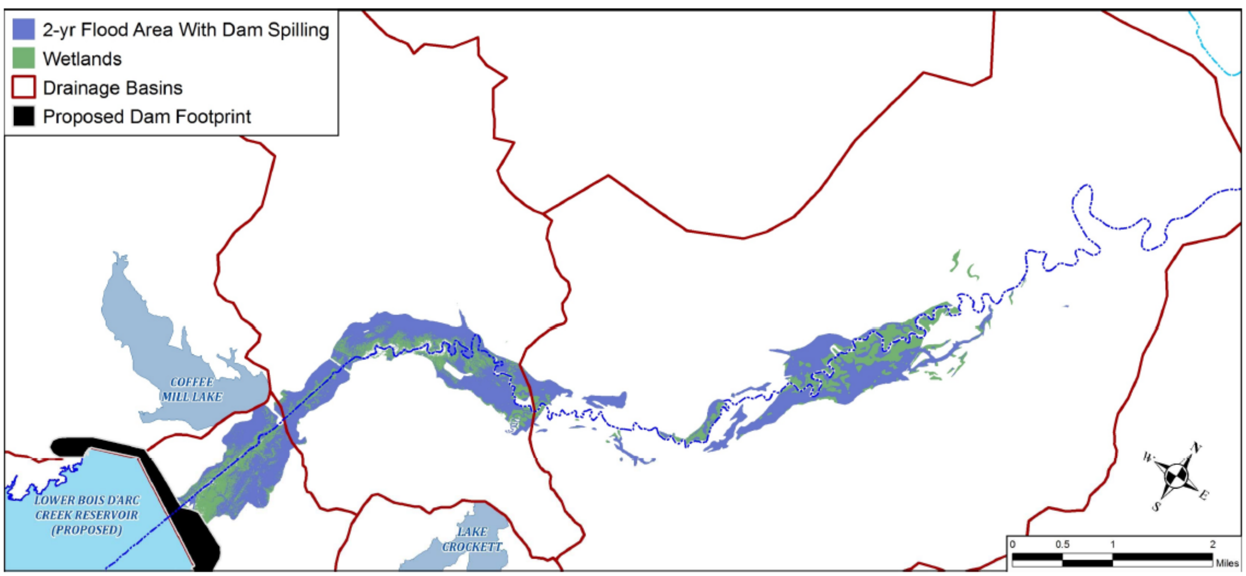


Figure 4.5-6. Two-year Flood Event on Bois d'Arc Creek with LBCR Dam and Spills, Showing Inundation Area

Source: Watters and Kiel, 2016

In the case of the five-year flood event and no spills from the LBCR dam, nearly all of the existing wetland areas within the floodplain would be inundated as shown on Figure 4.5-7. When the LBCR dam spills, Figure 4.5-8 indicates that additional wetland areas within the five-year floodplain would be inundated.

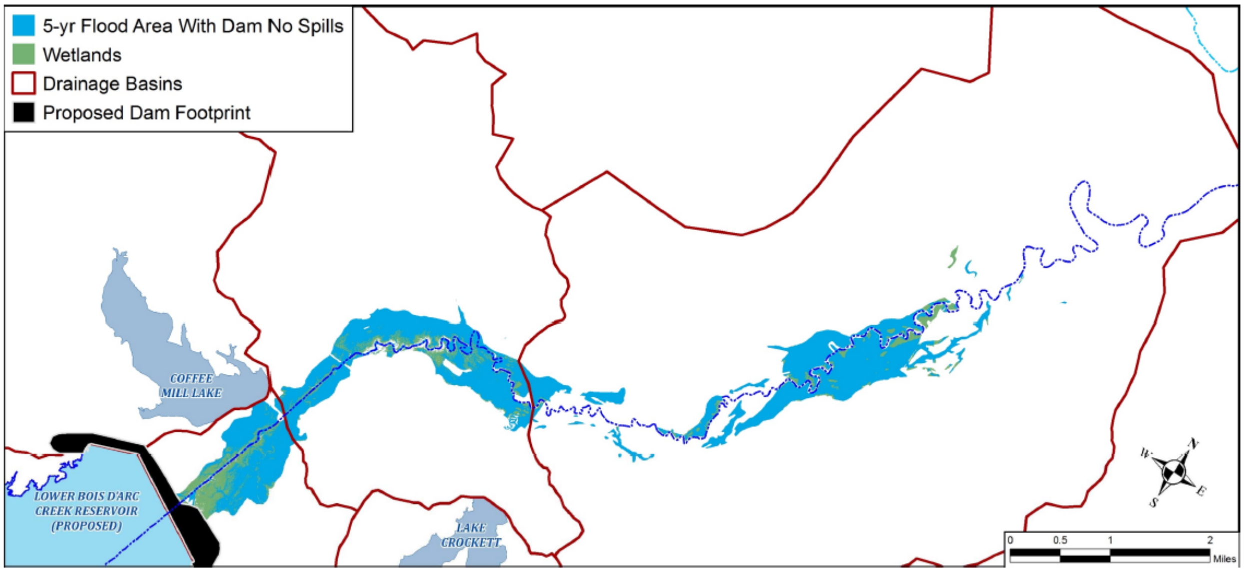


Figure 4.5-7. Five-year Flood Event on Bois d'Arc Creek with LBCR Dam and No Spills, Showing Inundation Area

Source: Figure 4.3-8 in Watters and Kiel, 2016

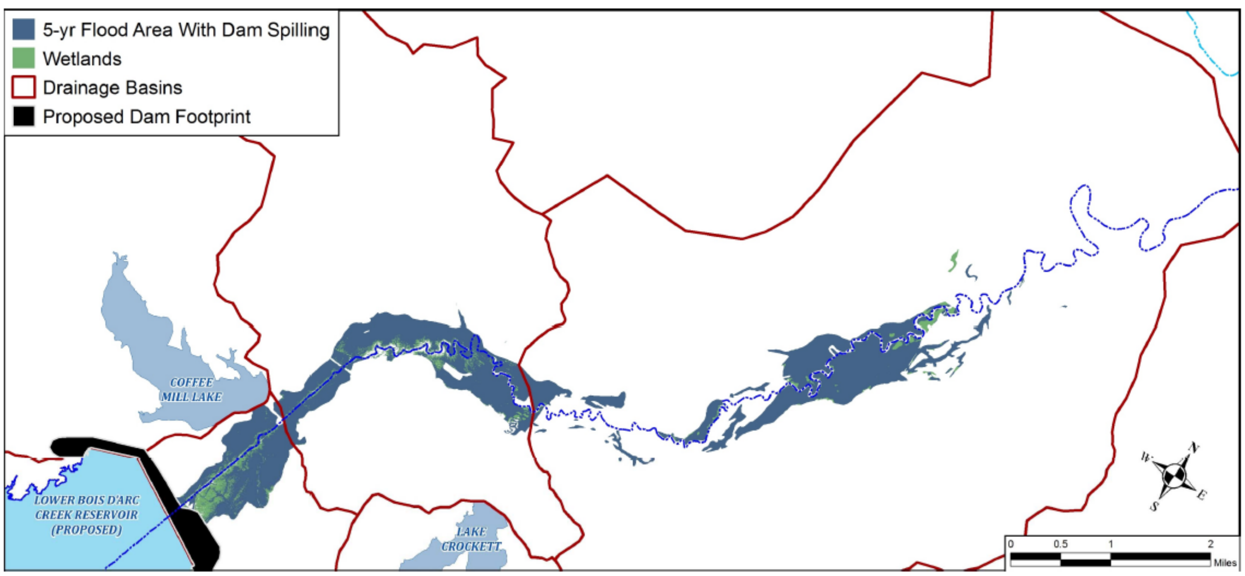


Figure 4.5-8. Five-year Flood Event on Bois d'Arc Creek with LBCR Dam and Spills, Showing Inundation Area

Source: Figure 8 in Watters and Kiel, 2016

Based on the results of modeling two-year and five-year flood hydrology, overbanking flows would continue with the LBCR dam in place. In most years, inundation of some of the downstream floodplains would occur from overbanking flows alone, and 84 percent of the downstream floodplains are expected to be inundated at least once every five years. When the reservoir is spilling in a 5-year flood event, 92 percent of the downstream wetlands would be inundated. The three additional sources of floodplain hydrology – direct precipitation, overland flow, and subsurface discharge from springs and seeps – would not be altered with the LBCR dam in place and functioning. During most years, these water sources are important in furnishing the floodplain hydrology needed to sustain inundation and/or saturation for two weeks during the growing season. When all four sources of water are taken into account, there is likely to be adequate wetland hydrology to sustain the existing downstream floodplains after implementation of the proposed LBCR, and impacts from construction of the proposed LBCR would be slight.

Navigation Flows

Discharges at USGS gages on Bois d'Arc Creek and the Red River were evaluated to determine whether or not there would be an observable or significant impact to the flows, water supply, and navigation in the Red River as a result of the proposed project. While there is no USGS gage on the Red River in Fannin County, the "Red River at Denison Dam near Denison, Texas" (USGS 07331600) gage is located upstream in Grayson County, just below Lake Texoma, approximately 65 river miles upstream of the Bois d'Arc Creek-Red River confluence. Average daily mean discharge values were summed for the period of record on this gage (1945 to 2010), yielding an average annual discharge value of 3.5 million acre-feet (USGS, 2011b).

The "Red River near De Kalb, Texas" (USGS 073368270) gage is located 112 miles downstream of the Bois d'Arc Creek-Red River confluence in Bowie County near the state line. Average daily mean discharge values were summed for this gage for its period of record (1969 to 2010), yielding an average annual discharge of 10.3 million acre-feet (USGS, 2011b). Data were also evaluated for the "Red River near Hosston, Louisiana" (USGS 07344400) stream gage, located approximately 110 miles downstream of the Texas state line and 30 miles north of Shreveport, Louisiana. Average daily mean discharge values were summed for the period of continuous record for this gage (1958-1968, since October 1968 the gage only records flows below 5,000 cfs), yielding an average annual discharge of 13.0 million acre-feet.

The minimum daily mean discharge values were also summed for the "Red River at Denison Dam near Denison, Texas"; "Red River near De Kalb, Texas"; and "Red River near Hosston, Louisiana" gages for their periods of record, yielding minimum annual discharges of approximately 45,000, 900,000, and 1.6 million acre-feet, respectively (USGS, 2011a and 2011b). Based on these totals for flow in the Red River, the predicted reduction in flow volumes caused by diversions from Bois d'Arc Creek is not expected to substantially impact water supply or flows in the Red River, as these diversions would be driven by hydrological conditions within the Bois d' Arc Creek watershed. No adverse water supply impacts are predicted to occur at the "Red River near De Kalb, Texas" or "Red River near Hosston, Louisiana" gages.

The closest USGS gage on the Red River downstream of its confluence with Bois d'Arc Creek is located at Arthur City (USGS 07335500). Approximately half the flow at this gage originates as releases from Lake Texoma, which consist mostly of water from a hydropower plant and can vary substantially on any given day. In recent years, on average, approximately 3 to 4 percent of the total flow at the Arthur City gage originated from the Bois d'Arc Creek watershed above the proposed dam site. Table 4.5-5 shows daily average flows at several selected gages in the area in cubic feet per second. The relatively small contribution of Bois d'Arc Creek to Red River flows can be appreciated, especially during low flow periods. Median flows on Bois d'Arc Creek at FM 409 (downstream of the proposed dam site) are 5 cfs compared to 2,150 cfs on the Red River at the Arthur City gage. At 25 percent low flows, Bois d'Arc Creek at FM 409 is 0 cfs, while the Red River at the Arthur City gage is 873 cfs.

While their influence is measurable, Bois d'Arc Creek flows have only a small effect at present on overall flows in the Red River at the nearest downstream gage at Arthur City. Therefore, intercepting and diverting up to 175,000 AFY of Bois d'Arc Creek's annual discharge to the Red River for the LBCR project would have only a minor effect on downstream flows in the Red River.

Table 4.5-5. Daily Average Flows at Selected Gages in the Bois d'Arc Creek and Red River Area, July 2006 to June 2014[1]

Relative Total Water Flow	Red River at Denison Dam [2]	Bois d'Arc Creek at FM 1396	Bois d'Arc Creek at FM 409 [3]	Red River at Arthur City, TX	Red River near De Kalb, TX
Maximum	38,379	11,600	12,400	80,800	97,800
90%	8,856	152	145	17,590	28,490
75%	3,535	40	37	5,288	9,265
Median	1,304	4	5	2,150	3,510
25%	174	0	0	873	1,623
10%	124	0	0	456	850
Minimum	61	0	0	177	351

FM = Farm to Market; TX = Texas.

[1] Values in cubic feet per second (cfs)

[2] Daily average flows at the Denison Dam gage were calculated from hourly instantaneous values.

[3] Bois d'Arc Creek at FM 409 began operation in June 2009.

Source: Albright, 2014b.

The USACE lists navigable waters for the Red River as including "from the U.S. Highway 71 bridge at the Texas-Arkansas state line upstream to the Oklahoma-Arkansas state line and from Denison Dam on Lake Texoma upstream to Warrens Bend, approximately 7.25 miles north-northeast of Marysville, in Cooke County, Texas" (USACE, 1999). Downstream of its confluence with Bois d'Arc Creek, the Red River runs along the northern boundary of two Texas water planning regions: C and D. Region C includes Cooke, Grayson, and Fannin counties bordering the Red River and 13 other counties to the south and southwest. Region D includes Lamar, Red River, and Bowie Counties bordering the Red River, and 16 other counties to the south. The Region C water plan lists the same navigable waters as the USACE source, citing "the segment of the Red River from Denison Dam forming Lake Texoma upstream to Warrens Bend in Cooke County." The Region D water plan indicates that the Red River is navigable below Shreveport-Bossier City in Louisiana, and also notes that a Southwest Arkansas Navigation Study is underway, which would make the Red River navigable from Shreveport, Louisiana through southwest Arkansas to near Texarkana, Texas. The minimum flow required for the navigable sections of the Red River is 1,200 cfs (USACE, 1989).

The possibility of reduced discharge from Bois d'Arc Creek having an adverse effect on the prospects for navigation in the Red River's navigable sections downstream of its confluence was evaluated by accessing the minimum daily mean discharges of the two nearest USGS gages downstream of the Bois d'Arc Creek-Red River confluence. The data that were analyzed are from one Red River gage located near De Kalb, Texas and another Red River gage located near Shreveport, Louisiana. These locations have contributing drainage areas of 47,348 and 57,041 square miles, respectively. As noted earlier, there is no USGS gage on the Red River in Fannin County.

Since navigability is dependent on daily flows and not annual discharge, the minimum daily mean discharges were evaluated for these three stream gages. The minimum daily mean discharge measurement at the Red River near the De Kalb, Texas gage was 254 cfs from 1969 to 2010, with the minimum daily mean discharges being less than the 1,200 cfs minimum navigation discharge requirement on 199 days of the year during this period (USGS, 2011b). This stream gage is located in Bowie County near the state line, in a section that is not defined as navigable. Evaluating the 10th percentile of daily mean values instead of the minimum daily mean discharge yields a minimum of 788 cfs, with the 10th percentile of daily mean values being less than the navigational requirement for 41 days of the year during this period (USGS, 2011b).

The minimum daily mean discharge measurements at the Red River near Hosston, Louisiana stream gage was 1,310 cfs for 1957-1994 (although records for this gage are discontinuous), with the minimum daily mean discharge exceeding the 1,200 cfs minimum navigation discharge requirement on every day of the year during this period (USGS, 2011a). There is no 10th percentile of daily mean values listed in the USGS dataset for this period (USGS, 2011a). This stream gage is located approximately 110 miles downstream of the Texas state line and 30 miles north of Shreveport, Louisiana.

Based on where the Red River is defined as navigable, the predicted reduction in flow volume in the Red River caused by removing up to 175,000 acre-feet of water annually (242 cfs, if timed evenly throughout the entire year) from one of its tributaries is not expected to adversely affect navigation on the navigable sections of the Red River (the Red River is not defined as navigable between the Bois d'Arc Creek-Red River confluence and Shreveport-Bossier City in Louisiana). The minimum daily mean discharge value at the Red River near DeKalb, Texas gage was less than the navigability flow requirement for approximately 55 percent of the days during the period of record; however, this gage is not located within a navigable reach. The minimum daily mean discharge value at the Red River near Hosston, Louisiana stream gage exceeded the minimum navigability flow requirement every day during the period of record, indicating that the Red River is navigable well upstream of Shreveport-Bossier City in Louisiana, where the navigable section begins. Water supply demand varies through the year, and the highest daily amounts required from the LBCR would be in late summer and early fall. However, these withdrawals would be taken from stored supply in the late summer/early fall, not from flows in Bois d'Arc Creek, which are quite minimal or non-existent in these months. Thus, the withdrawals would have no effect on navigability in the Red River.

Impacts to Existing Water Rights and Interbasin Water Transfers

Using the TCEQ Red River Water Availability Model (WAM), several existing water rights in the Bois d'Arc Creek watershed and water rights below the confluence of Bois d'Arc Creek and the Red River were identified and evaluated for impacts in the 2006 *Report Supporting an Application for a Texas Water Right for Lower Bois d'Arc Creek Reservoir*. In comparing the standard reliability measurements for existing water rights, the impact evaluation determined that "the proposed reservoir causes no injury to existing water rights" (Appendix R). This is a reasonable conclusion, one supported by TCEQ when it issued a Water Use Permit for the full-sized LBCR (Alternative 1) in June 2015.

Pursuant to Title 30 of Texas Administrative Code (TAC), §297.18, Subchapter B, "no person may take or divert any state water from a river basin and transfer such water to any other river basin without first applying for and receiving a water right or an amendment to a water right authorizing the transfer" and "the projected impacts of the proposed transfer that are reasonably expected to occur on existing water rights, instream uses, water quality, aquatic and riparian habitat, and bays and estuaries in each basin" should be assessed (TAC, 1999). As such, as part of its application submitted to the TCEQ for a Texas water right for the proposed LBCR, NTMWD also applied for an interbasin water transfer of 175,000 AFY from the Red River basin to the Trinity and Sulphur River basins.

The 2006 *Report Supporting an Application for a Texas Water Right for Lower Bois d'Arc Creek Reservoir* identified "no impacts associated with the interbasin transfer to water rights in the Trinity or Sabine River Basins." Alternatives 1 and 2 would only transfer water to the Trinity and Sulphur River Basin. Proposed LBCR water would be delivered to the proposed new WTP near Leonard, located in southwest Fannin County and the Trinity River Basin. TCEQ granted a Water Use Permit to NTMWD for LBCR in June 2015 that included an authorization for interbasin water transfer. The permit states: "Permittee is authorized an interbasin transfer to use the water appropriated hereunder within the Trinity

River Basin, and within that portion of Fannin County located in the Sulphur River Basin" (Appendix F-1).

Other Reservoirs Within the Bois d'Arc Creek Watershed

The only other reservoir in the Bois d'Arc Watershed potentially affected by Alternative 1 is Lake Bonham. Lake Bonham is located immediately upstream of the proposed Lower Bois d'Arc Creek Reservoir on Timber Creek (shown on Figure 4.5-9). The elevation of the top of the Lake Bonham Dam is 584 feet MSL, and its maximum height is 70 feet. The dam is an earthen embankment with a drop inlet, morning glory-type principal spillway (also called a "glory hole" or bell-mouth spillway, into which water can enter from around the entire perimeter) and an earthen cut emergency spillway with a narrow pilot channel (Miles, 2014). The bottom of Lake Bonham Dam is located at an elevation of approximately 514 feet MSL (TWDB, 2011b). The normal pool elevation for the proposed Lower Bois d'Arc Creek Reservoir is 534 feet MSL. This elevation corresponds to 50 feet below the top of the Lake Bonham dam, therefore, if the proposed Lower Bois d'Arc Creek Reservoir backs up far enough on Timber Creek to meet the Lake Bonham dam, 20 feet of the dam would be submerged at the normal pool elevation. Several significant impacts have been identified as a result of the anticipated partial submersion of the Lake Bonham Dam by the proposed Lower Bois d'Arc Creek Reservoir. These include stability of the dam's embankment, reduction in the discharge capacity of the emergency and service spillways and outlet works, and increased complexity of dam safety inspections.

Figure 4.5-9. Aerial Photograph of Lake Bonham Dam with LBCR Pool Superimposed

A detailed discussion about these five impacts to the Lake Bonham Dam is provided below. Protection of the Lake Bonham Dam would be provided as a part of the LBCR project. The preliminary design and cost estimate assumes protection of the front side of the dam and appurtenant facilities with rip rap, which will be completed prior to filling LBCR.

Dam/Embankment Stability Impacts

The downstream toe of Lake Bonham Dam would become submerged when the surface elevation of LBCR reaches 524 feet MSL. At a surface elevation of 534 feet MSL (LBCR normal full pool), approximately 900 feet of the downstream toe of the dam would be inundated. During these storage conditions, the Lake Bonham Dam embankment could experience erosion damage through wave action generated by LBCR. High water levels may also adversely affect the performance of the embankment's internal drainage system by impeding the system's ability to safely convey seepage through the embankment (Miles, 2014).

Proposed modifications to address these two issues include 1) placing a toe berm on the downstream slope of Lake Bonham Dam to armor and protect it from waves generated by LBCR and 2) modifying the drainage system to provide a blanket drain and a toe drain collector system below the proposed berm, which would be integrated into the existing system. The new drains would also have lateral outlets through the soil cement slope protection that would be located above elevation 534 feet MSL to permit sufficient drainage.

Emergency Spillway Impacts

The crest elevation of the Lake Bonham Dam emergency spillway is approximately 567 feet MSL. This is over 30 feet above the LBCR normal pool elevation of 534 feet MSL. This elevation difference would allow the safe passage of releases through the emergency spillway. In addition, the configuration of the emergency spillway in combination with the normal pool elevation of LBCR would ensure the spillway would not be eroded by water stored in LBCR (Miles, 2014).

Service Spillway Impacts

Lake Bonham Dam's service spillway stilling basin is at elevation 524 feet MSL. LBCR water elevations at or higher than 524 feet MSL may result in a decrease in the discharge capacity of the service spillway. Higher pool elevations in the LBCR, under both normal and flood conditions, would submerge the downstream outlet of the principal spillway and reduce its discharge efficiency by an average of about 17 percent (Miles, 2014).

Proposed increases to the discharge capacity of the emergency spillway's pilot channel would address the impacts of this reduced discharge capacity of the service spillway when storage in LBCR is at or above 52 feet MSL (Miles, 2014). Various hypothetical flood frequency events were modeled for Lake Bonham to determine the necessary modifications. Results of the modeling indicate that the proposed modifications should mitigate the flooding impacts of the LBCR on Lake Bonham Dam. In addition to modifying the emergency spillway pilot channel, a solid concrete wall would be constructed at the downstream end of the stilling basin to permit inspections of the stilling basin and conduit when the outlet is submerged beneath the LBCR pool. A small sluice gate would also be installed in this wall to allow the stilling basin to be dewatered for inspection (Miles, 2014).

Outlet Works Impacts

The outlet works for Lake Bonham Dam consist of one 18-inch concrete pipe that discharges into the service spillway conduit. The intake for this pipe is located approximately 200 feet north of the service spillway drop inlet structure at an elevation of 538 feet MSL. Under normal conditions, LBCR would not affect the discharge capacity of these outlet works because they are four feet above the proposed normal pool.

Dam Safety Inspection Impacts

Regular dam safety inspections are required for Lake Bonham Dam. Safety inspections have been ongoing throughout its period of service and are expected to continue after completion of the LBCR. Minor suggested changes to the procedures for these inspections would include dewatering of the stilling basin to observe its interior walls and the service spillway conduit, along with observations of the new internal drainage system outlets to confirm appropriate functioning (Miles, 2014).

Flood routing through Lake Bonham Dam during high flow events would be similar to existing conditions, with the exception of reduced service spillway discharges, which would be compensated for by increased emergency spillway discharges. The routing of large flood events through Lake Bonham Dam was taken into consideration in modeling of similar flood events for LBCR, and thus there would be no substantial impact to operations during high flow events.

Operation of LBCR could result in adverse impacts on the operation of Lake Bonham Dam. These effects would be avoided by implementing the measures described above including modifications to the downstream toe of the embankment, the embankment drainage system, the emergency spillway pilot channel, the service spillway, and the dam inspection procedures

Surface Water Quality Impacts

This section describes existing surface water quality in the project area and evaluates the potential water quality impacts related to downstream Red River and downstream floodplain wetlands that could result from implementation of Alternative 1.

Surface water in the proposed reservoir is expected to have similar or even lower average dissolved mineral concentrations than are currently estimated in Bois d'Arc Creek due to most of the inflows resulting from high-flow events (Appendix M). Historical water quality data for Bois d'Arc Creek and similar north Texas Red River tributaries were analyzed and used to estimate concentrations of total dissolved solids, chloride, and sulfate in runoff that will be captured by the reservoir. The predicted mean values estimated for the proposed reservoir are 221 mg/L total dissolved solids, 19 mg/L chloride, and 38 mg/L sulfate. The primary impact to surface water quality that is anticipated is reduced variability of these parameter concentrations.

Natural Inflow and Estimated Reservoir Water Quality

Alan Plummer Associates, Inc. developed a water-balance model using relationships between flow and water quality to estimate concentrations of chloride, sulfate, and total dissolved solids in the proposed reservoir (Appendix M). Limited water quality and USGS flow gage data were available for Texas tributaries downstream of Lake Texoma when this analysis was performed; however, these data represent the best available data at the time of this report and are an adequate representation of existing conditions based on USGS gages, a Red River Authority sampling station, and NTMWD sampling sites. The relationship between flow and water quality was based on a limited number of samples from Bois d'Arc Creek and Pine Creek. This relationship was compared to trends from the Wichita River, above Lake Texoma, to verify trends in the data (Appendix M).

The water model evaluation used an estimate of natural inflow, a net evaporation value derived using the Red River Basin Water Availability Model, and a water withdrawal rate of 110 million gallons per day (123,000 acre-feet per year). The model assumes that chloride, sulfate, and total dissolved solids would be completely mixed in the reservoir, and a monthly time-step was used to evaluate reservoir level and parameter concentration for the period of 1940 through 1986. Values used for the natural inflow water quality are presented in Table 4.5-6. The water model predictions may include a significant margin of error due to the limited available water quality data for Bois d'Arc Creek at the time of the analysis. However, these data represent the best available data at the time of this report. See the water quality analysis and discussion in Appendix M and Appendix R for further detail.

Table 4.5-6. Natural Inflow Water Quality Data Used in the Water-Balance Model

Parameter	Concentration at Low-Flow (mg/L)	Concentration at High-Flow (mg/L)
Chloride	31	12
Sulfate	61	24
Total dissolved solids	343	137

Source: Appendix M, Appendix R.

The estimated water quality for the proposed Lower Bois d'Arc Creek Reservoir that resulted from the water-balance model is shown in Table 4.5-7.

Table 4.5-7. Estimated Lower Bois d'Arc Creek Reservoir Water Quality

Parameter	Concentration (mg/L)
Chloride, mean	19
Chloride, maximum [a]	29
Sulfate, mean	38
Sulfate, maximum [a]	58
Total dissolved solids, mean	221
Total dissolved solids, maximum [a]	330

mg/L = milligrams per liter.

[a] Total concentration is a maximum 1-year running average.

Source: Appendix M and Appendix R.

The primary impact on water quality that would result from building the proposed reservoir would be a reduction in the variability of water quality in the reach downstream of the reservoir (Appendix M and Appendix R). Existing water quality is adequate and predicted water quality after implementation of Alternative 1 would remain adequate.

The expected chloride, sulfate, and total dissolved solids concentrations in the LBCR would not pose a problem for conventional water treatment processes to produce drinking water that meets state and federal standards. In general, the expected water quality in the reservoir would be amenable to the standardized, widely-used water treatment processes and technologies employed by NTMWD, which include flocculation/ coagulation, sedimentation, triple disinfection, filtration, and pH adjustment.

As a part of the 2010 Instream Flow Study, an analysis of the impact of the proposed reservoir on downstream dissolved oxygen (DO) concentrations was performed. The modeling used an existing Qual-TX model developed by TCEQ to evaluate waste loads in Bois d'Arc Creek, restricting the analysis to areas below the proposed reservoir dam. As described in the Draft Operation Plan (NTMWD, 2014b; an updated version is Appendix D to this EIS), the reservoir dam being proposed by the NTMWD includes a multiple level intake structure that would allow water to be selectively withdrawn from various depths in a manner that would minimize impacts from lake stratification on DO concentrations downstream.

DO and temperature data were reviewed from other comparable North Texas lakes and these data were used in the Qual-TX model. Jim Chapman Lake data were used where they were available because this lake has comparable size, depth, and geology to the proposed Lower Bois d'Arc Creek Reservoir. Data from Lake Texoma, Lake Whitney, Lewisville Lake, and Benbrook Lake were used for the months where Jim Chapman Lake data were not available (April, October, November, and December) since they had comparable geographic latitude, proximity, and depth (Appendix M).

Various flow regimes were modeled including subsistence flow (1 cfs), base flows (3 and 10 cfs), and pulse flows (50 cfs) using the maximum mean temperature and minimum mean dissolved oxygen concentration data from other North Texas lakes (Appendix M). Results of the water quality modeling predicting DO concentrations in Bois d'Arc Creek downstream of the proposed dam are summarized in Table 4.5-8.

Table 4.5-8. Bois d'Arc Creek Water Quality Modeling Results for the Proposed Flow Regimes in the Reservoir Operation Plan

Model Period	Flow Regimes Modeled (cfs)	Mean Input Temperature (°C)	Mean Dissolved Oxygen Input (mg/L)	Resulting Dissolved Oxygen (mg/L)	Corresponding Water Release Depth (feet)	Applicable TCEQ Dissolved Oxygen Standard (mg/L)
April-June	1, 10, and 50	27.2	5.7	5.82	1-20	5.5
July-October	1, 3 50	30.2 19.0	5.0 7.0	5.75	1	5.0
November-March	1, 3	15.8	7.8	8.38	1-40	5.0

°C = degrees Celsius; cfs = cubic feet per second; mg/L = milligrams per liter; TCEQ = Texas Commission on Environmental Quality

Source: Appendix M

The model results predict minimum DO concentrations of 5.82, 5.75, and 8.38 mg/L (depending upon season, flow regime, and parameter inputs), which are all above the applicable TCEQ DO standards. The TCEQ freshwater criteria for DO for a High Aquatic Life Use Subcategory (which includes Bois d'Arc Creek) are a mean of 5.0 mg/L and a minimum of 3.0 mg/L, with a mean of 5.5 mg/L and a minimum of 4.5 mg/L for the spring spawning period. Thus, the reservoir would not have adverse effects on DO, the main water quality parameter for the health of aquatic life. Under existing conditions, during the low-flow to no-flow period of late summer to early fall when water temperature rises, DO concentrations can drop below 5.0 or even 4.0 mg/L. With the reservoir in place, these seasonal DO concentrations would be expected to be slightly higher than at present, which could provide a beneficial impact for the creek.

NTMWD proposes obtaining water quality data collected by the USGS for the "Bois d'Arc Creek at FM 409" gaging station, and by the Red River Authority for the locations that are sampled quarterly as a part of the Texas Clean Rivers Program (FM 78 and FM 100) to monitor the proposed reservoir's impact on water quality below the dam after its construction.

Red River Downstream of the Bois d'Arc Creek Confluence

High salinity is a major water quality issue in the headwaters of the Red River upstream of Lake Texoma to the extent that it limits use of this water for municipal purposes. Since water in Lake Texoma is relatively salty, hydroelectric and other releases from Denison Dam largely determine salinity levels below Lake Texoma. Downstream along the Red River from Lake Texoma, less salty water enters the river from various tributaries and dilutes Denison Dam hydropower releases, gradually reducing salinity in the river (Albright and Coffman, 2014).

USGS reports daily specific conductance data for two stream gages in the vicinity of the proposed Lower Bois d'Arc Creek Reservoir:

- Red River at Arthur City, TX (07335500) - March 2007 to September 2008
- Bois d'Arc Creek at FM 1396 near Honey Grove, TX (07332620) – June 2006 to present

The watershed above the proposed LBCR affects TDS loads at the Red River's Arthur City gage in two ways. First, it contributes relatively low-salinity flow that helps dilute high-salinity releases from Lake Texoma. Second, it contributes dissolved solids that influence TDS loads at Arthur City. Although these loads and salinity concentrations are lower than Lake Texoma, the contribution of the Bois d'Arc Creek watershed can be significant during high flows (Albright and Coffman, 2014).

Analysis of specific conductance data from the FM 1396 and Arthur City gages from August 2007 to September 2008 shows that if the LBCR had been present during this 14-month period, TDS concentrations would have increased by 1.2-1.4 percent, representing a slight impact.

Golden Algae

Golden algae (*Prymnesium parvum*) are a toxic algal species that can cause extensive fish kills. Rivers, ponds, and reservoirs in north-central Texas have been susceptible to these events. Four Texas river systems (Brazos, Canadian, Colorado, and Red) and at least 29 Texas reservoirs have been affected by golden algae since 2001 (TPWD, 2011b). Golden algae-like cells have also been identified in four other reservoirs within the Trinity River and Sulphur River systems (TPWD, 2002). All species of Texas fish are susceptible to golden algae, and the resulting fish kills have the potential to greatly impact the local economies around affected reservoirs by reducing regional water-based recreation opportunities. (TPWD, 2017d).

The TPWD has developed management guidelines in an effort to control golden algae toxic events. For areas that are at high risk for the introduction of golden algae, the TPWD recommends that a prevention and mitigation plan be in place (TPWD, 2011b).

The following questions are used to determine whether a waterbody is in a high risk area for golden algae toxic events (TPWD, 2011b). The answers for the proposed LBCR are in italics, below:

- Have previous toxic golden algae events taken place? *Not Applicable (because the reservoir does not exist).*
- Is golden algae known to be present in the waterbody? *Not Applicable (because the reservoir does not exist).*
- Is the waterbody in the region of the state where toxic golden algae events are common? *Yes (at Lake Texoma and other water bodies in the Red River Basin).*
- Are alkaline soil and high pH (>7.0) water conditions present for the waterbody in question? *Yes. Measured pH in sampling conducted on Bois d'Arc Creek near Bonham was 8.1.*
- Does the waterbody have fairly salty water (high conductivity)? *Not considered excessive. Salinity (chloride) predicted in LBCR is below the favorable range for golden algae.*

Based on these risk factors, golden algae are unlikely to become a problem for the LBCR in the future. If it were to become problematic, treatments for use in public waters include algal treatments that are approved by the EPA and TDA (the most successful treatments have been with copper-based algaecides such as chelated copper compounds) as well as ultraviolet light treatment and ozonation for small volumes of water (TPWD, 2011b).

The TPWD monitors for algal blooms and provides golden algae bloom status reports on their website (TPWD, 2017d). Texas lakes within the Red River Basin that were found to have golden algae present as of January 2011 included Plum Lake, the Lebanon Pool area and the Red River arm of Lake Texoma, and Lake Diversion at the intake for the Dundee State Fish Hatchery (TPWD, 2011b). Each of these instances has occurred upstream of Bois d'Arc Creek, although the algae could spread to other lakes and reservoirs that are at risk for such blooms in the future. Golden algae can be spread from site to site via water or equipment that is used in multiple lakes (e.g., boats and trailers) (TPWD, 2011b), and so equipment cleaning could be important to keep from introducing this alga and other invasive species into the new reservoir.

Potential Impacts to Stream Channels and Open Water Features from the Proposed Pipeline

To connect the reservoir to the service area, a raw water transmission pipeline would be required to convey and deliver water from the proposed reservoir to a proposed new water treatment plant, the North WTP near the City of Leonard in southwest Fannin County (as described in Section 2.2.5 of this document). The proposed project includes approximately 35 miles of pipeline right-of-way. Jurisdictional water and wetland areas were avoided to the degree possible when selecting an alignment for this pipeline by consideration of existing right-of-way (ROW) and the possible use of horizontal directional drill technology for installing the pipeline beneath streams or water bodies (as opposed to open trenching, which may also be used). A Preliminary Jurisdictional Determination (PJD) was conducted in the fall of 2013 for the pipeline route and the proposed sites of connected facilities near Leonard (i.e., the terminal storage reservoir and the water treatment plant). The PJD found that the chosen pipeline alignment crosses 39 waters of the United States, including 36 streams (one perennial, 7 intermittent, and 28 ephemeral), one on-channel impoundment, and two upland/off-channel stock ponds. Based on the pipeline route selection and construction technology, the only potential impacts on waters of the United States from construction of the raw water pipeline to the North WTP near Leonard would be temporary; there would be no permanent adverse effects.

A number of stream crossings were avoided because the pipeline alignment follows high ground (upland) over approximately half its length along the divide between the Sulphur River basin and the Red River basin. Temporary impacts to Ward, Honey Grove and Bullard Creeks would be avoided by using horizontal directional drilling to install the pipeline at these stream crossings and staging areas would be located within the uplands. Overall impacts from pipeline construction to waters of the U.S. would be none to slight.

The proposed new water treatment plant and terminal storage reservoir (TSR) would occupy a site northwest of the City of Leonard. The location and design of the WTP and TSR are shown in Figures 2.2-12 through 2.2-17 in Chapter 2 of this Revised DEIS. The project site for the WTP and TSR is currently used primarily for livestock grazing and hay production. Within the area investigated in a 2010 PJD of waters of the U.S. for the project site, the tracts mostly consist of areas containing upland herbaceous vegetation, with wooded areas occurring along riparian corridors and fence lines (Alan Plummer Associates, 2010).

The PJD conducted in the fall of 2013 determined there are no jurisdictional waters or wetlands present within the planned footprints of either the North WTP near Leonard or its associated TSR. The sites for these two facilities were selected in upland areas to entirely avoid permanent impacts to waters of the U.S. including wetlands. USACE completed an Approved Jurisdictional Determination (AJD) in 2015, which confirmed that no impacts to waters of the U.S. or wetlands would occur from the proposed North WTP or related facilities (USACE, 2015c)

Groundwater Resources

The proposed LBCR project is not located directly over the recharge zone for any major or minor groundwater aquifer in Texas. The Woodbine and Northern Trinity aquifers, which are located in the area of the proposed LBCR, are confined and separated by relatively impermeable clay and carbonate units (Appendix M). The hydraulic head created by the impounded water reservoir could potentially serve as a source of recharge water for the subsurface aquifers due to water seepage, though this scenario is highly unlikely because the uppermost zone of the Woodbine aquifer is located between 500 and 1,000 feet below ground surface.

Other minor aquifers located above the Woodbine aquifer in the study area, including the Austin Chalk, the Blossom Aquifer and undefined alluvium aquifer(s), as well as a shallow, unconfined aquifer present beneath the proposed reservoir project area, are not considered to be significant aquifers in Fannin County. Groundwater wells completed in the undefined alluvium aquifer are presumably producing water from the Red River alluvium, which is located in the northern portion of the county adjacent to the Red River.

According to well location data obtained from the TWDB, very few existing groundwater wells are expected within the footprint of the proposed reservoir project, and the current existence and use of these wells has not been verified. The increase in surface water supply to the area as a result of the proposed reservoir project could potentially reduce the amount of groundwater pumping in the area, thereby allowing for increased aquifer recharge, storage and production. Therefore, the proposed project is not expected to have an adverse impact on local groundwater resources, and due to the potential increased aquifer recharge, storage, and production, could result in beneficial impacts.

4.5.3 Alternative 2

Smaller LBCR Reservoir Water Storage

The downsized LBCR in Alternative 2 (shown in Figure 2.3-1 of this Revised DEIS), with a lower conservation pool elevation of 515 feet MSL, would have a storage capacity of 135,200 AF, which is approximately 37 percent of the 367,609 AF storage capacity of Alternative 1. The surface area of the downsized LBCR in Alternative 2 would be approximately 8,600 acres, approximately half the acreage of the proposed reservoir for Alternative 1. The footprint of the dam would be about 90 percent of the size of the dam for Alternative 1 and would be constructed at the same location. The dam's outlets and spillways for Alternative 2 would be designed to safely pass the Probable Maximum Flood instream flow requirements for Bois d'Arc Creek downstream, as specified in the Texas water right permit for the full-sized LBCR of Alternative 1. The firm yield of the downsized LBCR would be approximately 86,100 (Kiel, 2015a; Appendix M).

As a consequence of its smaller storage capacity, the downsized LBCR would provide a less reliable water supply during drought events. With less storage capacity, the downsized LBCR would be more vulnerable than the full-sized LBCR to new droughts, which would decrease water supplies during times of decreased precipitation, and to climate change, which would affect evaporation rates. Figure 4.5-10 shows a comparison of storage capacities between the full-sized LBCR and the downsized LBCR. The volume of water in the downsized LBCR and full-sized LBCR would be below 50,000 acre-feet about nine percent and three percent of the time, respectively.

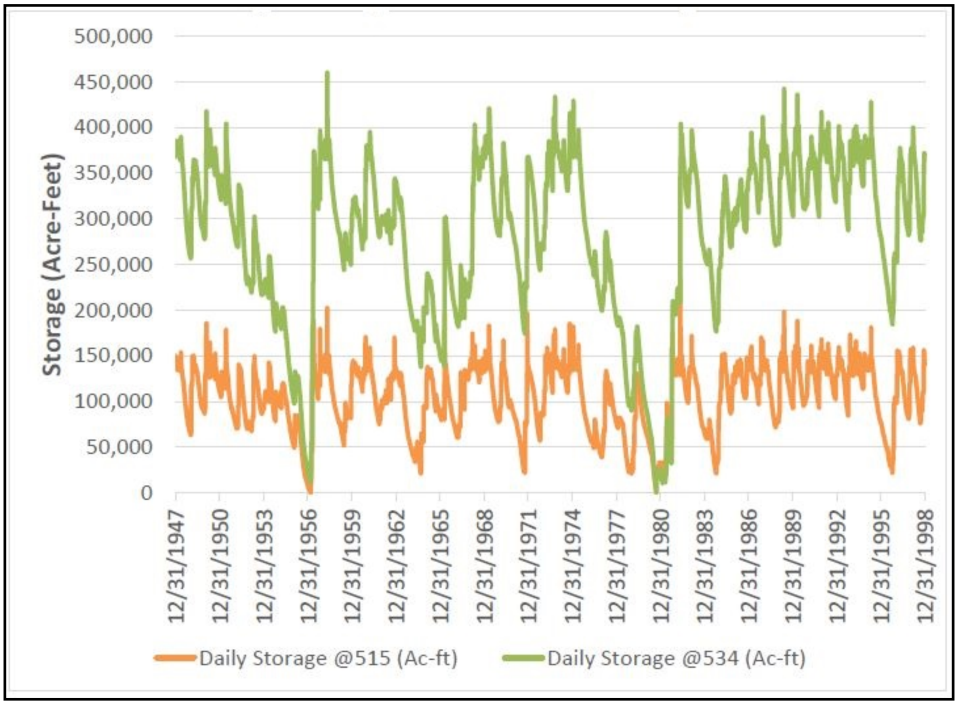


Figure 4.5-10. Comparison of Storage Traces Between a Full-scale LBCR (Alternative 1) at 534 MSL and a Smaller-scale LBCR (Alternative 2) at 515 MSL Elevation Based on Historic Record

Reservoir storage capacity of the downsized LBCR would be reduced over time by the deposition of sediment into the reservoir from surface runoff and erosion in the upstream drainage area. Because of its smaller size compared to the full-sized LBCR, the downsized LBCR would proportionately lose relatively more water storage capacity than the full-scale LBCR.

Assuming the same rate of sedimentation for the downsized LBCR and full-sized LBCR (0.94 AF/mi^2/year), the downsized LBCR would lose approximately 11,167 AF of storage capacity after its initial 40years of operation. This loss of storage capacity would comprise approximately eight percent of the initial reservoir capacity (135,200 AF), compared to three percent of the initial reservoir capacity lost for the full-sized LBCR after its initial 40 years of operation. Using the estimated same rate of sedimentation (0.94 AF/mi^2/year), the downsized LBCR and the full-sized LBCR would lose approximately 21 percent and 7.5 percent storage capacity, respectively, after 100 years of operation.

The downsized LBCR would not adversely affect existing water rights in the Bois d'Arc Creek watershed or water rights below the confluence of Bois d'Arc Creek and the Red River. There would be no impacts from the downsized LBCR associated with the interbasin transfer of water rights in the Trinity River Basin.

Stream Channels and Open Water Features within the Bois d'Arc Creek Watershed

The downsized LBCR would inundate approximately 8,600 acres, including waters, wetlands, and uplands within the Alternative 2 footprint. The downsized LBCR would also impact 3,800 acres of land around the perimeter of the proposed reservoir for the flood pool. The total potential impacted area from construction of the downsized LBCR would be 13,105 acres, which is approximately 58 percent of the potential impacted area of Alternative 1 (22,642 acres) (Kiel, 2016b). In addition, the downsized LBCR could impact an estimated 348,928 linear feet of streams, which would be approximately half of the 651,024 linear feet streams potentially impacted by Alternative 1. Making the assumption that Stream

Quality Factors (SQF's) are evenly distributed across the entire reservoir footprint, the impacted area under the downsized LBCR could affect approximately 95,000 Stream Quality Units (SQU's).

Surface Hydrology

Flood Flows

The downsized LBCR in Alternative 2 would have a conservation pool elevation of 515 feet MSL, 19 feet below Alternative 1's conservation pool elevation of 534 feet MSL. Construction and operation of the downsized LBCR would not increase upstream or downstream flooding along Bois d'Arc Creek compared to existing conditions.

Downstream Navigation

The firm yield of the downsized LBCR is estimated to total 86,100 AFY or approximately 68 percent of the 120,665 AFY firm yield of the full-scale LBCR. Although less water would be diverted from the Bois d' Arc Creek watershed in Alternative 2, water would be diverted from Lake Texoma in this alternative. The combined effect of diverting water from Bois d' Arc Creek and Lake Texoma would result in the same effect on flows in the Red River as discussed under Alternative 1, which concluded that there would be no adverse effect on navigation. The operation of a smaller LBCR in combination with diversions from Lake Texoma would not adversely affect navigation on the Red River.

Other Reservoirs in the Bois d'Arc Creek Watershed

The normal pool of the downsized LBCR would be 19 feet lower than the normal pool of the full-sized LBCR (515 versus 534 feet MSL). As indicated under Alternative 1, the Lake Bonham Dam embankment, spillway, outlets, and drainage system could be adversely affected when the LBCR surface elevation reaches 524 feet MSL. Under Alternative 2, the Lake Bonham Dam and facilities would not be affected because the surface elevation of the smaller LBCR would not be high enough to encroach on the embankment, spillways, outlets, or drainage system.

Under Alternative 2, up to 28,700 AFY of water would be withdrawn from Lake Texoma for blending with water from the downsized reservoir. NTMWD already has a water right to withdraw this water, so Alternative 2 would not have any impact on Lake Texoma. No other reservoirs in the Bois d'Arc Creek Watershed would be affected by Alternative 2.

Surface Water Quality Impacts

The quality of water stored in the downsized LBCR is expected to be similar to the quality of water stored in the full scale LBCR. As indicated under Alternative 1 above, the primary impact on water quality that would result from building the proposed reservoir would be a reduction in the variability of water quality in the reach downstream of the reservoir (Appendix M and Appendix R). Existing water quality is adequate and predicted water quality after implementation of Alternative 2 would remain adequate.

The expected chloride, sulfate, and total dissolved solids concentrations in the downsized LBCR would not pose a problem for conventional water treatment processes to produce drinking water that meets state and federal standards. In general, the expected water quality in the reservoir would be amenable to the standardized, widely-used water treatment processes and technologies employed by NTMWD, which include flocculation/ coagulation, sedimentation, triple disinfection, filtration, and pH adjustment.

As stated under Alternative 1, USGS reports daily specific conductance data for two stream gages in the vicinity of the proposed LBCR:

- Red River at Arthur City, TX (07335500) - March 2007 to September 2008
- Bois d'Arc Creek at FM 1396 near Honey Grove, TX (07332620) – June 2006 to present

The watershed above the proposed LBCR affects TDS loads at the Red River's Arthur City gage in two ways. First, it contributes relatively low-salinity flow that helps dilute high-salinity releases from Lake Texoma. Second, it contributes dissolved solids that influence TDS loads at Arthur City. Although these loads and salinity concentrations are lower than Lake Texoma, the contribution of the Bois d'Arc Creek watershed can be significant during high flows (Albright and Coffman, 2014).

Analysis of specific conductance data from the FM 1396 and Arthur City gages from August 2007 to September 2008 shows that if the LBCR had been present during this 14-month period, TDS concentrations would have increased by 1.2-1.4 percent, representing a slight impact.

Potential Impacts to Stream Channels and Open Water Features by the Proposed Pipelines

The impacted area of the related facilities and connected actions, including the raw water pipeline, terminal storage reservoir, and North water treatment plant, from construction of the downsized LBCR would be the same as for Alternative 1 and would have the same impacts ranging from none to slight. In Alternative 2, an additional 25-mile, 72-inch diameter raw water pipeline would be installed alongside the existing raw water pipeline from Lake Texoma to the Texoma Balancing Reservoir. Based on the pipeline route selection and construction technology, the only potential impacts on waters of the United States would be temporary. Overall impacts from Lake Texoma pipeline construction to waters of the U.S. would be none to slight.

Groundwater Resources

As indicated in Section 4.5.2.7, according to well location data very few existing groundwater wells are expected within the footprint of the proposed reservoir project, and the current existence and uses of these wells have not been verified. The increase in surface water supply to the area as a result of the downsized LBCR could potentially reduce the amount of groundwater pumping in the area, thereby allowing for increased aquifer recharge, storage and production. Therefore, similar to Alternative 1, the smaller reservoir in Alternative 2 is not expected to have an adverse impact on local groundwater resources, and could result in beneficial impacts due to the potential increased aquifer recharge, storage and production.

4.6 BIOLOGICAL RESOURCES

The following sections address the potential effects of Alternatives 1 and 2 on the available biological resources located within the project area. Discussion of environmental consequences of the No Action Alternative, Alternative 1, and Alternative 2 includes potential effects on upland and wetland habitats, aquatic biota, and terrestrial wildlife.

Construction impacts are those resulting from construction of the dam facilities and associated infrastructure. Dam facilities construction includes the dam, which would be a zoned earthen embankment, and a spillway and outlet works that would extend downstream from the dam centerline. The spillway would consist of an approach channel, a concrete weir, a chute, a hydraulic jump stilling basin, an outlet channel and a multi-level intake tower located near the dam. An uncontrolled broad crested weir structure emergency spillway would also be located in the right abutment of the dam.

Additional impacts would result from the construction of a raw water intake pumping station close to the southeastern end of the proposed LBCR dam site; a new electrical substation next to the proposed pumping station; a raw water pipeline that would run from just downstream of the proposed LBCR dam site in a southwesterly direction for approximately 35 miles to just west of Leonard; a raw water treatment plant (the North WTP) just west of the town of Leonard, Texas; and a rail spur off of the Missouri-Kansas-Texas Railroad routed through uplands along existing roads with a terminus at the WTP site. For Alternative 2, an additional 25-mile pipeline would be constructed from Lake Texoma to the Texoma

Balancing Reservoir. Details of the dam facilities and other associated infrastructure are presented in Chapter 2. Other impacts would occur with the extension of existing rural road FM 897 and construction of a new bridge over the reservoir along that alignment to replace FM 1396 which would be lost to inundation.

Clearing of vegetation must occur to accommodate the dam facilities; the Lower Bois d'Arc Creek Dam Conceptual Clearing Plan (Appendix T) provides guidance on the clearing process. The objectives of the plan are to enhance creation of fish habitat by minimizing the clearing of standing trees and shrubs in selected areas within the proposed reservoir; to improve human access to shore locations by creating shore access locations for boat ramps, bank fishing, etc. through selective clearing of trees and shrubs; to reduce hazards to boating safety and fishing resulting from large floating debris by minimizing the source of such debris; and to create aesthetic views of the reservoir along selected segments of the shoreline (NTMWD, no date-b; NTMWD, 2015b).

Operational impacts are those resulting after completion of the dam facilities including inundation of Bois d'Arc Creek and streams within the project footprint and surrounding habitat for the reservoir, on-going maintenance activities, and consequent anticipated development and recreation activities. Operational impacts also include the required low-flow releases that would pass from the reservoir through the multi-level intake tower and low-level outlet works and discharge to the service spillway chute and higher velocity pulse flows that would be released from the reservoir through multiple levels of sluice gates located in the service spillway.

The project footprint discussed for biological resources includes the proposed reservoir site, raw water pipeline, water treatment facility, and mitigation site, all of which are located in Fannin County and the pipeline from Lake Texoma which is in Grayson County. Impacts associated with the construction and operation of each alternative are summarized in Table 4.6-1. Impacts are presented for wetland habitat, open water and aquatic biota, upland habitat, terrestrial wildlife, threatened and endangered species, and invasive plants; however, the numbers presented are not additive, as impacts associated with each category may occur in the same habitats.

Table 4.6-1. Summary of Impacts to Biological Resources for Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Construction Phase			
Wetland Habitat			
Size	Construction of the dam and impoundment of water: 4,602 acres (4,035 FCUs) of forested wetlands, 1,223 acres (514 HUs) of emergent wetlands, and 49 acres (23 HUs) of scrub shrub wetlands.	Construction of the dam and impoundment of water: 2,909 acres (2,502 FCUs) of forested wetlands, 684 acres (237 HUs) of emergent wetlands, and 27 acres (12 HUs) of scrub shrub wetlands.	Continued degradation of channelized streambed.
Duration	100+ years (long-term)	100+ years (long-term)	Variable
Likelihood	High	High	High
Severity	Moderate	Moderate	Slight

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Aquatic Habitat			
Size	78 acres of open waters (ponds, stock tanks, etc.), and 651,140 linear feet (123.3 miles) of streams comprised of 286,139 linear feet (LF) (54.2 miles) of intermittent and 365,001 LF (69.1 miles) of intermittent/ephemeral streams.	78 acres of open waters (ponds, stock tanks, etc.) and 348,928 LF (66.1 miles) of streams comprised of 166,286 LF (31.5 miles) of intermittent and 182,642 LF (34.6 miles) of intermittent/ephemeral streams.	Continued degradation of channelized streambed contributing to support of generalist species and low overall diversity.
Duration	100+ years (long-term)	100+ years (long-term)	Variable
Likelihood	High	High	High
Severity	Slight	Slight (less than Alternative 1)	Slight
Upland Habitat			
Size	Approx. 11,440 acres (reservoir, pipeline, WTP)	Approx. 6,390 acres (downsized reservoir, 2 pipelines, WTP)	Additional rural home development over unknown amount of acreage in project area
Duration	3-4 years	3-4 years	Variable
Likelihood	High	High	High
Severity	Moderate	Moderate (less than Alternative 1)	Slight
Terrestrial (Upland) Wildlife			
Size	Approx. 11,440 acres (reservoir, pipeline, WTP) habitat disturbance	Approx. 6,390 acres (downsized reservoir, 2 pipelines, WTP) habitat disturbance	Unknown amount of habitat loss from rural home development.
Duration	3-4 years	3-4 years	Variable
Likelihood	High	High	High
Severity	Moderate	Moderate (less than Alternative 1)	Slight
Threatened and Endangered Species			
Size	Approx. 11,440 acres (reservoir, pipeline, WTP) habitat disturbance	Approx. 6,390 acres (downsized reservoir, 2 pipelines, WTP) habitat disturbance	Unknown amount of habitat loss from rural home development
Duration	3-4 years	3-4 years	Variable
Likelihood	None to low	None to low	None to low
Severity	None to slight	None to slight (less than Alternative 1)	None to slight (less than Alternatives 1 and 2)
Invasive Species			
Size	Approx. 11,440 acres (reservoir, pipeline, WTP) habitat disturbance	Approx. 6,390 acres (downsized reservoir, 2 pipelines, WTP) habitat disturbance	Unknown amount of habitat loss from rural home development
Duration	3-4 years	3-4 years	Variable
Likelihood	High	High	High

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Severity	Moderate	Moderate (less than Alternative 1)	Slight
Operation Phase			
Wetlands			
Size	4,602 acres (4,035 FCUs) of forested wetlands, 1,223 acres of emergent wetlands (514 HUs), 49 acres (23 HUs) of scrub shrub wetlands.	2,909 acres (2,502 FCUS) of forested wetlands, 684 acres (237 HUs) of emergent wetlands, 27 acres (12 HUs) of scrub shrub wetlands, and 20 acres of open water with a conservation pool elevation of 515 feet MSL.	Continued degradation of channelized streambed contributing to support of generalist species and low overall diversity.
Duration	>50-100+ years (long-term)	>50-100+ years (long-term)	Variable
Likelihood	High	High	High
Severity	Moderate	Moderate	Slight
Aquatic Habitat			
Size	78 acres of open waters (ponds, stock tanks, etc.), and 651,140 linear feet (123.3 miles) of streams comprised of 286,139 linear feet (LF) (54.2 miles) of intermittent and 365,001 LF (69.1 miles) of intermittent/ephemeral streams.	78 acres of open waters (ponds, stock tanks, etc.) and 348,928 LF (66.1 miles) of streams comprised of 166,286 LF (31.5 miles) of intermittent and 182,642 LF (34.6 miles) of intermittent/ephemeral streams.	Continued degradation of channelized streambed contributing to support of generalist species and low overall diversity.
Duration	>50-100+ years (long-term)	>50-100+ years (long-term)	Variable
Likelihood	High	High	High
Severity	Moderate	Moderate (less than Alternative 1)	Slight to moderate (adverse)
Upland Habitat			
Size	Approx. 11,230 acres loss of upland habitat from dam, reservoir, and WTP	Approx. 5,975 acres loss of upland habitat from dam, reservoir, and WTP	Additional rural home development over unknown amount of acreage in project area
Duration	>50-100+ years (long-term)	>50-100+ years (long-term)	>50-100+ years (long-term)
Likelihood	High	High	High
Severity	Moderate	Moderate (less than Alternative 1)	Slight
Terrestrial (Upland) Wildlife			
Size	Approx. 11,230 acres loss of upland habitat from dam, reservoir, and WTP	Approx. 5,975 acres loss of upland habitat from dam, reservoir, and WTP	Unknown amount of habitat loss from rural home development
Duration	>50-100+ years (long-term)	>50-100+ years (long-term)	Variable
Likelihood	High	High	High

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Severity	Moderate	Moderate (less than Alternative 1)	Slight
Threatened and Endangered Species			
Size	Approx. 11,230 acres loss of upland habitat from dam, reservoir, and WTP	Approx. 5,975 acres loss of upland habitat from dam, reservoir, and WTP	Unknown amount of habitat loss from rural home development
Duration	>50-100+ years (long-term)	>50-100+ years (long-term)	Variable
Likelihood	Low to medium	Low to medium	None to low
Severity	Slight to moderate	Slight to moderate (less than Alternative 1)	None to slight (less than Alternatives 1 and 2)
Invasive Species			
Size	Approx. 11,230 acres loss of upland habitat from dam, reservoir, and WTP	Approx. 5,975 acres loss of upland habitat from dam, reservoir, and WTP	Unknown amount of habitat loss from rural home development
Duration	>50-100+ years (long-term)	>50-100+ years (long-term)	Variable
Likelihood	Medium	Medium (less than Alternative 1)	High
Severity	Slight to moderate	Slight to moderate	Slight

FCU=Functional Capacity Units; HU=Habitat Units; LF=Linear Feet; WTP=Water Treatment Plant; ft=feet; MSL=Mean Sea Level

4.6.1 No Action Alternative

<u>Habitat</u>

As described in Section 3.4, there are eight habitat types within the project footprint of the affected environment that would require mitigation. Theses habitat types include the wetland habitats of forested wetland, scrub shrub wetland, emergent wetland, and open water; and the upland habitats of upland deciduous forest, riparian woodland /bottomland hardwood, grassland/old field, and upland shrubland. The most dominant vegetated habitat types are forested wetlands followed by emergent wetland.
Under the No Action Alternative, the proposed reservoir, dam, pipeline, and water treatment plant would not be built; therefore, no direct removal of vegetation and no inundation of vegetation related to project activities would occur.

Wetlands

Under the No Action Alternative, no direct impacts would occur to the wetland vegetation communities. However, changes to the environment would likely be variable in duration with a high likelihood of occurrence and slight severity. The continuing pattern of steady population growth in Fannin County is expected to continue over the next few decades, as are the current practices of silviculture, forestry and logging, and limited land clearing for agricultural purposes. The native wetland vegetation communities would experience negative changes in cover should there be an increase in agricultural use of land in the area or an increase in development of residential communities and commercial areas and associated infrastructure including roads and bridges, particularly should additional channelization or diversions occur.

The addition of new residential communities and commercial areas would lead to the disturbance of native wetland habitats, partial or entire removal of native wetland habitat vegetation, increased flows and reduced freshwater availability, accelerated delivery of contaminants and pollutants to the watershed, and could lead to the introduction of non-native and invasive plant species as well as the introduction of domestic animals such as dogs and cats. Effects from non-native invasive plant species introduction, activities of domestic pets, and increased contaminants and pollutants would result in a reduction in native plant cover and a reduction in habitat suitability and native wildlife diversity. Positive effects on native wetland habitats could occur in areas where agricultural activity has ceased; a natural succession of native wetland plant communities could occur. Any substantive change to vegetation communities in the area would come from projects unrelated to the proposed reservoir, dam, WTP and pipeline. Under the No Action Alternative, without additional agriculture, development, or modifications to the watershed, adverse effects to the vegetation communities or habitat of the proposed project site and surrounding area would be expected to be slight and would be expected to change based upon anticipated slight to moderate changes of the hydrology and hydraulics of Bois d'Arc Creek and affected tributaries over time; historic trends in the area would be expected to continue for several decades.

Forested Wetlands

The forested wetland vegetation community observed in the Bois d'Arc Creek watershed has overall relative low diversity. While this could be indicative of the immature condition of some areas of the forested wetlands as a direct result of the decades-long logging activities, such operations have not been prevalent within properties owned and managed by the USFS in the Caddo National Grasslands areas downstream of the proposed reservoir, which have been shown to have similar functional capacity as the upstream areas. Under the No Action Alternative without additional agriculture, development, or modifications to the watershed, the 4,602 acres (4,035 Functional Capacity Units) of forested wetlands observed in the Bois d'Arc Creek watershed would not be expected to experience significant changes, but may gradually and slightly increase in value over time.

Emergent Wetlands

Under the No Action Alternative, no impacts would occur to the 1,223 acres (514 HUs) of emergent wetlands in the project footprint. However, changes could occur due to additional agriculture, development, or modifications to the watershed vegetation as a result of the excessive erosion and downcutting in Bois d'Arc Creek. These trends would affect the ability of emergent wetlands to persist in various portions of the project footprint.

Scrub Shrub Wetlands

Under the No Action Alternative, no impacts would occur to the 49 acres (23 HUs) of scrub shrub wetland vegetation. However, changes to this cover type would occur if additional agriculture, development, or modifications to the watershed occurred. Because the scrub shrub wetlands are wetlands in successional transition between emergent wetlands and bottomland wetland forests, the continuing bank instability and erosion in Bois d'Arc Creek could affect persistence of scrub shrub wetlands in certain locations within the project footprint. Some of the scrub shrub wetlands would likely undergo succession and become forested wetlands while new scrub shrub would be created by natural forces.

Upland Habitats

As noted above, projected population growth in Fannin County over the coming decades is likely to result in substantial development in the county, leading to the conversion of an unknown amount of the upland habitat within the project footprint to developed land uses, such as rural residential. This would entail long-term habitat loss to some extent, including forest, grassland/old field, cropland, and tree and scrub savanna.

Open Water Habitats and Biota

Under the No Action Alternative, no direct and immediate impacts would occur to the 78 acres of open water and associated aquatic life. Terrestrial habitat would not be converted to lacustrine habitat at the proposed reservoir site. Changes would nevertheless occur and would be long-term in duration with a high likelihood of occurrence and moderate severity. Any substantive change to aquatic life would come from projects unrelated to Alternatives 1 and 2 such as changes in agricultural practices and development that could occur near or within the surface waters of the area. Without changes in the watershed, Bois d'Arc Creek is expected to continue to down-cut and erode. As the channel becomes even more incised, lateral connectivity with the surrounding floodplain would continue to decrease. Due to the unstable nature of much of the stream banks along Bois d'Arc Creek and easily erodible bed materials, the stream channel will continue to enlarge. This would further reduce longitudinal connectivity at low flows and continue to constrain aquatic species to specific habitats that contain water (e.g., pools).

Fish

Under the No Action Alternative, no direct impacts would occur to fish populations. The majority of the fish species) collected from Bois d'Arc Creek during this instream flow study were generalist species (81 percent), with only a few that are characteristically found only in flowing water or considered fluvial specialists. The slight to moderate changes in the hydrology of Bois d'Arc Creek and tributaries that are anticipated to occur over time are expected to continue to support existing populations of generalist fish species and contribute to overall low biodiversity.

Benthic Macroinvertebrates

Under the No Action Alternative, no impacts would occur to benthic macroinvertebrates. Due to the ongoing degradation of the watercourses, the dominance of collector-gatherer, predator, and scraper species (representing more than 80 percent of the population) would continue. The presence of few filter-feeding or shredder species, which is an indicator of ecological degradation, would also continue.

Terrestrial (Upland) Habitat and Species

Under the No Action Alternative, effects to wildlife habitat and wildlife in the project footprint of Alternatives 1 and 2 would likely be slight and adverse. Few effects to wildlife would be likely to occur in the area of the proposed reservoir, dam, pipelines, and WTP near Leonard from the No Action Alternative. Existing wildlife habitats would not be removed, replaced or converted at these sites except for changes due to possible agricultural, residential, and other development; additionally, natural succession would occur where not interrupted by natural or human disturbances. These changes or growth are anticipated to follow historic patterns and continue at a gradual though perhaps increasing rate, in conjunction with expected population growth and development in Fannin County, much of which would occur regardless of whether or not Alternative 1 or Alternative 2 is implemented. Any substantive change to wildlife populations in the project footprint under the No Action Alternative would be from additional rural home construction, timber harvest, an increase or intensification of agriculture practices, or abandonment of agricultural fields to old fields, grass fields, or eventually, woody habitat. There could also be changes in upland small and large game hunting intensity (increasing or decreasing) as human population grows and with changes in the populations of native species such as deer, rabbit, and squirrel or of competing invasive species, like feral hogs.

Threatened and Endangered Species

Under the No Action Alternative, effects to both federal and state-listed threatened and endangered species would be none to slight and associated with independent actions in the area. Any effects are expected to be gradual and result over time from an increase in population, development, or agricultural activity. Because of the small number of potential threatened or endangered species in Fannin County and lack of suitable habitats within the proposed reservoir and dam site, effects to threatened and endangered species under the No Action Alternative would likely be no more than slightly adverse.

Invasive Species

Invasive plant species – especially grasses and forbs – are generally found in disturbed soil conditions.

Surface disturbance and construction activities from increased development in the project area could facilitate the establishment and spread of noxious weeds. Aggressive non-native species could become established if ground disturbance during construction is extensive and lengthy. Construction equipment could aid in the facilitation of invasive species by transporting an invasive species from one area to another (FHWA, 1999). Invasive species – both plants and animals – can harm native flora and fauna in a number of ways, such as by preying on them, out-competing them for food and other resources (e.g., sunlight), preventing them from reproducing, changing food webs, and modifying ecosystem conditions. Overall effects of invasive species under the No Action Alternative are expected to be slight in severity, of high likelihood, and long-term.

4.6.2 Alternative 1

Impacts Associated with Project Phases

In general, the impacts to biological resources are best described based on two project phases: 1) construction and 2) operations.

Construction Phase

Clearing of vegetation for the dam, reservoir, and associated structures under Alternative 1 would result in direct and permanent elimination of a variety of vegetation cover types and wildlife habitat within the proposed 17,068-acre reservoir footprint. Before inundation of the proposed reservoir, much but not all of the standing woody material, including dead and living trees and shrubs five feet tall or taller, as well as fallen trees five feet or more in length with a diameter of six inches or greater, would be cleared and removed in accordance with the reservoir clearing plan. Trees and shrubs that are not cleared would eventually drown and die, gradually decomposing underwater but contributing to underwater habitat structure for a number of years. The partial reservoir clearing would take place approximately two years preceding reservoir inundation. Areas used for construction of the dam and associated facilities would be cleared earlier. Both hand and machine clearing could take place, and cleared materials would be placed in windrows or piles and left to dry and eventually burned depending on fire danger conditions.

Raw water transmission facilities including the intake pump stations at the edge of the reservoir near the dam and the 35-mile long, 90-96 inch raw water pipeline would be constructed fully in uplands or existing right-of-way (ROW) and would avoid wetlands habitat. However, during construction, a temporary construction easement is proposed for a total width along the alignment of the pipeline of 70 feet. After construction, the permanent easement would be 50 feet wide. The proposed WTP and TSR would be located on NTMWD-owned property near the city of Leonard in Fannin County. There would be no effects to wetland vegetation, since the entire construction area is located on upland.

In addition to clearing and direct inundation, potential effects from general construction activities include soil compaction, possible spills of fuels and/or other materials, introduction and spread of invasive species, erosion, and an increase in construction dust.

Construction of the dam and reservoir would result in soil compaction of the proposed dam site and surrounding area, although the vegetation is scheduled to be removed during the dry season, which would reduce possible impacts of soil compaction. Excessive soil compaction can impede root growth by altering the structure of soil, decreasing a plant's ability to take up nutrients and water. Soil compaction also increases water runoff and soil erosion. Surface water runoff and sediment from areas disturbed by construction could adversely affect local vegetation by exposing soils and transporting sediment off site. Since vegetation would be cleared two years before inundation, the soil in this area would be exposed and experience soil erosion. A storm water pollution prevention plan (SWPPP) and erosion and sedimentation control plan would be implemented to minimize the potential for contamination of surface or groundwater resources.

Possible spills of fuels and/or other material could cause shifts in population structure, abundance and diversity, and distribution of plant species. Some materials could remain in the environment long after a spill event. With appropriate oversight, any spills during construction of the dam and reservoir would be expected to be small, contained, and remedied appropriately.

During construction, adverse effects to local vegetation outside of the proposed reservoir site might occur as a result of fugitive dust emissions from construction machinery and worker traffic along unpaved roads (Ko and Alberico, no date). Dust emissions could reduce photosynthesis by reducing the light penetrating into the leaves of plants and could increase the growth of plant fungal disease (Farmer, 1993). Dust from construction related activities would be short-term and controlled by dust suppression measures (e.g., water spraying) as required by regulation. After construction, local off-site vegetation is expected to recover in a reasonable time. Construction equipment and surface disturbance could aid in the facilitation of invasive plant species by transporting an invasive species from one area to another (FHWA, 1999). Aggressive non-native species could become established if ground disturbance during construction is extensive and lengthy.

Individual and population-level impacts to wildlife during the construction phase would include displacement of those individual animals whose habitat is eliminated, with probable declines in overall local population numbers, as displaced individuals are forced into neighboring territories where they would compete with already established members of their species for limited food supplies and other resources. Other construction-related adverse effects would include collisions with construction equipment and workers' personal vehicles, direct mortality of smaller vertebrates and invertebrates unable to avoid bulldozers and scrapers during land clearing, and noise and general disturbance impacts from intensive construction activity.

During construction of the proposed dam and reservoir, short-term, localized adverse effects to wildlife are expected to occur from noise, light pollution, and general disturbance. Wild animals rely on meaningful sounds for communicating, navigating, avoiding danger and finding food. Noise pollution is defined as any human sound that alters the behavior of animals or interferes with their daily functions (FHWA, 2011). The level of impact from noise on wildlife depends on decibel levels, durations, and the physical characteristics of the environment (Ouren et al., 2007). Noise pollution can harm the health, reproduction, survivorship, habitat use, physical distribution, abundance or genetic distribution of wildlife (FHWA, 2011). Noise can also lead to changes in behavior, including avoidance behavior and changes in normal patterns (Radle, 1998). For example, intrusion-induced behaviors, such as nest abandonment and decreased nest attentiveness have led to species decline (USFS, 2009). As noted, impacts would be localized to the general vicinity of the proposed dam and reservoir during construction.

Injury or mortality of wildlife may result from collisions with vehicles and construction equipment. These effects normally remain localized and limited to the immediate vicinity of a construction project site and are not expected to impact the population of affected species as a whole. Birds are especially susceptible to collisions with stationary objects (USFWS, 2002).

Operations Phase

Operation of the proposed reservoir would result in continued permanent effects to vegetation communities as a result of inundation as well as indirect effects to vegetation outside of the immediate project footprint. Potential adverse effects to biological resources include an increase in recreational activities and an increase in residential housing and commercial establishments along the shoreline of the proposed reservoir. Anticipated increases in recreation and residential housing would result in an increase in vegetation removal, soil compaction, soil erosion, surface water runoff, and an increase in the introduction and facilitation of invasive plant species. Recreational users could trample vegetation, increasing soil compaction and soil erosion, and surface water runoff along the reservoir shoreline. Soil erosion and surface water runoff would degrade nearby water sources, including the proposed reservoir.

Operating the proposed reservoir could affect the vegetation along the stream channel downstream of the dam, including within the Caddo National Grasslands. The presence of the dam and reservoir and the proposed operation plan, including water releases, would reduce or eliminate large erosive flow events and would allow vegetation along banks to become better established. This would increase stream bank stability from deeper and denser vegetative roots. The plant matter on the bank faces would deflect flowing water away from the banks, reducing shear stress from moving water on stream banks. Vegetation downstream within the Caddo National Grasslands would follow this trend and any adverse effects to this area would likely be slight.

To provide recreational enjoyment and for emergency purposes, shoreline vegetation would be removed in certain locations for user access to the reservoir. A number of landing sites would be identified along the future reservoir shoreline. Clearing at these sites might require the removal of stumps and other vegetation to ensure safe access/exit to the shoreline. To minimize environmental effects, hand clearing would be considered at landing sites above the high water mark. In addition, large woody debris within the reservoir would be removed as necessary.

4.6.2.2 Habitat

Overall the wetland habitats with the greatest acreage of loss from implementation of Alternative 1 would be forested wetland and emergent wetland, with 4,602 acres (4,035 FCUs) and 1,223 acres (514 HUs) of impacts, respectively. Additional losses would occur to scrub shrub wetland and habitats (49 acres/23 Hus). Table 4.6-2 summarizes the habitat impacts associated with Alternative 1. Under Alternative 1, subject to the provisions of the Section 404 permit, Texas water right permit and Section 401 water quality certification, selected trees and shrubs would be cleared from the LBCR footprint prior to impoundment of water behind the dam. Standing woody material, including dead and living trees and shrubs five feet or more in height, as well as fallen trees five feet or more in length with a diameter of six inches or greater, would be cleared and removed in designated areas in accordance with the Conceptual Clearing Plan (Appendix T).

Table 4.6-2. Habitat Impacts Associated With Alternative 1

Cover Type	Area (acres)	Habitat Units	Functional Capacity Units
Forested Wetland	4,602	--	4,035
Scrub Shrub Wetland	49	23	--
Emergent Wetland	1,223	514	--
Open Water	78	--	--
Upland Deciduous Forest	2,216	1,058	--
Riparian Woodland/ Bottomland Hardwood	1,728	434	--
Grassland/Old Field	4,761	2,896	--
Shrubland	64	--	--

Note: Forested wetlands were assessed using the Modified East TX HGM Methodology. All other cover types were assessed using the USFWS's HEP Procedures.

Wetlands

Under Alternative 1, overall effects to the wetland vegetation communities of the affected environment during construction and operations would likely be long-term (100+years) in duration with a high likelihood of occurrence and moderate severity. More information on the specific vegetation communities is provided below.

Forested Wetlands

During the construction of the dam and related facilities and inundation of the reservoir under Alternative 1, approximately 4,602 acres (4,035 HUs) of forested wetlands would be directly and permanently eliminated by clearing, direct fill impact or and/or inundation. Ninety-two percent (11 of 12) of the twelve tree species identified are classified either as facultative (equally likely to occur in wetlands or uplands) or facultative upland (usually found on non-wetland sites), indicating that these forested wetlands are comprised of tree species adapted to temporary or seasonal flooding, rather than semi-permanent flooding, inundation, or saturation. Because the tree community is already dominated by facultative and facultative upland species (rather than obligate wetland or facultative wetland species), the majority of forested wetland areas not cleared mechanically for the project and that will be subject to inundation would not be expected to survive.

Forested wetlands within the temporary construction pipeline easement would revert to their respective cover types over time. Within the permanent 50-foot pipeline easement, however, forest cover types would be converted to grassland following re-vegetation of the easement and would be maintained as such. After reservoir impoundment, large woody debris would continue to be removed as necessary for the safe operation of boat ramps, swimming areas, water intake structures, and spillways (NTMWD, 2015b). The downstream corridor below the dam along Bois d'Arc Creek is expected to continue to function as forested wetlands after the construction of the dam because hydric soils will remain in place and would continue to be supported by periods of saturation and inundation during the growing season; the existing riparian community is comprised of facultative species, which are "equally likely to occur in wetlands and non-wetlands" (Lichvar et al., 2012). Existing species can tolerate hydrology changes; there are no expected changes to plant communities or wildlife habitat, and multiple sources of hydrology will remain to support wetlands.

Emergent Wetlands

Construction of the dam and impoundment of water under Alternative 1 within the normal pool elevation of 534 feet MSL would result in the removal of 1,233 acres (514 BHUs) of emergent wetland vegetation by direct fill impact or inundation of waters of the habitat. However, emergent wetlands are expected to develop following inundation and during the operation phase within the littoral zone of the proposed reservoir; they would provide a functional wetland community which would offset some of the impacts resulting from the proposed reservoir project.

Many of the areas where these littoral wetlands are expected to develop are currently functioning emergent wetlands and would continue to function as emergent wetlands following impoundment of the reservoir. The existing wetlands would also serve as a seed source for the newly developed littoral wetlands, helping to establish vegetation. Based on a review of data collected from seven freshwater reservoirs located within the North Texas area, on average, approximately 16 percent of the total surface area of the lakes/reservoirs surveyed develop submerged, emergent, or floating leaved (or a combination of) vegetation within the littoral zone.

If similar conditions were to develop at the proposed Lower Bois d'Arc Creek Reservoir site (reservoir area at conservation pool elevation is approximately 16,641 acres), this would equate to approximately 2,663 acres (16 percent of 16,641 acres) of littoral zone wetland development. However, a more conservative approach, and one that would have a greater probability of occurring, is to use the reservoir area between elevations 531-534 feet MSL, which equates to the development of approximately 1,400 acres of littoral zone wetlands along the shoreline of LBCR. More information is available in the Mitigation Plan (Appendix C).

Scrub Shrub Wetlands

Construction of the dam and impoundment of water under Alternative 1 within the normal pool elevation of 534 feet MSL would result in the removal of 49 acres (23 HUs) of scrub shrub wetland vegetation by direct fill impact or inundation of waters. Clearing of habitat for the dam and associated structures would directly remove some scrub shrub habitat. Because it is dominated by plants in successional transition between herbaceous wetlands and bottomland hardwood forests, much of the habitat in the inundation footprint would not survive, however the habitat in the newly established transition zones would be expected to recover.

Upland Habitats

Upland Deciduous Forest

Approximately 2,216 acres (1,058 HUs) of upland deciduous forest would be permanently eliminated or converted to other habitat types by Alternative 1 at the site of the dam and reservoir. This habitat would be replaced by the dam and related structures (e.g., spillway, electrical substation) and by the impounded water of the reservoir. A much smaller area of upland deciduous forest or woodland patches – about 10 acres – would be permanently removed along the maintained 50-foot-wide raw water pipeline corridor and at the North WTP. This area would be converted to grassland and kept free of trees. Overall, the permanent loss of 2,216 acres at the reservoir site would represent a slight, long-term impact on the upland deciduous forest resource in Fannin County.

Riparian Woodland/Bottomland Hardwood Forest

Approximately 1,728 acres (434 HUs) of riparian woodland/bottomland hardwood forest would be permanently eliminated or converted to other habitat types by Alternative 1, almost entirely at the site of the dam and reservoir. This habitat would be replaced by the dam and related structures, as well as by the impounded water of the reservoir. Virtually no riparian woodland/bottomland hardwood forest would be eliminated along the raw water pipeline and at the North WTP. Overall, the permanent loss of 1,728 acres of the regionally scarce riparian woodland/bottomland hardwood forest resource would represent a moderate, long-term impact.

Grassland/Old Field

Approximately 4,761 acres (2,896 HUs) of grassland/old field habitat would be permanently eliminated or converted to other habitat types by Alternative 1, mostly at the site of the dam and reservoir. This habitat would be replaced by the dam and related structures and by the impounded water of the reservoir. Virtually no grassland/old field would be permanently eliminated along the raw water pipeline. Grassland within the proposed 70-foot wide temporary easement and 50-foot permanent easement would be restored through re-vegetation upon completion of construction. Up to 300 acres or more of grassland/old field habitat at the WTP site would be developed into the WTP and terminal storage reservoir (TSR). Overall, the permanent loss of 4,761 acres at the reservoir site and several hundred acres

Reservoir Pool

- Expect similar aquatic species found in the instream study to thrive in lake environment
- Expect similar water quality conditions to existing North Texas Lakes
    - Some stratification during hot summer months
- May decrease sediment loading downstream due to reduced hydraulic gradient and current velocities

at the WTP/TSR site would represent a slight, long-term impact on grassland/old field habitat in Fannin County.

Shrubland

Approximately 64 acres of shrubland would be permanently eliminated or converted to other habitat types by Alternative 1, almost entirely at the site of the dam and reservoir. This habitat would be replaced by the dam and related structures (e.g., spillway, electrical substation) and by the impounded water of the reservoir. Overall, the permanent loss of 64 acres at the reservoir site would represent a slight, long-term impact on shrubland in Fannin County.

Aquatic Habitats and Aquatic Biota

The effects of dam and reservoir construction activities under Alternative 1 to 78 acres of open water and associated aquatic life would be both adverse and beneficial. Overall effects of construction and operations under Alternative 1 would likely be long-term (more than 50 to over 100 years) in duration with a high likelihood of occurrence and slight to moderate severity. Impounding Bois d'Arc Creek and converting riparian bottomland hardwood forests and stream habitats to open water, marsh, and mudflats would have both beneficial and adverse indirect effects on aquatic species. The effect of reservoir impoundment on many fish species would likely be beneficial due to the increased acreage of deep open water for foraging and reproducing.

Operation of the proposed reservoir could result in indirect adverse effects to aquatic biota outside of the immediate footprint. Potential adverse effects might occur from an increase in recreation and residential housing along the shoreline of the proposed reservoir. Increases in recreation and residential housing would result in an increase in habitat removal, soil compaction, soil erosion, and surface water runoff, and might facilitate the introduction of invasive species. Depending on how much recreation and development would increase, adverse effects could be small to medium in extent.

Recreational users could trample species habitat and food sources. Recreational users could also increase soil compaction, soil erosion, and surface water runoff. Soil erosion and surface water runoff could degrade nearby water sources, including the proposed reservoir. Recreational users could facilitate the spread of invasive species into the reservoir area because invasive species can travel from one location to another on vehicles, pets, and people. Invasive species could become established, replacing the natural habitat and food source for native wildlife species.

Bois d'Arc Creek experiences rapid rises and falls in response to rainfall events and extended periods of little or no flow, which determines what aquatic species survive in this extreme flow dynamic. During project construction, stream habitat would be inundated and converted to lacustrine (lake-like) habitat. Diversity and relative abundance of aquatic fauna (both vertebrates and invertebrates) within the reaches that would be permanently flooded are expected to change as a result of the creation of a permanent water source with both shallow and deep water lentic (still water) habitat for a variety of aquatic species. Aquatic species more adapted to lacustrine or lentic environments would benefit while those with a preference for stream (lotic or flowing water) habitats would be disadvantaged. The abundance of species that are more generalist or versatile are expected to experience little change.

The reservoir would increase the surface area, depth, and the volume of water of the Bois d'Arc stream system, which in turn would alter the water quality. Current stream velocities would decrease to almost zero throughout most of the reservoir, causing sediment particles to fall from suspension, and water that exhibited low transparency (high turbidity) as a flowing stream carrying a substantial load of suspended sediments could become relatively clear. Because of the proposed reservoir's depth and lack of water movement, the reservoir would be expected to stratify; i.e. to develop distinct warmer layers near the surface and colder layers toward the bottom, during the late spring through fall months. A strong temperature gradient known as a thermocline could develop in the late summer months, which could become a barrier between the lighter, well-oxygenated surface water and colder, oxygen-starved deeper water. Due to this barrier, low dissolved oxygen (DO) levels could occur in the proposed reservoir in deeper water during very hot summer months which could be harmful to some aquatic biota. By October the DO levels would be expected to increase from the summer months and exceed the High Aquatic Life criterion of 5.5 mg/L throughout the reservoir pool.

Effects to the aquatic biota downstream of the dam would be mitigated through periodic, regulated releases of reservoir water to Bois d'Arc Creek below the dam (environmental flow releases). These releases would be performed to compensate for losses of stream function and wildlife habitat, and are expected to enhance instream uses below the dam. The flow regime required in the draft water right permit would maintain flowing water in the creek channel, provide for connectivity between pools, maintain existing aquatic habitat and communities, and protect water quality downstream. The proposed pulse flow regime is expected to provide sufficient flows to benefit and maintain habitat without causing erosion and channel degradation and to meet seasonal criteria for dissolved oxygen concentration (Watters and Kiel, 2016).

Fish

Dam construction and operation under Alternative 1 would cause the loss of riverine habitat and consequently the loss of fish found only in rivers and streams. These effects would be long-term (more than 50 to over 100 years) in duration with a high likelihood of occurrence and slight severity.

Dewatering activities during project construction may impact aquatic resources by stranding finfish and shellfish. Other harmful construction activities can trample, dredge, or fill areas with sessile (immobile) aquatic resources such as attached plants and mussels. To avoid or reduce these potential impacts, TPWD may recommend relocating aquatic life – including but not limited to, fish, turtles, and mussels – to one or more areas of suitable habitat away from the project footprint. Such relocation activities would be approved and carried out under the authority of a TPWD *Permit to Introduce Fish, Shellfish or Aquatic Plants into Public Water*. An Aquatic Resource Relocation Plan (ARRP) is used to plan resource handling activities and to assist in the permitting process with TPWD (Melinchuk, 2015).

After inundation and during the operation phase, the current riverine habitat in the proposed reservoir site would be converted to lacustrine habitat. A Reservoir Clearing Plan has been developed to guide the process of removing vegetation so as to enhance creation of fish habitat by minimizing the clearing of standing trees and shrubs in selected areas within the reservoir. The species composition after inundation is expected to shift towards more pool-associated species, largely composed of sunfish (Centrarchids *spp.*), temperate bass (Moronidae *spp.*), catfish (Ictalurids *spp.*), and suckers (Catostomids *spp.*). The magnitude of this change depends upon impoundment size, position of the impoundment along the stream, stream size, and current species composition. The newly created lacustrine habitat would compensate for some of the loss of fish species that are found only in rivers and streams through the increased numbers of pool-associated fish species.

Current aquatic habitat in the proposed site is degraded because Bois d'Arc Creek has been channelized and stream flows are inconsistent with intermittent periods of no flows; the proposed reservoir and dam would create a more stable lacustrine environment. A study conducted in Illinois found that a creek in which 48 fish species were documented prior to impoundment supported a total of 74 species and two hybrids after inundation (Taylor et al., 2001). The increase in species richness was attributed to introductions of non-native species from other regions and creation of favorable habitat for certain species. Six species from pre-impoundment were not found post-impoundment. Other studies have shown little change in overall fish species richness, substantial reductions in richness, and large shifts in dominant species within assemblages (Appendix M).

The dominant fish in the proposed reservoir are expected to include combinations of longear sunfish, bullhead minnow, freshwater drum, logperch, and orange spotted sunfish. Other fish that are expected to be common in the proposed reservoir include gizzard shad, threadfish shad, bluegill, redear sunfish, channel catfish, white bass, and largemouth bass. Fish species found generally abundant in other Texas reservoirs could also become abundant in the proposed reservoir. Chapter 3 contains information on the fish species that were collected in the Bois d'Arc watershed during four separate studies. To determine if these species would be likely inhabitants of the proposed reservoir, each species' preferred habitat was reviewed. If a species' habitat included a lacustrine environment or the species had previously been found in a reservoir, the species was considered as likely to survive in the proposed reservoir. Thirty-three of the species currently found in the Bois d'Arc watershed were determined to be likely to survive in the proposed reservoir; ten were determine to be unlikely to survive in the proposed reservoir. The results of these studies are shown in Table 4.6-3.

Table 4.6-3. Fish Species Documented in Bois d'Arc Creek and Likelihood of Survival in the Reservoir Environment

Scientific Name	Common Name
Likely to Survive In Reservoir Environment	
Ameiurus melas	Black bullhead
Ameiurus natalis	Yellow bullhead
Aplodinotus grunniens	Freshwater drum
Carpiodes carpio	River carpsucker
Cyprinella lutrensis	Red shiner
Cyprinella venusta	Blacktail shiner
Cyprinus carpio	Common carp
Dorosoma cepedianum	Gizzard shad
Dorosoma petenense	Threadfin shad
Fundulus notatus	Blackstrip topminnow
Gambusia affinis	Western mosquitofish
Ictalurus punctatus	Channel catfish
Ictiobus bubalus	Smallmouth buffalo
Labidesthes sicculus	Brook silverside
Lempois macrochirus	Bluegill
Lempois megalotis	Longear sunfish
Lepisosteus oculatus	Spotted gar
Lepisosteus osseus	Longnose gar
Lepomis gulosus	Warmouth
Lepomis humilis	Orangespotted sunfish
Lepomis microlophus	Redear sunfish
Micropterus punctulatus	Spotted bass
Micropterus salmoides	Largemouth bass
Notemigonus crysoleucas	Golden shiner
Noturus gyrinus	Tadpole madtom
Percina caprodes	Logperch
Percina macrolepida	Bigscale logperch
Pimephales vigilax	Bullhead minnow
Pomoxis nigromaculatus	Black crappie

Scientific Name	Common Name
Pomoxis annularis	White crappie
Pylodictis olivaris	Flathead catfish
Notropis amabilis	Texas shiner
Lepomis cyanellus	Green sunfish
Not Likely to Survive in Reservoir Environment	
Campostoma anomalum	Central stoneroller
Lythrurus fumeus	Ribbon shiner
Moxostoma erythrurum	Golden redhorse
Notropis atrocaudalis	Blackspot shiner
Notropis stramineus	Sand shiner
Noturus nocturnus	Freckled madtom
Percina sciera	Dusky darter
Phenacobius mirabilis	Suckermouth minnow
Percina phoxocephala	Slenderhead darter
Etheostoma gracile	Slough darter
Unknown if Likely to Survive in Reservoir Environment	
Cyprinella hybrid	*
Lepomis hybrid	*

Sources: Freese and Nichols, 2010a; Texas A&M, no-date

*Data and reports do not identify which species of fish contribute to the hybrid family classification

Because of the changed flow rate downstream, vegetation along downstream stream banks is anticipated to be denser than what is currently there, reducing the amount of erosion. Release criteria in the prescribed environmental flows would maintain the existing geomorphic features and remove accumulated fine sediments from those features while reducing the potential for additional erosion or downcutting below the reservoir. In general, changes in flow regime downstream of reservoirs can negatively affect fish species with narrow habitat requirements. These species use temperature or flow for reproductive cues, are substrate-specific spawners, and depend on higher flows for egg dispersal. Additional adverse effects may include nutrient limitation, water temperature changes, and loss of stream connectivity. Indirect effects from reduction in habitat diversity could result from predation and altered community structure. However, given that the majority of fish species documented from Bois d'Arc Creek are habitat generalists, little adverse effect is expected on downstream fish community and biodiversity provided there is water flowing in the creek (Watters and Kiel, 2016).

During long-term operations at the LBCR, it is expected that fish populations would be managed in the reservoir by an entity other than NTMWD for the benefit of a sports fishery. Aquatic life downstream of the dam would be managed by means of the proposed water releases and instream flow regime. These measures have been approved by TCEQ in the form of special conditions to the water right permit (Appendix F). Downstream of the reservoir, likely effects of Alternative 1 on aquatic life would be largely beneficial, due to the ability of water managers to control flows throughout the year, thereby avoiding excessively erosive discharges during storm events as well as periods of little and no flow later in the season, both of which tend to be harmful to aquatic species and habitat. Pulse flows throughout the year may assist certain species that require those cues for spawning, reproduction, and movement.

Benthic Macroinvertebrates

Impacts under Alternative 1 to benthic macroinvertebrates are expected to be long-term (more than 50 to over 100 years) in duration with a high likelihood of occurrence and slight severity. Slight adverse effects to invertebrates would occur due to construction and inundation of the proposed dam and reservoir. Invertebrates occupy habitats with both still and running waters, including slow-moving muddy rivers. Most invertebrates spend most of their life cycle attached to submerged rocks, logs, and vegetation. In a stream environment, invertebrate habitat includes the rocks and sediments of the stream bottom, the plants in and around the stream, leaf litter and other decomposing organic material that falls into the stream, and submerged logs, sticks, and woody debris. These organisms rely on these areas for shelter, food, and dissolved oxygen (USEPA, 2009). The aquatic habitat available for invertebrates would be changed in the proposed reservoir pool from a riverine habitat to a lacustrine habitat. In general, invertebrates of streams are adapted to these environments. Organisms that inhabit reservoirs do not usually require highly oxygenated waters. The reservoir habitat created could support a productive invertebrate community, although the overall species diversity of macroinvertebrates would likely decrease (Young et al., 1976).

Adverse effects to invertebrates as a whole are expected, though adverse effects to mussel species from the proposed reservoir and dam are not expected to occur. Table 3.4-5 in Chapter 3 of this EIS lists mussel species found in the proposed reservoir site. Since many of these species occur in lacustrine environments, they are expected to adapt to life in the proposed reservoir.

Because the raw water pipeline route crosses mostly upland habitat and open farmland and completely avoids valuable habitats such as forested wetlands, impacts to aquatic species are mostly indirect, and potentially include water quality degradation from soil compaction, soil erosion, and surface water runoff. There would be minimal direct, temporary impacts to waters and wetlands, and a SWPPP would be developed to address soil erosion and surface water runoff. Due to the size, nature, and location of the proposed pipeline construction, any effects to aquatic species would be adverse, negligible to slight in severity, short-term, small in extent, probable, and slight in precedence and uniqueness.

Increased recreational use of the proposed reservoir area could facilitate and spread invasive species as well as increase soil compaction, soil erosion, and surface water runoff. Boat propellers, bilges, and livewell tanks could introduce invasive species from one water body to another, both into the Lower Bois d'Arc Creek Reservoir from other lakes and from this reservoir to other lakes. Stocking fish for recreation could introduce non-native predators or parasites into the aquatic environment. Soil compaction, soil erosion, and surface water runoff could degrade the water quality of the reservoir, adversely affecting aquatic life. Impacts from operation of the reservoir would be adverse, slight to moderate in severity, long-term, medium in extent, and probable.

Downstream of the proposed reservoir, existing macroinvertebrate communities should not change greatly, as long as adequate flows are maintained, which is likely to be the case as this will be required by permit.

Terrestrial (Upland) Habitat and Wildlife Species

Adverse effects from the proposed dam and reservoir construction and operation on wildlife are of high likelihood, and would be expected to be moderate in severity and short-term and long-term in duration. During construction, terrestrial habitats at the dam site and within the cleared areas would be removed and replaced by largely open water lacustrine habitat with perhaps some emergent marsh and other shallow waters at the upper end of the reservoir. Generally, according to the HEP evaluation, the habitat quality (HSI) is the highest for cropland, tree savanna, and shrublands. Riparian woodland/bottomland hardwood habitat is of relatively low quality, with a habitat suitability index of 0.25. Though tree savannas in the proposed site have the highest HSI value of 0.73, there are only 132 acres of tree savannas in the proposed 17,068 acre reservoir site. Shrublands have an HSI of 0.57 and make up 63 acres of the 17,068 acre site. Though croplands have an HSI value of 0.72 and 1,757 acres of the site are croplands, those vertebrates that use croplands (primarily birds and mammals) rely on croplands primarily for food sources.

While some direct mortality to birds, small mammals, reptiles and amphibians may occur during construction (inadvertent destruction of dens, nests, hiding organisms, etc. by heavy equipment,) most terrestrial wildlife within the project site would be displaced and would relocate to adjacent and nearby areas. These nearby areas may already be occupied territories by members of the same species or related species with similar habitat or food requirements and thus would be incapable of supporting a higher population density. In that case, further displacement or mortality of wildlife would occur. Because of the loss of habitat, effects on wildlife would be moderate in severity. Construction of the reservoir would also result in the creation of habitat for migratory waterfowl, shorebirds, and wading birds that to some extent would offset habitat losses for other types of wildlife.

The greatest short-term and long-term adverse effects, both direct (mortality) and indirect (habitat loss) would occur to reptiles, amphibians, and small mammals, which have smaller territories or home ranges that would be completely eliminated. However, these population declines would be insignificant in the context of county-wide and regional populations of these organisms.

Impounding Bois d'Arc Creek and converting riparian bottomland hardwood forests and stream habitats to open water, marsh, and mudflats would have both beneficial and adverse indirect effects on migratory birds. The effect on migratory waterfowl (ducks, geese, swans) would likely be somewhat beneficial due to their ability to take advantage of open water for foraging, loafing and resting. The effect on shorebirds is likely to be neutral or mixed, but the net effect would probably be positive due to an increase in shallow flooded areas and mudflats, especially at the upstream end of the reservoir. The indirect effect on neotropical migratory, forest-dependent songbirds such as warblers and vireos and grassland-dependent birds like the dickcissel would be negative due to the disappearance of their habitats from the site.

Construction of the reservoir, dam, and access roads would result in a small amount of localized habitat fragmentation. Habitat fragmentation is defined as "an ecological process in which a large patch of habitat is divided into smaller patches of habitats", and it is considered a growing threat to species existence (Al-jabber, 2003). Habitat fragmentation can isolate wildlife populations, decreasing population productivity. Construction of the roads, the dam and associated water transmission facilities could create wildlife barriers and alter migration patterns and species dispersal. Effects of habitat fragmentation from road construction and reservoir inundation would be long-term and adverse but of slight severity. The project area and surroundings are already quite fragmented, as reflected by the variety and configuration of existing habitat types.

Threatened and Endangered Species

Due to the lack of habitat and lack of occurrence records of federal listed threatened and endangered species, adverse effects to federally listed threatened and endangered species are not expected to occur as a result of construction and operation of the proposed dam and reservoir. Section 7 of the ESA requires federal agencies to consult with the USFWS to ensure that actions they authorize, fund, or carry out will not "jeopardize" listed species. The USFWS Species by County list for Fannin County (USFWS, 2013) includes three species – the bald eagle (delisted and in recovery), the interior least tern (endangered) and the black bear (similarity of appearance with the Louisiana black bear subspecies, which is threatened) as known or believe to occur in Fannin County. However, bald eagles have been delisted and the project area contains no nesting sites and limited foraging habitat for interior least terns, and while potential habitat for black bears does occur within the reservoir footprint; none have ever been documented on-site.

No direct adverse impacts to the interior least tern would be anticipated. The project site lacks suitable nesting habitat and foraging habitat during nesting season is generally confined to within two to four miles of the nest site.

No direct adverse impacts to the black bear would be anticipated from the proposed of the dam and reservoir. While potential habitat is present for the black bear, only one siting has occurred in Fannin County, in 1977. Also, the preferred habitat of the black bear consists of expansive forests with escape cover and minimal human disturbance. Though there is little developed land in the project area, agricultural fields are a large part of the proposed site.

In sum, since the federally listed species for Fannin County are unlikely to be found on site or in adjacent areas, indirect impacts are not anticipated.

The TPWD county list website (TPWD, 2014) identifies 20 state threatened and endangered animal species (nine birds, two mammals, five fish, three reptiles, and one insect) as potentially occurring in Fannin County, Texas. While the majority of the species on the TPWD list do not have suitable habitat on the proposed site, three fish (blackside darter, blue sucker, and creek chubsucker), four mussels (Louisiana pigtoe, sandbank pocketbook, Texas heelsplitter, and Texas pigtoe), and one reptile (timber/canebrake rattlesnake) all do. To date, the American burying beetle has not been documented within the proposed reservoir and dam site, or anywhere else in Fannin County, and adverse effects are not anticipated. It is unlikely that the beetle occurs on the proposed dam and reservoir site.

Adverse impacts are possible to the three Texas state-threatened fish species, the four mussel species, and the timber/canebrake rattlesnake due to the construction and inundation of the proposed dam and reservoir. Though possible habitat of these species exists within the proposed reservoir site, none of the fish species was observed during four separate fish collection surveys within the Bois d'Arc Watershed. It is unlikely that any of these fish species currently inhabits this area. However, four state-threatened mussel species were not specifically targeted in surveys and could be present. Potential adverse effects to all these state-listed species would be of low to medium likelihood, slight to moderate severity, and long-term duration.

Invasive Species

As noted above, the spread of invasive plant species is often facilitated by disturbing soils. Most of the potential impacts associated with invasive terrestrial plant species would be initiated during the construction phase and some of these invasions and encroachments would be perpetuated during the long-term operation phase of Alternative 1.

With lake-based recreation underway, recreational users could also facilitate spread of invasive species into the reservoir area, both aquatic and terrestrial portions, because invasive species can travel or "hitchhike" from one location to another via vehicles, boats, boots, pets, and people.

Invasive species – both plants and animals – can harm native flora and fauna in a number of ways, such as by preying on them, out-competing them for food and other resources (e.g., sunlight and space in water bodies), preventing them from reproducing, changing food webs, and modifying ecosystem conditions.

Overall, the effects of invasive species on the project area under Alternative 1 are anticipated to be long-term, of medium likelihood, and slight to moderate in severity.

4.6.3 Alternative 2

Impacts Associated with Project Phases

Construction Phase

Clearing of wetland vegetation for the dam, reservoir, and associated structures under Alternative 2 would be similar to Alternative 1, though on a somewhat smaller scale due to the downsized dimensions of the reservoir footprint. The downsized LBCR impacts 790 acres for construction of the dam, spillway and pump station. The effects of construction of the downsized dam would be long-term (more than 50 to over 100 years), high in likelihood and of moderate severity. Subject to the provisions of the Section 404 permit, revised Texas water right permit and Section 401 water quality certification, selected trees and shrubs would be cleared from the downsized LBCR footprint prior to impoundment of water behind the dam. Standing woody material, including dead and living trees and shrubs five feet or more in height, as well as fallen trees five feet or more in length with a diameter of six inches or greater, would be cleared and removed. NTMWD prepared first a preliminary Reservoir Clearing Plan and then a Conceptual Clearing Plan to guide the reservoir footprint clearing process. Under Alternative 2, the objectives of these plans would remain the same: to enhance creation of fish habitat by minimizing the clearing of standing trees and shrubs in selected areas within the reservoir; to improve human access to shore locations by creating shore access locations for boat ramps and bank fishing through selective clearing of trees and shrubs; to reduce hazards to boating safety and fishing resulting from large floating debris by minimizing the source of such debris; and to create aesthetic views of the reservoir along selected segments of the shoreline.

Both hand and machine clearing would be used in Alternative 2. The preferred method is mechanical clearing by shear-blading during the dry season. Under this method, the cleared material would be deposited in windrows or piles and left to dry and eventually burned as fire danger conditions allow. Machine clearing has the advantage of shearing stumps off at ground level, along with all other vegetation, and minimizes the amount of woody and organic debris remaining on site and entering the water after reservoir flooding. It may also be necessary to utilize hand clearing where it is not possible to operate mechanical clearing equipment due to site location or conditions. Clearing would occur to allow the establishment of access and safe landing sites along the reservoir shoreline to facilitate eventual lake-based recreational development. Consideration would be given to both wood salvage and environmentally sensitive areas that may require specific treatment during clearing operations. Flagging or marking of clearing boundaries and on-site supervision would be carried out for the successful implementation of all aspects of reservoir clearing.

Operations Phase

The downsized LBCR would inundate 8,600 acres. The effects of operation of the downsized dam and reservoir on wetland vegetation would be long-term (more than 50 to over 100 years), high in likelihood, and moderate in severity. Trees and shrubs that were not cleared from the reservoir footprint would eventually drown and die, gradually decomposing underwater but contributing to underwater habitat structure for a number of years. After impoundment, large woody debris would continue to be removed as necessary for the safe operation of boat ramps, swimming areas, water intake structures, and spillways (NTMWD, 2015b).

Under Alternative 2, as in Alternative 1, year-to-year and seasonal operation of the reservoir would be governed by an operation plan which would be similar to that already drafted for Alternative 1 (NTMWD, 2015b). In general, Alternative 2 would impound up to 135,200 AF of water and produce an estimated firm yield of 86,100 AFY, an average of 108 million gallons per day (mgd). The conservation pool, or normal water surface, of the reservoir would be maintained at an elevation of 515.0 feet MSL, though actual water surface and shoreline would fluctuate above and below this level. In a typical year, the reservoir would be fullest in May and June and would drop during the drier months of late summer due to less precipitation and in-flow and more surface evaporation, with the lowest elevations typically occurring in September and October. However, the water levels would also fluctuate during extended periods of dry conditions versus wet conditions. The reduced diversions from the downsized reservoir would result in an average downstream flow of approximately 34,500 AFY of additional water past the LBCR impoundment compared to Alternative 1. Much of this aggregate volume would be during high, ephemeral flows associated with storm events rather than during longer base flow periods. During base flow periods, as in the case of Alternative 1, environmental flows from the downsized reservoir would probably provide for limited instream habitat.

Downstream impacts from the downsized LBCR would be similar to the full-scale project because of the need to meet TCEQ's water right permit instream flow requirements. Please see the discussion under "Downstream Impact Analysis" in Section 4.6.2.3. Because the smaller LBCR would have 37 percent of the storage capacity of Alternative 1, it would have less ability to detain high inflows from storm events, and more of these high-flow events would spill and be passed to downstream habitats. Thus, this downsized alternative would have a less pronounced effect on moderating the severity and frequency of overbanking and erosive downstream flows and floods.

As with Alternative 1, with Alternative 2 the LBCR would provide lake-based recreational opportunities, such as boating, fishing, water-skiing, swimming, and other water sports. NTMWD would collaborate with county and state authorities to facilitate development of recreation infrastructure (e.g., docks, marinas, beaches, campgrounds, access roads, utilities) at the downsized LBCR.

Habitat

In general those wetland habitats impacted the most by Alternative 2 would be forested wetland and emergent wetland, with 2,909 acres (2,502 FCUs) and 684 acres (237 HUs) of impacts, respectively. Implementation of Alternative 2 would include installation of a dam and associated facilities located at the same site as Alternative 1 (the proposed full-scale LBCR project). The dam and spillways under Alternative 2 would have almost the same footprint as the infrastructure for the full-sized LBCR. The downsized dam would be lower in height compared to Alternative 1 which would result in a smaller reservoir.

Incidental areas between the dam and the conservation pool (515 feet MSL) are expected to be disturbed during construction and are included in the limits of construction. Based on these assumptions, the limit of construction of the smaller LBCR is estimated at 9,390 acres (Kiel, 2016b), which is slightly more than half that of the full-sized LBCR (Alternative 1). A map of vegetation cover types within the downsized reservoir footprint may be found in Figure 3.4-4. The service spillway and outlet works for Alternative 2 would be slightly smaller versions of those proposed for Alternative 1. The potential impact to wetlands of the downsized Alternative 2 is estimated at approximately 3,620 acres; this includes impacts to forested wetlands, scrub shrub wetlands, and emergent wetlands (Table 4.6-4). Most of the wetlands and forested wetlands occur at the lowest elevations, which lie along the river banks, and these areas would be impacted first as the lake fills. All of these impacts are associated with the reservoir and dam; there are no wetland impacts associated with the other project components (raw water pipelines and WTP).

Table 4.6-4. Habitat Impacts Associated With Alternative 2

Cover Type	Area (acres)	Habitat Units	Functional Capacity Units
Forested Wetland	2,909	--	2,502
Scrub Shrub Wetland	27	12	--
Emergent Wetland	684	287	--
Open Water	78	--	--
Total	3,620	299	2,502

Note: Forested wetlands were assessed using the Modified East TX HGM Methodology. All other cover types were assessed using the USFWS's HEP Procedures.

Wetlands

Under Alternative 2, overall effects to the wetland vegetation communities of the affected environment during construction and operations would likely be long-term more than 50 to over 100 years) in duration with a high likelihood of occurrence and moderate severity. More information on the specific vegetation communities is provided below.

Forested Wetlands

Construction of the dam and associated infrastructure under Alternative 2 would impact 2,909 acres (2,502 FCUs) of forested wetlands. All of the impacts on vegetation from dam construction discussed in Section 4.6.2.1 for Alternative 1 would also occur with the downsized LBCR, to approximately half the extent. Overall, effects of construction and operations on forested wetlands would be short-term and long-term in duration with a moderate likelihood of occurrence and moderate severity. Most of the forested wetlands occur at the lowest elevations along the river banks, and would be impacted first as the lake fills; therefore, because the majority of the forested wetlands is already dominated by facultative and facultative upland species, the forested wetlands not cleared mechanically for the project and that would be subject to inundation would not be expected to survive.

The operational phase of a reduced dam structure would result in a smaller reservoir with a normal pool elevation of 515 feet MSL. See Section 4.6.2.1 for a more detailed discussion of effects related to operations. After reservoir impoundment, large woody debris would continue to be removed as necessary for the safe operation of boat ramps, swimming areas, water intake structures, and spillways (NTMWD, 2015b). As with Alternative 1, indirect adverse effects to vegetation outside of the immediate project footprint as a result of potential adverse effects brought about by an increase in recreation and residential housing along the shoreline of the proposed reservoir would be expected.

Emergent Wetlands

Overall, effects of construction and operations on emergent wetlands would be short-term and long-term in duration with a moderate likelihood of occurrence and moderate severity. Construction of the dam and impoundment of water under Alternative 2 within the normal pool elevation of 515 feet MSL would result in the removal of 684 acres (287 HUs) of emergent wetland vegetation by direct fill impact or inundation of waters. However, during the operational phase, as in Alternative 1, emergent wetlands are expected to develop after inundation along the lake edges.

Scrub Shrub Wetlands

Overall, effects of construction and operations on scrub shrub wetlands would be short-term and long-term in duration with a moderate likelihood of occurrence and moderate severity. Construction of the dam and impoundment of water under Alternative 2 within the normal pool elevation of 515 feet MSL would result in the removal of 27 acres (12 HUs) of scrub shrub wetland vegetation by direct fill impact or inundation. Clearing of habitat for the dam and associated structures would directly remove some scrub shrub habitat. Most of the scrub shrub wetlands occur at the lowest elevations along the river banks, and would be impacted first as the lake fills; therefore, the scrub shrub wetlands not cleared for the project and that would be subject to inundation would not be expected to survive.

Upland Habitats

Upland Deciduous Forest

Approximately 999 acres (423 HUs) of upland deciduous forest would be permanently eliminated or converted to other habitat types by Alternative 2, at the site of the dam and reservoir (Table 4.6-5). This habitat would be replaced by the dam and related structures (e.g., spillway, electrical substation) and by the impounded water of the reservoir. A much smaller area of upland deciduous forest or woodland patches – about 10 acres – would be permanently removed along the maintained 50-foot-wide raw water pipeline corridor from the LBCR to the North WTP and at the WTP itself. This area would be converted to grassland and kept free of trees. Loss of upland deciduous forest along the eight miles of new pipeline corridor carrying raw water from Lake Texoma for blending is expected to be none to slight, as the new pipeline will parallel an existing pipeline. Overall, the permanent loss of 999 acres at the reservoir site would represent a slight, long-term impact on the upland deciduous forest resource in Fannin County.

Riparian Woodland/Bottomland Hardwood Forest

Approximately 714 acres (179 HUs) of riparian woodland/bottomland hardwood forest would be permanently eliminated or converted to other habitat types by Alternative 2, almost entirely at the site of the dam and reservoir (Table 4.6-5). This habitat would be replaced by the dam and related structures, as well as by the impounded water of the reservoir. Virtually no riparian woodland/bottomland hardwood forest would be eliminated along the raw water pipeline carrying water from blending from Lake Texoma, or along the raw water pipeline from the downsized LBCR to the North WTP. Overall, the permanent loss of 714 acres of the regionally scarce riparian woodland/bottomland hardwood forest resource would represent a moderate, long-term impact.

Grassland/Old Field

Approximately 2,270 acres (1,348 HUs) of grassland/old field habitat would be permanently eliminated or converted to other habitat types by Alternative 2, mostly at the site of the dam and reservoir (Table 4.6-5). This habitat would be replaced by the dam and related structures and by the impounded water of the reservoir. Virtually no grassland/old field would be permanently eliminated along either of the raw water pipelines (from Lake Texoma and from LBCR to the North WTP). In both cases, grassland within the proposed 70-foot wide temporary easement and 50-foot permanent easement would be restored through re-vegetation upon completion of construction. Up to 300 acres or more of grassland/old field habitat at the WTP site would be developed into the WTP and terminal storage reservoir (TSR). Overall, the permanent loss of 2,270 acres at the reservoir site and several hundred acres at the WTP/TSR site would represent a slight, long-term impact on grassland/old field habitat in Fannin County.

Shrubland

Approximately 16 acres of shrubland would be permanently eliminated or converted to other habitat types by Alternative 2, almost entirely at the site of the dam and reservoir (Table 4.6-5). This habitat would be replaced by the dam and related structures (e.g., spillway, electrical substation) and by the impounded water of the reservoir. Overall, the permanent loss of 16 acres at the reservoir site would represent a slight, long-term impact on shrubland in Fannin County.

Table 4.6-5. Upland Habitat Impacts at Reservoir Site from Alternative 2

Type of Habitat	Area (acres)	Habitat Units
Upland Deciduous Forest	999	423
Riparian Woodland /Bottomland Hardwood	714	179
Grassland / Old Field	2,270	1,348
Shrubland (acres)	16	--

Aquatic Habitats and Aquatic Biota

Overall, effects of construction and operations on open water habitats and biota would be long-term with a moderate likelihood of occurrence and slight to moderate severity. The effects of constructing the smaller dam and reservoir on aquatic life would be both adverse and beneficial.

Within the smaller reservoir site there are 27 acres of scrub shrub wetland, 684 acres of emergent/ herbaceous wetland, 115 acres of riverine habitat, 16 acres of lacustrine habitat, and 2,909 acres of forested wetland which would all be eliminated and/or altered by a downsized alternative, with a larger share converted to the open water, variable-depth aquatic habitat of a reservoir/lake, and a smaller share buried beneath the dam structure. Approximately 325,000 linear feet of stream length along Bois d'Arc creek and its tributaries would be modified and converted from lotic to lentic conditions, or buried under the dam structure.

The ecological phenomena, processes, and conditions that would occur as a result of the downsized LBCR would be essentially the same as with Alternative 1, but on a smaller scale. In general, diversity and relative abundance of aquatic fauna (both vertebrates and invertebrates) within the reaches that would be permanently inundated are expected to change as a result of the reservoir, which would provide a permanent water source and create both shallow and deep water lentic habitat for a variety of aquatic species. Aquatic species more adapted to lacustrine or lentic environments would benefit while those with a preference for stream habitats would be disadvantaged. The relative abundance of other species that are more generalist or versatile may be little changed. See Section 4.6.2.3 for a more in-depth discussion of these impacts.

While the full-scale Alternative 1 and the downsized Alternative 2 differ primarily in size and scale, there may be one qualitative difference in their operation and functioning that could have implications for the type and quality of habitat that develops around the lake fringe. A smaller reservoir may be subject to greater water level fluctuations and partial drawdown, especially during periods of prolonged drought, than the full-scale reservoir. This is a consequence of the higher priority both of meeting NTMWD's higher water demands during drought conditions and of adhering to stipulated water releases to maintain instream flow requirements and aquatic habitat downstream of the dam, per conditions of NTMWD's water rights permit from TCEQ, than of maintaining a constant water level within the reservoir. If these more frequent fluctuations do occur, the lake edge may offer less stable conditions under which wetland habitat (e.g., emergent herbaceous vegetation) could develop and thrive. The smaller reservoir may be ringed more often by a less productive or sterile zone of dried mudflats that offer little habitat value for aquatic biota.

Fish

Dewatering activities during project construction may impact aquatic resources by stranding finfish and shellfish. Other harmful construction activities can trample, dredge, or fill areas with sessile (immobile) aquatic resources such as attached plants and mussels.

It is not possible to predict whether fish species diversity within the reservoir would be greater or less than the number of species currently inhabiting Bois d'Arc Creek within the reservoir footprint. Adverse impacts would be less than significant. Downstream of the reservoir, likely effects of Alternative 2on aquatic life would be largely beneficial, although not as beneficial as with Alternative 1, due to the ability of water managers to control flows throughout the year (although with less ability to manipulate downstream flows than with Alternative 1), thereby avoiding excessively erosive discharges during storm events as well as periods of little and no flow later in the season, both of which tend to be harmful to aquatic species and habitat. Pulse flows throughout the year may assist certain species that require those cues for spawning, reproduction, and movement within the creek.

After inundation, the current riverine habitat in the smaller reservoir site would be converted to lacustrine habitat. As with Alternative 1, the species composition after inundation would likely shift towards more pool-associated species, largely composed of sunfish (Centrarchids), temperate bass (Moronidae), catfish (Ictalurids), and suckers (Catostomids). Fish species that are found only in rivers and streams would tend to disappear, but the newly created lacustrine habitat and corresponding increase in pool-associated species would compensate for some of these losses. The loss of riverine habitat and fish found only in rivers and streams would be long-term, slight in severity, and medium in extent. See the discussion under "Fish" in Section 4.6.2.3, for a more detailed consideration of the expected shifts in fish abundance and diversity.

Benthic Macroinvertebrates

Under the downsized Alternative 2, short-term and long-term adverse effects to invertebrates would occur due to construction and inundation of the smaller dam and reservoir. These impacts would be similar in type to those of Alternative 1 (see Section 4.6.2.3), but smaller in extent. No direct effects and slight indirect effects on aquatic life would be expected at the site of the proposed water treatment plant, terminal storage reservoir, and related facilities because they are located entirely on upland habitat, completely avoiding open waters and wetlands. FM 1396 construction would occur primarily on upland sites and construction of the new bridge over the reservoir would occur prior to impoundment, therefore most direct effects on aquatic biota would be avoided. However, a small amount (under one-half acre) of jurisdictional waters appears to be present along the proposed alignment and would likely require fill or some other disturbance to construct the road, which could potentially result in a negligible impact on localized aquatic biota. Indirect effects from erosion would be mitigated by implementing a SWPPP and Construction General Permit.

Terrestrial (Upland) Habitat and Wildlife Species

The types of impacts of Alternative 2 on terrestrial wildlife habitat and wildlife species would essentially be the same as for Alternative 1, though not as severe because they would occur on approximately half the scale or less. See Section 4.6.2.4 for more detailed discussion. Overall impacts of Alternative 2 would be long-term, of medium likelihood, and moderate severity.

Threatened and Endangered Species

The types of impacts of Alternative 2 on threatened and endangered species would essentially be the same as for Alternative 1, though not as severe because habitat disturbance and loss would occur on roughly half the scale as with Alternative 1. See Section 4.6.2.5 for more detailed discussion of potential effects on threatened and endangered species. No effects from Alternative 2 would be expected on federally-listed species, but effects on one or more state-listed aquatic species are possible. Overall impacts of Alternative 2 on threatened and endangered species would be long-term, of low to medium likelihood, and slight to moderate severity.

Invasive Species

The kinds of impacts of Alternative 2 related to invasive species would be very similar to those for Alternative 1. See Section 4.6.2.6.

As in the case of Alternative 1, lake-based recreation associated with Alternative 2 could facilitate spread of invasive species into the reservoir area, both aquatic and terrestrial portions, because invasive species can travel ("hitchhike") from one location to another via vehicles, boats, boots, pets, and people.

Invasive plant and animal species can cause harm to native flora and fauna in a number of ways, such as by preying on them, out-competing them for food and other crucial resources, preventing them from reproducing, changing food webs, and modifying ecosystem conditions.

Overall, the effects of invasive species on the project area under Alternative 2 are expected to be long-term, of medium likelihood, and slight to moderate in severity.

4.6.4 Mitigation

4.6.4.1 Project Area

A mitigation plan was developed to offset impacts to waters of the United States, which includes wetlands, as a result of the construction and inundation of the LBCR project. The complete mitigation plan can be found in Appendix C. The plan was developed in accordance with the applicable federal statutory and regulatory requirements, particularly, Regulatory Guidance Letter 02-2, "Guidance on Compensatory Mitigation Projects for Aquatic Resource Impacts under the Corps Regulatory Program Pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899" and the "Aquatic Resource Mitigation and Monitoring Guidelines" (USACE, 2004).

As proposed, the LBCR project encompasses approximately 20,732 acres of land (excluding proposed mitigation acres); of which 19,872 acres lie within the Bois d'Arc Creek watershed. For purposes of the mitigation plan, the scope of the LBCR project consists of:

- 19,768 acres, which includes 16,641 acres for the reservoir (conservation pool elevation 534 feet MSL), 2,700 acres of storage lands (between 534 and 541 feet MSL) and 427 acres for the dam and spillways;
- 860 acres associated with the proposed raw water pipeline, water treatment plant, terminal storage reservoir, and rail spur; and
- 104 acres associated with the relocation of FM 1396 outside of the reservoir footprint

Mitigation Objectives

The plan objective is to mitigate for unavoidable adverse impacts to a mix of habitats such as uplands and waters of the United States, including wetlands, in the project area. Compensatory mitigation would be provided for forested wetlands, emergent wetlands, scrub shrub wetlands, open water, and streams that would be permanently impacted as a result of constructing the proposed LBCR. This mitigation would be achieved through wetland restoration and enhancement as well as stream restoration and enhancement at the nearby Riverby Ranch and Upper Bois d'Arc Creek (BDC) Mitigation Site.

Riverby Ranch is a historic active Ranch site with cattle farming activities. As a result of Riverby Ranch being converted to a mitigation site, the cattle would be removed and the land would no longer support cattle farming. The Upper BDC Mitigation site is located along Bois d'Arc Creek upstream of the proposed reservoir site and was selected to avoid fragmentation of the proposed mitigation. The creation of the reservoir would offset impacts to open waters and some of the stream impacts, and it would provide the means for creating emergent wetlands in shallow areas around the lake (littoral wetlands). The development of the reservoir also would enhance Bois d'Arc Creek through reductions in the frequency of destructive high flow events and the passage of sustainable environmental flows to enhance and maintain existing downstream habitats. Specific plan objectives are to mitigate for impacts to:

- 4,035 FCUs of forested wetlands
- 514 HUs of emergent wetlands
- 23 HUs of scrub shrub wetlands
- 78 acres of open water
- 192,377 SQUs of streams

The impacts to 49 acres (23 HUs) of scrub shrub wetland at the reservoir site would be mitigated by restoring 150 acres (103.5 HUs) of scrub shrub wetlands habitat at the Riverby Ranch mitigation site, resulting in a mitigation surplus of 80.5 HU for this habitat type. In addition to restoring 150 acres of scrub shrub wetlands, NTMWD proposes to preserve 98 acres of existing scrub shrub wetlands at Riverby Ranch for a total scrub shrub mitigation area of 248 acres.

Mitigation would occur in three main areas: 1) On-site mitigation at the proposed reservoir site; 2) near-site mitigation on the nearly 15,000-acre Riverby Ranch; and 3) near- site mitigation on the 1,900-acre Upper Bois d'Arc Creek Mitigation Site (Figure 4.6-1). Important points to note are that most of the proposed aquatic and terrestrial mitigation would occur on the Riverby Ranch, a single, nearly 15,000-acre tract of land located downstream of the proposed reservoir site and partially within the Bois d'Arc Creek watershed (the remainder is located within the Red River Basin). The remaining terrestrial mitigation area is located adjacent to the project site. The reservoir site, Riverby Ranch, and Upper BDC Mitigation sites are proximal to each other and to lands enrolled in the Pintail Farms Wetlands Reserve Program (WRP) area and the nearby Caddo National Grasslands.

The proposed mitigation areas would contribute to conservation of contiguous lands within the Bois d'Arc Creek watershed and support the USACE's preference to mitigate for projects using a watershed or ecosystem approach. With implementation of the proposed mitigation plan, approximately 50,170 acres of aquatic and terrestrial habitat along an approximately 42-mile long corridor adjacent to and connected by Bois d'Arc Creek would be protected in perpetuity.

Impacts and Mitigation

The Habitat Evaluation Procedure (HEP) methodology was used to evaluate emergent, scrub shrub, and terrestrial resources that could be impacted following construction of the proposed reservoir and its related components. Impacts for emergent and scrub shrub wetlands were measured using Habitat Units (HU), a metric specific to the HEP methodology, however, HU mitigation credits were only used for the proposed emergent wetland mitigation. It was agreed on by the inter-agency assessment team that scrub shrub wetland mitigation be measured in acres because there is limited opportunity to improve the habitat value of the existing scrub shrub wetlands at the proposed mitigation sites. The Modified East Texas Hydrogeomorphic Method (HGM) was used to assess the functions of forested wetlands. The proposed impacts and mitigation credits for forested wetlands were measured using Functional Capacity Units (FCUs). The Rapid Geomorphic Assessment (RGA) tool was used to assess stream quality. Stream impacts and mitigation credits were measured using RGA Stream Quality Units (SQUs). A summary of potential net impacts to resources and proposed compensatory mitigation to offset those impacts is shown in Tables 4.6-6, 4.6-7 and 4.6-8.

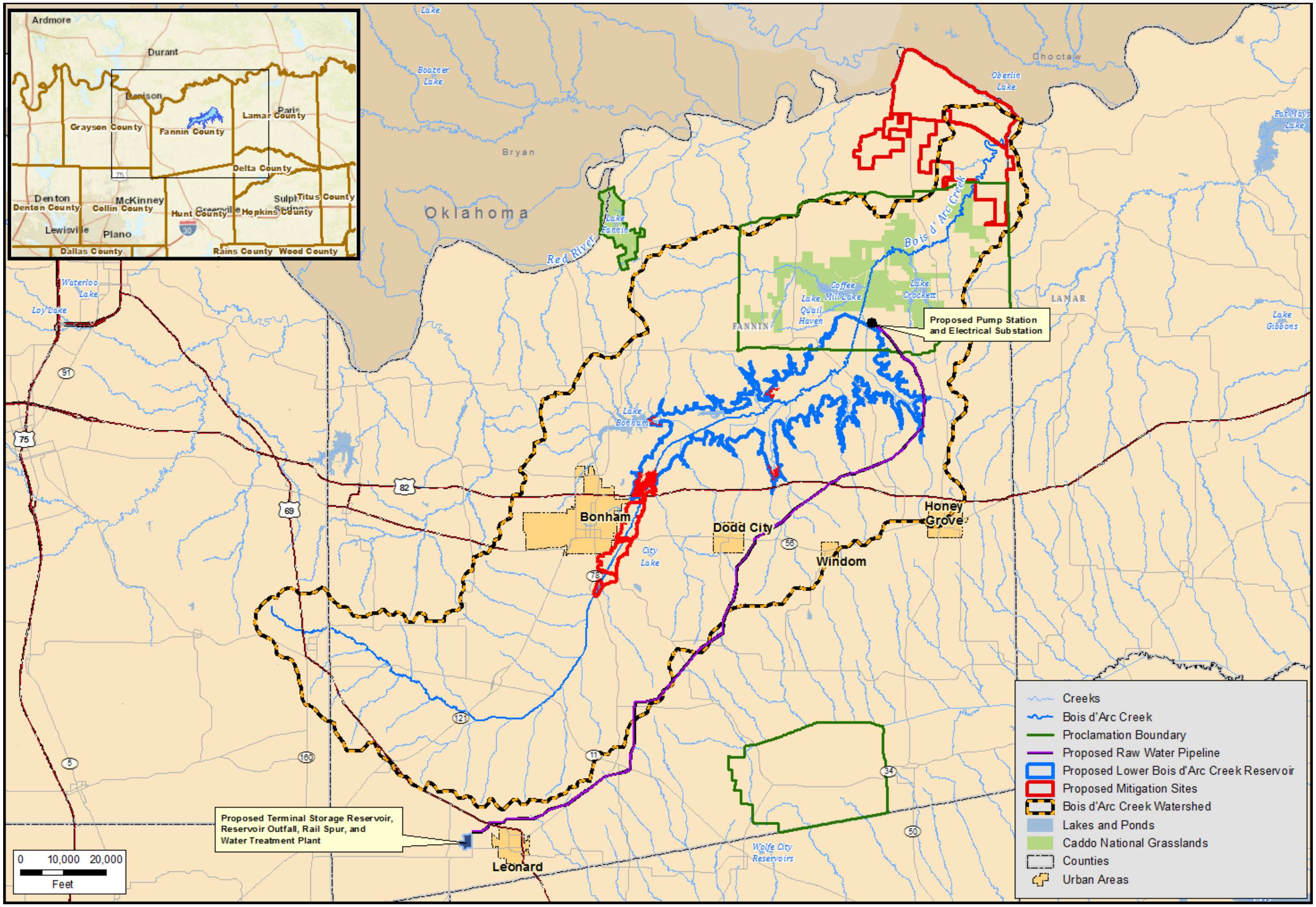


Figure 4.6-1. Location of Project Mitigation Sites at the Proposed Reservoir, at Riverby Ranch and at the Upper Bois d'Arc Creek Mitigation Site

Table 4.6-6. Summary of Potential Net Impacts to Waters of the United States and Proposed Mitigation

Type of Water of the United States	Acres Impacted	Functional Capacity/ Habitat Units Impacted (FCU/HU)	Acres Mitigated	Functional Capacity/ Habitat Units Mitigated (FCU/HU)	Net Change in Acres Mitigated - Impacted	Net Change in FCU/HU Created - Impacted
Forested Wetland	4,602	4,035	5,801	4,675	(+) 1,199	(+) 640
Emergent Wetland	1,223	514	3,082	957	(+) 1,859	(+) 443
Scrub Shrub Wetland	49	23	248	103.5	(+) 199	(+) 80.5
Open Waters	78	N/A	16,036[1]	N/A	+) 15,958	N/A
	Linear Feet Impacted	**SQUs**	**Linear Feet Mitigated**	**SQUs**	**Linear feet**	**SQUs**
Streams[2]	651,140	192,377	392,265	181,153	(-) 258,875	(-) 11,224
Perennial	None	None	65,247	10,565	-	-
Intermittent	286,139	85,100	125,667	46,425	-	-
Intermittent/Ephemeral	365,001	107,277	41,140	15,491	-	-
Ephemeral	N/A	N/A	160,212	108,672	-	-

[1]This represents the offset of open waters by the creation of the reservoir, less the acreage identified for littoral wetlands.

[2]For a complete description of stream classifications refer to Appendix C.

Table 4.6-7. Summary of Potential Impacts to Terrestrial Resources and Proposed Mitigation

Terrestrial Resource Type	Amount Impacted	Amount of Mitigation	Net Gain (+) – Net Loss
Upland Deciduous Forest (HUs)	1,058	742	(-) 316
Riparian Woodland/Bottomland Hardwood Forest (HUs)	434	855	(+) 421
Grassland/Old Field (HUs)	2,896	2,393	(-) 503
Shrubland (acres)	64	41	(-) 23

Table 4.6-8. Summary of the Proposed Mitigation Actions to Offset Impacts to Open Waters

Impacts to Open Waters (acres)	Near-Site Mitigation (acres)	On-Site Mitigation (acres)	Net Gain (+) – Net Loss of Open Waters
(-) 78	(+) 50	(+) 16,036	(+) 16,008

The proposed mitigation throughout the three proposed mitigation sites (Figure 4.6-1) consists of creation, restoration, and/or enhancement. Table 4.6-9 summarizes where on-site and near-site mitigation components are being performed in accordance with the aquatic resource types.

Table 4.6-9. Summary of On-Site and Near-Site Mitigation Associated with the Proposed LBCR Project

Aquatic Resource Type	Mitigation Component					
	On-Site		Riverby Ranch Site		Upper BDC Site	
	Reservoir Site	Reservoir/ Littoral Wetlands	Restoration	Enhancement	Restoration	Enhancement
Wetlands						
Forested						
			X	X	X	
Emergent			X	X		
Scrub						
Shrub		X				
Non-	X		X	X		X
wetlands				X		X
Streams						
Open						
water						

Once initial construction of the mitigation components are completed, the mitigation sites would be monitored as provided for in the Monitoring Requirements and Performance Standards sections of the plan (Appendix C). Monitoring reports would be submitted every year for the first five years, every other year from year five until year 15, and again in year 20 for all components of the proposed mitigation plan. As such, all components of the proposed mitigation plan would be monitored for 20 years.

Site Protection, Management, and Financial Assurances

The compensatory mitigation, resulting from construction of the LBCR, would provide long-term protection through USACE- approved deed restrictions for the time the NTMWD owns and controls the properties. Should the properties be transferred to a third-party land manager other than a governmental entity, a conservation easement, or some other similar USACE-approved agreement, shall be placed on the properties for perpetual protection.

All sites proposed as part of this mitigation plan would be managed long-term as compensatory mitigation areas associated with impacts to waters of the United States, including wetlands. The long-term management of the mitigation site would be provided by the NTMWD until the USACE has determined that the mitigation project is meeting its performance standards or is on an acceptable trajectory to meeting those standards. An adaptive management approach would be used to assess mitigation conditions to facilitate project success with the final goal of native habitats that are stable and self-sustaining over time. If monitoring reports indicate that mitigation progress is falling short of success standards, coordination with the USACE and applicable federal, state or local agencies would be initiated regarding the need for additional adaptive management measures to increase the likelihood of meeting performance standards and overall mitigation goals and objectives. Once the USACE determines the mitigation project is fulfilling the compensatory mitigation requirements, and the mitigation site is self-sustaining, NTMWD may seek to convey the mitigation site and long-term management to a public agency (i.e., state or federal resource agency).

NTMWD has made a commitment to mitigating for impacts to natural resources by already purchasing the approximately 15,000-acre Riverby Ranch Mitigation Site and portions of the 1,900-acre Upper BDC Mitigation Site that would be used for compensatory mitigation.

4.7 AIR QUALITY AND GREENHOUSE GAS EMISSIONS

This section discusses the air regulations that could apply to the project and the air quality impacts and greenhouse gas emissions that would occur under each alternative. For Alternatives 1 and 2, the air quality impacts from construction and operation activities are discussed separately to provide a more detailed analysis. A summary of the impacts discussed in the following sections is provided in Table 4.7-1.

Table 4.7-1. Summary of Impacts Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Construction Phase			
Size	Air Quality Control Region 215[a]	Air Quality Control Region 215 [a]	No change from current conditions.
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Slight	Slight	
Operation Phase			
Size	Air Quality Control Region 215[a]	Air Quality Control Region 215[a]	Possible slight decrease in air quality from current conditions as Fannin County population and tailpipe emissions increase.
Duration	100+ years (long-term)	100+ years (long-term)	
Likelihood	Medium	Medium	
Severity	Slight	Slight	

[a] Air Quality Control Region 215 encompasses 19 counties and includes those portions of Fannin County where Alternatives 1 and 2 would occur.

4.7.1 Regulatory Review

The CAA, as amended in 1990, mandates that states develop a State Implementation Plan (SIP) that explains how the state will comply with the Clean Air Act and achieve and maintain attainment of the National Ambient Air Quality Standards (NAAQS). The Texas SIP[5] applies to industrial sources, commercial facilities, and residential development activities. Regulation occurs primarily through a process of reviewing engineering documents and other technical information, applying emission standards and regulations in the issuance of permits, performing field inspections, and assisting industries in determining their compliance status.

TCEQ has the authority to issue permits for the construction and operation of new or modified stationary source air emissions in Texas. TCEQ air permits are required for any facility that will emit or currently emits regulated pollutants and must comply with the following regulations of the Clean Air Act: New Source Review, Prevention of Significant Deterioration, Title V Permitting, National Emission Standards for Hazardous Air Pollutants (HAPs), and New Source Performance Standards. TCEQ air permits are not required for mobile sources, such as trucks. An overview of the applicability of the Clean Air Act air regulations to the project is shown in Table 4.7-2.

[5] The Texas SIP was initially approved in May 1972 and is revised as needed to comply with new federal or state requirements, when new data improves modeling techniques, when a specific area's attainment status changes, or when an area fails to reach attainment (TCEQ 2017).

Table 4.7-2. Clean Air Act Regulatory Review for Alternatives 1 and 2

Clean Air Act Regulation	Applicability to Alternatives 1and 2
New Source Review	New Source Review permitting protects air quality when factories, industrial boilers, and power plants are built or modified. Because none of the alternatives would involve construction or operation of any of these facilities, the project would be exempt from New Source Review permitting requirements. However, it is possible that a permit would be required for emergency back-up generators if they became part of the project.
Prevention of Significant Deterioration	Prevention of Significant Deterioration (PSD) applies to new major sources or modifications at existing sources of air pollutants where the area the source is located is in attainment or unclassifiable. There are no existing sources of air pollutants associated with the project, therefore, the project would not be subject to PSD review.
Title V permitting requirements[a]	A Title V Permit requires sources of air pollutants to obtain and operate in compliance with an operating permit. A Permit is required if a source has actual or potential emissions greater than or equal to 100 tons per year. Because the construction and operation activities under Alternatives 1 and 2 would be below this threshold, a Title V Permit is not required.
National Emission Standards for Hazardous Air Pollutants	National Emission Standards for Hazardous Air Pollutants (NESHAP) are stationary source standards for hazardous air pollutants (HAPs). HAPs are those pollutants that are known or suspected to cause cancer or other serious health effects. Because the potential HAP emissions would not exceed NESHAP thresholds for any of the alternatives, the use of Maximum Available Control Technology would not be required.
New Source Performance Standards	New Source Performance Standards (NSPS) are technology based emission standards which apply to new, modified, and reconstructed facilities in specific source categories such as manufacturers of glass, cement, rubber tires, and wool fiberglass. Because neither alternative would involve construction or operation of any of these types of facilities, the project would be exempt from NSPS permitting requirements. However, it is possible that emergency generators and boilers would be subject to NSPS if they became part of the project.

[a] This threshold only applies to areas that are in attainment. Because the project is located in an attainment area, the 100 tons per year of any air pollutant threshold was used.

Source: USEPA, 2017b

While the Clean Air Act regulations listed in Table 4.7-2 do not apply to the project, there are more specific Texas State regulations that apply to activities that are likely to occur during construction. These regulations are outlined in TCEQ Regulation Title 30, Part 1, Chapters 101 through 118. They include the following:

- General Air Quality Rules (Chapter 30 Texas Administrative Code [TAC] 1.101);
- Air pollution from Visible Emissions and Particulate Matter (Chapter 30 TAC 1.111.A);
- Air pollution from Open Burning (Chapter 30 TAC 1.111.B);
- Air pollution from Motor Vehicle (Chapter 30 TAC 1.114); and

- Air pollution from VOCs (Chapter 30 TAC 1.101).

Fugitive Dust Control

The grading and site-preparation phases of dam and reservoir construction would generate fugitive dust emissions. Chapter 30 TAC 1.111.A requires reasonable precautions to prevent particulate matter from becoming airborne. Such precautions can include:

- Using water for dust control when grading roads or clearing land;
- Applying water on dirt roads, materials stockpiles, and other surfaces that could create airborne dust;
- Paving roadways and maintaining them in a clean condition;
- Covering open equipment when conveying or transporting material likely to create objectionable air pollution when airborne; and
- Promptly removing spilled or tracked dirt or other materials from paved streets.

Open Burning

Project activities would likely include the burning of construction or demolition material and land-clearing debris, which may require a permit (30 TAC 1.111.B). Before burning, the appropriate state and local agencies would be contacted to acquire the necessary open burning permits. The open burning ordinance includes, but is not limited to, the following:

- All reasonable efforts shall be made to minimize the amount of material burned;
- The material to be burned shall consist of brush, stumps, and similar waste and lean burning demolition material;
- The burning shall be at least 300 feet from any occupied building unless the occupants have given prior permission, other than a building located on the property on which the burning is conducted;
- The burning shall be conducted at the greatest distance practicable from highways and air fields
- The burning shall be attended at all times and conducted to ensure the best possible combustion with a minimum of smoke being produced;
- The burning shall not be allowed to smolder beyond the minimum period of time necessary for the destruction of the materials; and
- The burning shall be conducted only when the prevailing winds are away from any city, town, or developed area.

4.7.2 No Action Alternative

The No Action Alternative is not expected to appreciably affect air quality within AQCR 215 because land uses at and within the vicinity of the proposed LBCR site are not expected to substantially change. However, due to overall expected population growth in the region and a commensurate increase in traffic and tailpipe emissions of criteria pollutants from vehicles, there may be a slight decrease in air quality in the region.

Under the No Action Alternative, there would be no water treatment plant, raw water pipeline, or reservoir to affect greenhouse gas (GHG) emissions. This alternative would not have any direct impact on the climate, and would not contribute to climate change. Although there would be no GHG emissions, the No Action Alternative, by foregoing the development of greater water storage capacity that could be drawn upon during dry periods and droughts, would constitute a riskier approach to water management under future climatic conditions compared to Alternatives 1 and 2.

4.7.3 Alternative 1

Alternative 1 would involve the construction and operation of a dam and reservoir on Bois d'Arc Creek and construction and operation of other project components including water pipelines, a water treatment plant (WTP), a terminal storage reservoir (TSR), a new road extension, and a new bridge over the new reservoir. This section describes the potential air impacts that would result from implementing Alternative 1.

Estimated Criteria Pollutant Emissions and General Conformity

As explained in Section 3.5 of this EIS, EPA's General Conformity Rule under the Clean Air Act ensures that the actions taken by federal agencies do not interfere with a state's plans to attain and maintain the National Ambient Air Quality Standards (NAAQS) (40 CFR 93.153(b)). Because Air Quality Control Region (AQCR) 215, which encompasses the entire proposed project area, is in attainment, the General Conformity Rule requirements do not apply. However, for completeness, all direct and indirect emissions of criteria pollutants were estimated for the construction phase of the proposed project and compared to the General Conformity Rule *de minimis* threshold rates to determine whether implementation of Alternative 1 would impact the air quality in the region. The emissions included in Table 4.7-3 include air emissions from reservoir clearing and construction of the dam, water pipelines, and all other project components (described below in more detail). As shown in Table 4.7-3, the total direct and indirect emissions associated with the construction phase of Alternative 1 would not exceed the *de minimis* threshold rates. Therefore, the project would be exempt from the General Conformity Rule requirements. Any later indirect emissions during operations would not be within the USACE's continuing program responsibility, and the USACE cannot practicably control them.

Table 4.7-3. Alternative 1 Emissions Compared to General Conformity Rule Thresholds

Activity	Estimated Annual emissions (short tons per year)		*de minimis* threshold (short tons per year)
	CO	NO_x	
Site preparation and construction	1.8	5.8	100

Note: Emissions of all other criteria pollutants and their precursors would be appreciably lower than those of CO and NO_x.

Source: Freese and Nichols, 2011b

Reservoir and Dam

Construction

The use of heavy construction equipment, deliveries to the site, fugitive dust, and burning of cleared vegetation material from the reservoir footprint would cause short-term, slight adverse impacts on air quality. All emissions of criteria pollutants from construction of the proposed reservoir and dam are included in Table 4.7-3, and would not exceed the annual *de minimis* threshold rates. These impacts would occur during the estimated 3 to 4 years of construction and would end upon completion of construction.

Operation

Long-term negligible adverse and long-term slight beneficial impacts on air quality would occur from operation of the proposed reservoir and dam. Long-term negligible adverse impacts would occur from recreational visitors (personal vehicles and watersport engines [i.e., motorboats]), increased development around the lake which could result in additional vehicles on roadways, and generators. These small sources are not expected to generate appreciable amounts of emissions; however, any new sources of air emissions that require permitting under one or more of the regulations listed in Table 4.7-2 would be permitted by TCEQ. Long-term slight beneficial impacts would be primarily due to the elimination of existing sources of air emissions (agricultural operations and biomass burning) within the proposed project footprint.

Raw Water Transport Pipelines

Construction

Heavy construction equipment, deliveries to the site, and fugitive dust would cause short-term slight adverse impacts on air quality. All emissions of criteria pollutants from construction of the proposed pump station and pipeline are included in Table 4.7-3, and would not exceed the annual *de minimis* threshold rates. These impacts would end upon completion of construction.

Operation

Operation of the proposed pipeline would have no direct impacts on air quality locally, as there would be no ongoing sources of air emissions associated with this part of the project. However, there are both fossil fuel and non-fossil fuel based electricity providers in the surrounding area that could provide electricity to pump the water through the pipeline. If a fossil fuel based provider is used, there would be indirect impacts from increased emissions of criteria pollutants at the electricity generation site. These emissions would not occur if a non-fossil fuel generator was used.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

Construction

Heavy construction equipment, deliveries to the site, and fugitive dust would cause short-term slight adverse impacts on air quality. All emissions of criteria pollutants from construction of the WTP, TSR, and related facilities are included in Table 4.7-3, and would not exceed the annual *de minimis* threshold rates. These impacts would end upon completion of construction.

Operation

Long-term slight adverse impacts on air quality from operation of the proposed WTP, TSR, and related facilities would potentially be caused by air emissions from vehicles used for worker commutes and delivery of equipment and supplies and the use of generators. These small sources are not expected to generate appreciable amounts of emissions; however, any new sources of air emissions that require permitting under one or more of the regulations listed in Table 4.7-2 would be permitted by TCEQ.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Construction

Heavy construction equipment, deliveries to the site, and fugitive dust would cause short-term minor adverse impacts on air quality. All emissions of criteria pollutants from the FM 1396 relocation and new bridge construction are included in Table 4.7-3, and would not exceed the annual *de minimis* threshold rates. These impacts would end upon completion of construction.

Operation

For purposes of analysis, it was assumed that the commuters currently utilizing FM 1396 would utilize the new FM 897 extension and the new bridge. Therefore, the overall traffic would not increase and the long-term impacts on air quality from vehicular use of the proposed FM 897 extension and new bridge would be negligible.

Summary of Air Quality Impacts

Overall, short-term slight adverse and long-term slight beneficial impacts to air quality would be expected with the implementation of Alternative 1. During construction activities, short-term emissions would be limited to fugitive dust and diesel emissions from construction and delivery equipment and from the burning of cleared vegetation material. Direct and indirect air emissions would not be expected to exceed the annual *de minimis* threshold rates or to contribute to a violation of any federal, state, or local air regulations. Long-term slight beneficial impacts would be primarily due to the elimination of existing sources of air emissions (agricultural operations and biomass burning) within the proposed project footprint, although these may well be offset or more than offset by localized population growth, development, and greater tailpipe emissions from increased levels of traffic by new residents and recreationists both around and on the new lake.

Mitigation of Air Quality Impacts from Construction

In the event that a Section 404 permit is issued and the project is implemented, EPA Region 6 recommended that NTMWD, its contractors, and all responsible parties develop mitigation measures to control PM_{10} emissions and fugitive dust during construction. These mitigation measures would be included in a detailed Construction Emissions Mitigation Plan that would identify Best Management Practices (BMPs) for the construction effort. The BMPs would be designed to reduce air quality impacts associated with emissions of criteria pollutants (NOx, CO, CO_2, PM, and SO_2) and specifically to minimize potential exposure of individuals near the construction sites to PM_{10} from fugitive dust and heavy equipment tailpipe emissions.

Greenhouse Gas Emissions

Alternative 1 would generate a relatively small amount of GHG emissions during both construction and operation (primarily from pumping raw water to the treatment plant), and in the short term it would represent an incremental, but overall negligible, contribution to climate change. Although there would be an incremental increase in greenhouse gases, Alternative 1 would constitute a more effective approach to water conservation and management under future conditions when compared to the No Action Alternative. As the climate becomes hotter and potentially drier (NRC, 2011), having more water storage capacity to take advantage of heavy precipitation and runoff storm events would become more important.

GHG emissions in the vicinity of the future reservoir would likely increase due to long-term local population growth, additional recreational visitors, increased vehicular usage and power generation, and general development in the lake vicinity. These increases would be offset at a one-to-one basis by these same activities not occurring at other locations. For example, individuals who moved to the area would no longer emit GHG's at the location they otherwise would have lived at without implementing Alternative 1.

A carbon footprint is an inventory of the GHG emissions caused by a project, event, or product over a given period of time, and is often expressed in terms of carbon dioxide (CO_2) equivalent. CO_2 equivalent is a measure used to compare the emissions from various greenhouse gases based upon their global warming potential. Table 4.7-4 shows estimates of GHG emissions during the construction, the lake inundation (impoundment of water), the embodied emissions from the raw materials used, and the electricity consumption over one hundred years. Given the long duration of the reservoir, Alternative 1 would have a relatively small carbon footprint, and would have an incremental, but overall negligible, contribution to climate change. The total amount of GHG emissions that would occur over the 100-year life of the project represents approximately 0.7 percent of Texas' annual GHG emissions (641 million metric tons of CO_2 equivalent in 2013) (Climate Central, 2015).

Table 4.7-4. Carbon Dioxide Equivalent Emissions During the 100-Year Life of the Project

Total Carbon Dioxide Equivalents (tons)				
Lake Inundation	**Construction**	**Embodied in Fabrication Materials**	**Power Use**	**Total**
1,018,000	5,000	188,000	3,305,500	4,517,000

Long-term slight beneficial effects from augmenting water storage capacity in North Texas would be expected. Although there would be negligible direct effects from the emissions on climate change, Alternative 1 would constitute a more effective approach to water management under future conditions associated with reductions in available precipitation when compared to the No Action Alternative. As noted above, total available precipitation will likely decrease in the coming decades and beyond. As available precipitation decreases and summer deficits increase when compared to historical conditions, drought contingency operations would be required more frequently when compared to historical operations. In general, maintaining adequate water storage capacity is an important strategy in adapting to predicted climate change in Texas, a future that is likely to be drier and hotter and with lower available precipitation.

Reservoir and Dam

There would be slight adverse effects from GHG emissions associated with Alternative 1. Lake inundation, that is, initial impoundment of the water in Bois d'Arc Creek, would account for approximately 1,018,000 tons of CO_2 equivalent, much of which would take place in the first five to ten years after the dam was built. GHG emissions from reservoir inundation includes the GHG that are currently being removed or sequestered by existing vegetation within the reservoir site, and, for the first 10 years, the GHG emitted by the biomass that would decompose after inundation as a result of conversion to permanently flooded land. After that, any additional GHG emissions from the reservoir would be from organic material that would have decomposed with or without the reservoir.

Raw Water Pipeline and Pump Station

Small amounts of GHG emissions associated with the proposed raw water pipeline would have an incremental, but overall negligible, contribution to climate change. All emissions of GHG from construction and operation of the pipeline are included in Table 4.7-4. The largest component of ongoing GHG emissions due to the project is the use of power to run the single pump station at the start of the pipeline near the edge of the lake; however, these emissions would be indirect and controlled at the point of power generation. Alternative methods of supplying water to the region such as piping it in from a remote location or desalination would have a much larger carbon footprint.

Water Treatment Plant, Terminal Storage Reservoir and Related Facilities

Small amounts of GHG emissions associated with the proposed WTP, TSR, and related facilities would have an incremental, but overall negligible, contribution to climate change. All emissions of GHG from construction and operation of the WTP, TSR, and related facilities are included in Table 4.7-4. The largest component of ongoing GHG emissions due to the project is the use of power to run the pump stations and WTP; however, these emissions would be indirect and controlled at the point of power generation.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

As in the case of other connected actions, small amounts of GHG emissions would be associated with construction (heavy construction equipment) and operation (motorized vehicles) of these facilities.

4.7.4 Alternative 2

Similar to Alternative 1, Alternative 2 would involve the construction and operation of a dam and reservoir on Bois d'Arc Creek. However, under Alternative 2, the reservoir would be smaller and the project would include construction and operation of an additional pipeline for blending water from Lake Texoma. The construction and operation of other project components described under Alternative 1 including the water pipeline, WTP, TSR, a new road extension, and a new bridge over the new reservoir would be the same under Alternative 2. This section describes the potential air impacts that would result from implementing Alternative 2.

Estimated Emissions and General Conformity

The footprint of the proposed smaller-scale LBCR is within the larger boundaries of Alternative 1 in AQCR 215. Potential areas where new pipelines would need to be constructed for Lake Texoma blending are located within Fannin and Grayson counties, which are both in attainment with NAAQS. Therefore, the entire project area for this alternative is in attainment and the General Conformity rule of the CAA does not apply. The total direct and indirect emissions associated with constructing and operating the proposed smaller-scale LBCR would be less than the total emissions under Alternative 1 (shown in Table 4.7-3). Therefore, the total direct and indirect emissions associated with this alternative would not exceed the *de minimis* threshold rates, and overall impacts to air quality under this alternative would be slight.

Reservoir and Dam

Construction

As in Alternative 1, short-term slight adverse air quality impacts from construction of the smaller-scale LBCR would be caused by heavy construction equipment, deliveries to the site, and fugitive dust. Due to the reduced amount of construction required for the smaller-scale LBCR, annual emissions of criteria pollutants from construction of the reservoir and dam would be approximately 10 percent lower than emissions estimated for Alternative 1 and would not exceed the annual *de minimis* threshold rates. These emissions would occur during the estimated 3 to 4 years of construction and would end upon completion of construction.

Operation

As in Alternative 1, long-term negligible adverse impacts and long-term slight beneficial impacts on air quality would occur from operation of the smaller-scale reservoir and dam. Long-term negligible adverse impacts would occur from recreational visitors (personal vehicles and watersport engines [i.e., motor boats]), increased development around the lake which could result in additional vehicles on roadways, and generators. These small sources are not expected to generate appreciable amounts of emissions; however, any new source of air emissions that require permitting under one or more of the regulations listed in Table 4.7-2 would be permitted by TCEQ. Due to the smaller scale of the LBCR, there would likely be fewer recreational visitors, less development, and fewer generators associated with this alternative than for Alternative 1. Long-term slight beneficial impacts would be primarily due to the elimination of existing sources of air emissions (agricultural operations and biomass burning) within the proposed project footprint.

Raw Water Transport Pipelines

Construction

As in Alternative 1, heavy construction equipment, deliveries to the site, and fugitive dust would cause short-term slight adverse impacts on air quality. All emissions of criteria pollutants from construction of the pump station and LBCR pipeline would be similar to emissions under Alternative 1, and would not exceed the annual *de minimis* threshold rates. Emissions associated with construction of the new pipeline for delivery of Lake Texoma water for blending with LBCR water are expected to be slight, and would not exceed the annual *de minimis* threshold rates. These impacts would end upon completion of the construction phase.

Operation

Operation of the proposed pipelines would have no direct impacts on air quality locally, as there would be no ongoing sources of air emissions associated with this part of the project. However, there are both fossil fuel and non-fossil fuel based electricity providers in the surrounding area that could provide electricity to pump the water through the pipelines. If a fossil fuel based provider is used, there would be indirect impacts from increased emissions of criteria pollutants at the electricity generation site. Because Alternative 2 would involve operation of a second water pipeline, additional electricity would be required to pump the water. Therefore, the impacts from operating the two pipelines would be greater than Alternative 1. These emissions would not occur if a non-fossil fuel generator was used.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

Construction

As in Alternative 1, heavy construction equipment, deliveries to the site, and fugitive dust would cause short-term slight adverse impacts on air quality. Emissions of criteria pollutants from construction of the WTP, TSR, and related facilities would be similar to emissions under Alternative 1 and would not exceed the annual *de minimis* threshold rates. These impacts would end upon completion of construction.

Operation

Long-term slight adverse impacts from operation of the proposed WTP, TSR, and related facilities would potentially be caused by air emissions from vehicles used for worker commutes and delivery of equipment and supplies and generators. These small sources are not expected to generate appreciable amounts of emissions; however, any new sources of air emissions that require permitting under one or more of the regulations listed in Table 4.7-2 would be permitted by TCEQ.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Construction

Similar to alternative 1, Alternative 2 would include FM 1396 inundation and relocation and new bridge construction. The combined length of the new road and bridge and therefore the air emissions resulting from construction would be approximately the same under Alternatives 1 and 2. Heavy construction equipment, deliveries to the site, and fugitive dust would cause short-term slight adverse impacts to air quality. All emissions of criteria pollutants from road and bridge construction would not exceed the annual *de minimis* threshold rates. These impacts would end upon completion of construction.

Operation

For purposes of analysis, it was assumed that the commuters currently utilizing FM 1396 would utilize the new FM 897 extension and the new bridge. Therefore, the overall traffic would not increase and the long-term impacts on air quality from vehicular use of the proposed FM 897 extension and new bridge would be negligible.

Summary of Air Quality Impacts

Overall, the impacts of Alternative 2 on air quality would likely be similar to but somewhat lower than the impacts of Alternative 1. Short-term slight adverse and long-term slight beneficial impacts to air quality would be expected with the implementation of Alternative 2. During construction activities, short-term emissions would be limited to fugitive dust and diesel emissions from construction and delivery and from the burning of cleared vegetation material. Direct and indirect air emissions would not be expected to exceed the annual *de minimis* threshold rates or to contribute to a violation of any federal, state, or local air regulations. Long-term slight beneficial impacts would be primarily due to the elimination of existing sources of air emissions (agricultural operations and biomass burning) within the project footprint, although these may well be offset by localized population growth, development, and greater tailpipe emissions from increased levels of traffic by new residents and recreationists in the vicinity of the new lake.

Mitigation of Air Quality Impacts from Construction

In the event that the Section 404 permit is issued and the project is implemented, EPA Region 6 recommended that NTMWD, its contractors, and all responsible parties develop mitigation measures to control PM_{10} emissions and fugitive dust during construction. These mitigation measures would be included in a detailed Construction Emissions Mitigation Plan that would identify BMPs for the construction effort. The BMPs would be designed to reduce air quality impacts associated with emissions of criteria pollutants (NOx, CO, CO_2, PM, and SO_2) and specifically to minimize potential exposure of individuals near the construction sites to PM_{10} from fugitive dust and heavy equipment tailpipe emissions.

Greenhouse Gas Emissions

Similar to Alternative 1, Alternative 2 would have short-term slight adverse climate effects and long-term slight beneficial effects. Overall adverse effects would be smaller than Alternative 1; however, the GHG emissions associated with power use would be higher under Alternative 2 due to the additional power required to operate the Lake Texoma pipeline. The long-term beneficial effects of Alternative 2 would be lower than Alternative 1 due to the reduced addition of storage capacity.

Long-term slight beneficial effects from augmenting water storage capacity in North Texas would be expected. Although there would be negligible direct effects from the emissions on climate change, Alternative 2 would constitute a more effective approach to water management under future conditions associated with possible reductions in available precipitation when compared to the No Action Alternative. However, it would result in reduced benefits compared to Alternative 1 due to its smaller storage capacity.

GHG emissions associated with Alternative 2 would result from the same actions and processes as Alternative 1: lake inundation, facilities construction, release of CO_2 embedded in fabrication materials, and power use. Table 4.7-5 shows estimates of GHG emissions during construction, lake inundation (impoundment of water), embodied emissions from the raw materials used, and electricity consumption over one hundred years. Given the long duration of the reservoir, Alternative 2 would have a relatively small carbon footprint, and would have an incremental, but overall negligible, contribution to climate change. The total amount of GHG emissions that would occur over the 100-year life of the project represents approximately 0.6 percent of Texas' annual GHG emissions (641 million metric tons of CO_2 equivalent in 2013) (Climate Central, 2015). Total GHG emissions would be approximately 11 percent lower than those of Alternative 1.

Table 4.7-5. Carbon Dioxide Equivalent Emissions During the 100-Year Life of the Project

Total Carbon Dioxide Equivalents (tons)				
Lake Inundation	**Construction**	**Embodied in Fabrication Materials**	**Power Use**	**Total**
487,500	4,840	182,000	3,347,500	4,021,840

Reservoir and Dam

There would be slight adverse effects from GHG emissions associated with Alternative 2. Lake inundation, that is, initial impoundment of the water in Bois d'Arc Creek, would account for approximately 487,500 tons of CO_2 equivalent, much of which would take place in the first five to ten years after the dam was built. GHG emissions from reservoir inundation includes the GHG that are currently being removed or sequestered by existing vegetation within the reservoir site, and, for the first 10 years, the GHG emitted by the biomass that would decompose after inundation as a result of conversion to permanently flooded land. After that, any additional GHG emissions from the reservoir would be from organic material that would have decomposed with or without the reservoir.

LBCR Raw Water Pipeline, Texoma Water Conveyance Pipeline, and Pump Stations

Similar to Alternative 1, small amounts of GHG emissions associated with construction of the proposed raw water transport pipeline would have an incremental, but overall negligible, contribution to climate change. While these emissions would increase with the additional construction of a pipeline for conveyance of water from Lake Texoma, construction emissions would still be negligible.

The largest component of ongoing GHG emissions under Alternative 2 is the use of fossil fuel electrical power to run the pump stations. Alternative 2 requires pumping in two locations: at the pumping station by the edge of the LBCR as in Alternative 1, and a pumping station to convey Lake Texoma water to a reservoir where the blending would occur. These emissions would be indirect and controlled at the point of power generation. Overall, long-term GHG emissions from pumping water under Alternative 2 would be greater than Alternative 1.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

Similar to Alternative 1, small amounts of GHG emissions associated with the proposed WTP, TSR, and related facilities would have an incremental, but overall negligible, contribution to climate change. Power use to operate the pump stations and WTP is the largest source of ongoing emissions; however, these emissions would be indirect and controlled at the point of power generation. Because Alternative 2 would produce less treated water than Alternative 1, emissions associated with operating the WTP, TSR, and related facilities would be lower than Alternative 1.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Similar to Alternative 1, small amounts of GHG emissions would be associated with construction (heavy construction equipment) and operation (motorized vehicles) of these facilities under Alternative 2. These emissions would be approximately the same as Alternative 1.

4.8 ACOUSTIC ENVIRONMENT (NOISE)

This section discusses the noise impacts that would occur under each alternative. For Alternatives 1 and 2, the construction and operation activities are discussed separately to provide a more detailed analysis. A summary of the noise impacts discussed in the following subsections is provided in Table 4.8-1.

Table 4.8-1. Summary of Impacts to the Acoustic Environment Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Construction Phase			
Size	Area within 800 feet of construction or work areas	Area within 800 feet of construction or work areas	No change from current conditions.
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Slight (beneficial and adverse)	Slight (beneficial and adverse)	
Operation Phase			
Size	Area within 400 feet of the WTP or water pipeline pumping stations and the area in and around the reservoir	Area within 400 feet of the WTP or water pipeline pumping stations and the area in and around the reservoir	Slight increase in ambient noise levels likely caused by the expected population growth and development over the coming decades.
Duration	100+ years (long-term)	100+ years (long-term)	
Likelihood	Medium	Medium	
Severity	Slight (beneficial and adverse)	Slight (beneficial and adverse)	

4.8.1 No Action Alternative

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth. These changes would result in an increase in noise, although not to the degree attributable to the construction or operation of Alternatives 1 or 2.

4.8.2 Alternative 1

Implementation of Alternative 1 would have short-term slight adverse and long-term slight beneficial and adverse effects on the noise environment. Short-term slight increases in noise would result from the temporary use of heavy equipment during land clearing and construction, estimated to last 3 to 4 years. Beneficial effects would result from most of the existing sources of noise within the reservoir footprint, such as agricultural equipment, automobile traffic, and lawn maintenance equipment ending with acquisition of the land for the proposed dam and reservoir. However, there are likely to be long-term noise impacts from the increase in traffic associated with recreational and real estate development at and in the vicinity of the reservoir. Other long-term noise impacts would result from traffic passing over the new bridge, operation of the water pumping stations, and operation of the WTP. To ensure project construction activities would not violate any federal, state, or local noise ordinance, BMPs would be implemented to reduce potential noise impacts. These BMPs are discussed further in the following sections.

<u>Reservoir and Dam</u>

Construction

Construction of the dam and clearing of the reservoir area would have short-term slight adverse effects on the noise environment. Noise would primarily be caused by tree clearing activities and the use of cranes, concrete trucks, mud pumps, diesel generators, and heavy construction vehicles during the construction of the dam. As shown in Table 4.8-2, individual construction activities typically generate noise levels of 80 to 90 A-weighted decibels (dBA) at a distance of 50 feet.

Table 4.8-2. Noise Levels Associated with Outdoor Construction

Construction phase	dBA L_{eq} at 50 feet from Source
Ground clearing	84
Excavation, grading	89
Foundations	78
Structural	85
Finishing	89

dBA = A-weighted decibel; L_{eq} = equivalent sound level
Source: USEPA, 1974

With multiple pieces of equipment operating concurrently, noise levels can be relatively high during daytime periods at locations within several hundred feet of active construction sites. The zone of relatively high construction noise levels typically extends to distances of 400 to 800 feet from the site of major equipment operations. Locations (i.e., noise sensitive receptors) more than 800 feet from construction sites seldom experience appreciable levels of construction noise (USEPA, 1974). Given the temporary nature of proposed construction activities and the surrounding low population density, these effects would be slight.

Although construction-related noise impacts would be slight, the following BMPs would be implemented to further reduce any noise impacts:

- Construction would primarily occur during normal weekday business hours in areas adjacent to noise sensitive land uses such as residential areas and recreational areas; and
- Construction equipment mufflers would be properly maintained and in good working order.

Construction noise would dominate the soundscape for all on-site personnel. Construction personnel, particularly equipment operators, would wear personal hearing protection to limit exposure and ensure compliance with federal health and safety regulations.

Operations

There are no sources of noise associated with operating the proposed reservoir and dam; therefore, its operation would have negligible effects to the existing noise environment. Upon the initial acquisition of land on which the dam and reservoir would be located, most existing sources of noise on that land, such as agricultural activities, automobile traffic, and lawn maintenance equipment, would end. This return to natural quiet and the absence of manmade noise would have a slight beneficial effect on the noise environment.

However, if recreational and real estate development occur at the LBCR, then there would be noise associated with these activities such as the use of motor boats in the reservoir and personal vehicles around the reservoir. This noise would be compatible with the end use of the property; for example, noise from motor boats and personal vehicles is typical for lakes and lakeside areas and would likely not be unexpected nor objectionable to visitors and adjacent residents.

Raw Water Pipeline

Construction

Construction of the pipeline would have short-term slight adverse effects on the acoustic environment. These effects would be primarily due to noise from heavy construction equipment and vehicles during the construction of the pipeline. The noise would be similar in nature to construction noise described above for the dam and reservoir, though on a smaller scale. Heavy equipment would not be fixed in one location but would move along the pipeline route as construction progressed. Construction noise would be temporary and would subside at a particular location as activities progressed to a new location. There are some nearby residents who could experience annoying levels of noise; however, given the temporary nature of proposed construction activities, these effects would be slight.

Although construction-related noise impacts would be slight, the BMPs and worker hearing protection discussed in section 4.8.2.1 would be implemented during construction of the raw water pipeline to further reduce any noise impacts.

Operations

Operation of the proposed pipeline would have long-term slight adverse effects on the noise environment. All equipment would be enclosed at the pumping stations, but some mechanical noise could be audible at close range. Some noise due to the use of backup generators would occur during power outages. Noise from the generators is estimated to range from 74 dBA to 91 dBA at 23 feet, depending on the sound attenuation implemented (Cummins, 2016). Noise from these generators would be expected to decrease to less than 50 dBA within 300-400 feet of each pumping station. Noise from generators would be both intermittent and temporary in nature lasting only as long as the power outage. The effects would be slight.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

Construction

Construction of the proposed WTP, TSR, and related facilities would have a short-term slight adverse effect on the acoustic environment. As noted above in Table 4.8-2, individual construction activities typically generate noise levels of 80 to 90 dBA at a distance of 50 feet. Given the temporary nature of proposed construction activities, noise effects would be slight.

Although construction-related noise impacts would be slight, the BMPs and worker hearing protection discussed in section 4.8.2.1 would be implemented during construction of the WTP, TSR, and related facilities to further reduce any noise impacts.

Operations

Operation of the WTP would have long-term slight adverse effects on the noise environment. All equipment would be enclosed, but some mechanical noise could be audible at close range. The noise effects from operating the WTP would be similar to the impacts discussed for the pumping stations in Section 4.8.2.2.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Construction

Construction of the proposed new road and bridge would have a short-term slight adverse effect on the acoustic environment. As with other components of the proposed project described above in Table 4.8-2, individual construction activities typically generate noise levels of 80 to 90 dBA at a distance of 50 feet. Given the temporary nature of proposed construction activities, these effects would be slight.

Although construction-related noise impacts would be slight, the BMPs and worker hearing protection discussed in section 4.8.2.1 would be implemented during relocation of FM 1396 and construction of the new bridge to further reduce any noise impacts.

Operations

Traffic flow along the proposed FM 897 extension would have adverse effects on the nearby acoustic environment comparable to the effects of traffic on FM 1396 at present. Traffic traveling over the bridge could cause slight adverse acoustic impacts for recreationists utilizing the proposed lake. However, if the area around the new reservoir becomes more developed, the noise associated with traffic on the proposed FM 897 extension and the new bridge could increase.

4.8.3 Alternative 2

Under this alternative, there would be short-term slight adverse and long-term slight beneficial and adverse effects on the noise environment. Short-term slight increases in noise from the temporary use of heavy equipment during land clearing and construction would result in an adverse impact; these activities are estimated to last 3 to 4 years. Under this alternative, the extent of this impact would be similar to Alternative 1 due to similar reservoir clearing and construction activities that would occur. Beneficial effects would result from most of the existing sources of noise within the reservoir footprint, such as agricultural activities, automobile traffic, and lawn maintenance ending with acquisition of the land for the proposed dam and reservoir. However, there are likely to be long-term noise impacts from the increase in traffic associated with recreational and real estate development at and in the vicinity of the reservoir. Other long-term noise impacts would result from traffic passing over the new bridge, operation of the water pumping stations, and operation of the WTP. To ensure project construction activities would not violate any federal, state, or local noise ordinance, BMPs would be implemented to reduce potential noise impacts. These BMPs are discussed further in the following sections.

<u>**Reservoir and Dam**</u>

Construction

Similar to Alternative 1, construction of the dam and clearing of the downsized reservoir area would have short-term slight adverse effects on the noise environment. Noise would primarily be caused by tree clearing activities and the use of cranes, concrete trucks, mud pumps, diesel generators, and heavy construction vehicles during the construction of the dam. The noise levels generated by construction equipment would be the same under this alternative as Alternative 1 (see Table 4.8-2). Given the temporary nature of the proposed construction activities, these effects would be slight. The effects from this alternative would be similar to the effects from Alternative 1 due to the similar duration of construction.

Although construction-related noise impacts would be slight, the following BMPs would be implemented to further reduce any noise impacts:

- Construction would primarily occur during normal weekday business hours in areas adjacent to noise sensitive land uses such as residential areas and recreational areas; and
- Construction equipment mufflers would be properly maintained and in good working order.

Construction noise would dominate the soundscape for all on-site personnel. Construction personnel, particularly equipment operators, would wear personal hearing protection to limit exposure and ensure compliance with federal health and safety regulations.

Operations

There are no sources of noise associated with operating the proposed reservoir and dam; therefore, its operation would have negligible effects to the existing noise environment. Upon the initial acquisition of land on which the dam and reservoir would be located, most existing sources of noise on that land, such as agricultural activities, automobile traffic, and lawn maintenance equipment, would end. This return to natural quiet and the absence of manmade noise would have a slight beneficial effect on the noise environment.

However, if recreational and real estate development occur at the LBCR, then there would be noise associated with these activities such as the use of motor boats in the reservoir and personal vehicles around the reservoir. Such noise would be compatible with the end use of the property; for example, noise from motor boats and personal vehicles is typical for lakes and lakeside areas and would likely not be unexpected nor objectionable to visitors and adjacent residents.

Raw Water Pipelines

Construction

Construction of the proposed pipelines from the new reservoir to the WTP and from Lake Texoma to the WTP for blending with LBCR water would have short-term slight adverse effects on the noise environment, primarily due to noise from heavy equipment and vehicles during construction. These effects would be slightly greater than those described for Alternative 1 due to the additional Texoma pipeline that would be constructed under Alternative 2.

Although construction-related noise impacts would be slight, the BMPs and worker hearing protection discussed in section 4.8.3.1 would be implemented during construction of the raw water pipelines to further reduce any noise impacts.

Operations

Pipeline operation would have long-term slight adverse effects on the noise environment. These effects would be slightly greater than those under Alternative 1 due to the increased number of pumping stations required for the Texoma pipeline.

Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

Construction

Construction of the WTP, TSR, and related facilities would have short-term slight adverse effects on noise. These effects would be the same as those described under Alternative 1.

Although construction-related noise impacts would be slight, the BMPs and worker hearing protection discussed in section 4.8.3.1 would be implemented during construction of the WTP, TSR, and related facilities to further reduce any noise impacts.

Operations

Operation of the WTP would have long-term slight adverse effects on the noise environment. All equipment would be enclosed, but some mechanical noise could be audible at close range. The noise effects from operating the WTP would be similar to the impacts discussed for the pumping stations under Alternative 1.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Construction

Construction of the proposed new road and bridge would have a short-term slight adverse effect on the acoustic environment. While the bridge constructed under Alternative 2 would be shorter, the total distance of the bridge and road would be the same under both alternatives. Therefore, the impact would be similar to the impact described under Alternative 1.

Although construction-related noise impacts would be slight, the BMPs and worker hearing protection discussed in section 4.8.3.1 would be implemented during relocation of FM 1396 and construction of the new bridge to further reduce any noise impacts.

Operations

Traffic flow along the proposed FM 897 extension would have adverse effects on the nearby acoustic environment comparable to the effects of traffic on FM 1396 at present. Traffic traveling over the bridge could cause slight adverse acoustic impacts for recreationists utilizing the proposed lake. The impacts would be the same as those described under Alternative 1. However, if the area around the new reservoir becomes more developed, the noise associated with traffic on the proposed FM 897 extension and the new bridge could increase.

4.9 Recreation

The effects analysis considers how visitor experiences would change with implementation of Alternative 1 or 2 and what contributes or detracts from desirable visitor opportunities. Desirable visitor opportunities can be described as the ability to experience the fundamental resources and values within their natural settings. The nonmarket value of the activity includes the recreational experience itself (e.g., birdwatching), the aesthetic value (including natural and scenic landscape values) of recreation amenities and conditions, and the fulfillment of aesthetic values (e.g., sighting an eagle).

The type, duration, timing, and proximity of construction (short-term, temporary, or intermittent) and operation (long-term) activities is compared to the location, type, and usage of land and water-based recreational resources. Access is considered as it relates to traffic or delays, visitation and visitor spending, and revenue at nearby lakes and reservoirs and local recreational outfitters. For each alternative, potential impacts on visitation, visitor spending, recreational experience and aesthetic value are categorized in terms of severity, duration, size or physical extent, and likelihood – and are summarized in Table 4.9-1 below.

Table 4.9-1. Summary of Impacts to Recreation Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Construction Phase			
Size	Small (localized)	Small (localized)	No change from current condition
Duration	3-4 years (short-term), temporary, or intermittent	3-4 years (short-term), temporary, or intermittent	
Likelihood	High	High	
Severity	Moderate (direct, adverse) Slight (Indirect, adverse and beneficial)	Slight (direct, adverse) Slight to Moderate (Indirect, adverse and beneficial)	

<table>
<tr><th rowspan="2">Impact Factors</th><th colspan="3">Magnitude of Impacts</th></tr>
<tr><th>Alternative 1</th><th>Alternative 2</th><th>No Action Alternative</th></tr>
<tr><th colspan="4">Operation Phase</th></tr>
<tr><td>Size</td><td>Medium (regional)</td><td>Medium (regional)</td><td rowspan="4">No change from current condition</td></tr>
<tr><td>Duration</td><td>100+ years (long-term)</td><td>100+ years (long-term)</td></tr>
<tr><td>Likelihood</td><td>Medium</td><td>Medium</td></tr>
<tr><td>Severity</td><td>Severe (beneficial)
Slight to Moderate (direct, adverse)</td><td>Severe (beneficial)
Slight (direct and indirect, adverse)</td></tr>
</table>

4.9.1 No Action Alternative

This alternative would not include construction activities in or adjacent to Bois d'Arc Creek, and therefore would not cause any short- or long-term impacts to visitor opportunities, the recreational experience, the aesthetic value of recreation amenities and conditions, or the fulfillment of aesthetic values. Access to both water- and land-based recreational opportunities would remain unchanged.

Bois d'Arc Creek

Bois d'Arc Creek would continue to be used for recreation by private landowners and their guests. The recreational experience and aesthetic value of boating, wildlife observation, bird watching, fishing, hunting, trapping, and enjoyment of scenic natural beauty in Bois d'Arc Creek are expected to remain the same.

Legacy Ridge Country Club

The LRCC would continue to be used as a semi-private golf facility. It is currently partially protected by berms, but part of the golf course is below the 100-year flood plain level at 541 feet MSL. Under the No Action Alternative, the intermittent flooding of the "back nine" holes of the golf course would continue to occur after heavy rain events. This is expected to continue and cause temporary impacts to golfers during closures (which generally last seven days) or until it is deemed "playable."

A housing development is planned on the west side of the golf course and country club, with a lot of the infrastructure – water, electricity, and sewer – already in place. However, golf course real estate without the adjacent golf course would devalue the land considerably given the risk of flooding on the "back nine" (NTEN, 2010). While the reservoir has not been constructed, the owner noted that the "uncertainty of the project negatively impacts us now. Any potential buyer must be informed of the reservoir's impact" (LRCC, 2011). Under the No Action Alternative, the land would not be devalued and is expected to sell without uncertainty of the reservoir negatively affecting business transactions.

Caddo National Grasslands WMA and Regional Lakes and Reservoirs

Visitation and visitation expenditures at nearby reservoirs, lakes, and recreational areas are also expected to remain the same. The projected population growth in the region and the (assumed) simultaneous recreational demand would likely put pressure on existing recreational facilities and opportunities within the region, and could degrade the quality of the recreation experience if the parks become overcrowded. That said, county and regional population may not grow as quickly as projected with the selection of the No Action Alternative.

4.9.2 Alternative 1

Under Alternative 1, the reservoir footprint and surface area would be 16,641 acres and the reservoir's normal water surface or conservation pool would be maintained at 541 feet MSL. Alternative 1 would include the construction of water transmission, storage, and treatment facilities, including a 35-mile pipeline from the proposed reservoir site to a water treatment plant (WTP) and terminal storage reservoir (TSR) near the City of Leonard in southwest Fannin County. There are no recreational areas in or around the proposed WTP and TSR and as such are not discussed further. Potential direct and indirect impacts on recreation in and around Bois d'Arc Creek are evaluated for the construction and operation phase of each action alternative.

Construction Phase

Bois d'Arc Creek

Existing recreation activities in Bois d'Arc Creek would cease once the construction phase begins, and last the duration of the three- to four-year construction phase and beyond. Boating, bird watching, fishing, trapping, and enjoyment of scenic natural beauty in Bois d'Arc Creek would no longer be available to private landowners. The size or physical extent of such adverse impacts would be small (localized), given the relatively few number that would be affected.

Values and beliefs associated with recreation link residents to public lands and resources. Landscape appearance and scenery can be important public land amenities, not just as recreational opportunity settings, but also as elements of the region's identity. In 2010, brothers Russell and William Graves released a documentary entitled "Bois d'Arc Goodbye," "…a story about how a creek…transforms. The transformation affects not only the landscape, but people as well. This is a story about a creek's cultural, natural, and historic importance to a rural part of Texas" (Graves, 2010). This concern, while real, is voiced by a few residents and does not necessarily reflect the beliefs of the majority of those that would be affected.

That said, the documentary does appear to generally reflect public comments submitted during the scoping period regarding existing flora and fauna in the project area (USACE, 2010c). The value held by natural resources for purposes other than direct use is called non-use value (Brookshire, 1983). There is value in knowing that Bois d'Arc Creek exists, even for those who do not visit or use it for recreational or other purposes. The existence value of Bois d'Arc Creek reflects the benefit people receive from knowing that it exists, or its intrinsic value. Several commenters – landowners and local residents alike – were concerned with the destruction of Bois d'Arc Creek and the wildlife it supports.

Legacy Ridge Country Club

The owner of the Legacy Ridge Country Club (LRCC) has indicated the possibility of replacing the "back nine" portion of the golf course located below 541 MSL, which would be a costly and lengthy process (LRCC, 2011). It is unclear if the new "back nine" would be available at the time construction of the proposed LBCR begins. For purposes of this analysis, it is assumed the "back nine" would not be, and that the NTMWD would lease the approximately 47 acres of land below 541 MSL from the LRCC (LRCC, 2011). Under this scenario, the LRCC would continue to operate its existing golf course, including the "back nine" portion which would be located immediately southwest of the upstream edge of the proposed reservoir.

The use of heavy equipment, clearing and grading of land, and the construction of access roads would cause scenic degradation, decreased air quality, and distractions to golfers (e.g., noise) on the "back nine" holes. Emissions from the use of heavy equipment, airborne dust, and soil surface disturbance could degrade the air quality and adversely affect the golfing experience. As discussed in Section 4.6, Acoustic Environment (Noise), increased noise levels would occur from tree clearing activities, the use of cranes and concrete trucks, mud pumps, diesel generators, and heavy construction vehicles during the construction of the dam. Locations more than 800 feet from use of heavy equipment would seldom experience appreciable levels of construction noise. To minimize the effects of noise impacts, construction would primarily occur during normal weekday business hours in areas adjacent to noise sensitive land uses such as recreation areas; and construction equipment mufflers would be properly maintained and in good working order. Depending on the exact location of construction activities and therefore the distance to the golf course, potential impacts would be either direct and indirect, and last the duration of the construction phase.

Revenue would likely decline during the construction phase, as would beneficial impacts to labor income, value added, and jobs associated with non-local visitor spending at the LRCC. Its owner would continue to have difficulty selling real estate on the west side of the golf course and country club, and would likely be forced to sell at a loss.

Caddo National Grasslands WMA

Construction activities at the reservoir would not cause any of the recreational facilities at Caddo National Grasslands WMA to close. However, the use of heavy equipment, clearing and grading of land, and the construction of access roads could cause short-term impacts to recreationists in the Bois d'Arc Unit, which (as shown in Figure 3.7-1) includes several campsites, multi-use trails, recreational fishing and boating lakes, and hunting opportunities. The use of heavy equipment would likely cause scenic degradation and distractions to users (e.g., noise), particularly those at CR 2285 and CR 2700 or hunters seeking a natural outdoor recreational experience.

Emissions from the use of heavy equipment, airborne dust, and soil surface disturbance could also degrade the air quality and directly and indirectly affect recreationists in the southern portion of the Bois d'Arc Creek Unit and throughout. Depending on the exact location of construction activities and therefore the distance to the recreational facility or recreationist, potential impacts would be either direct and indirect, and last the duration of the construction phase.

Visitors might avoid activities in the southern portion of the Bois d'Arc Creek Unit, opting for quieter or more pleasant recreational experiences offered in other parts of Caddo National Grasslands WMA. This could cause a higher concentration of visitors at other facilities and degrade the experience for all visitors in the northern parts of the Bois d'Arc Creek Unit.

As discussed in Section 4.13.2.3.1, the construction phase would create a total of about 5,000 person-years of employment, or 5,000 full-time jobs for one year. While a portion of the construction workforce would be hired locally (in Fannin County) and a portion would be hired regionally (from surrounding counties); a portion would also relocate from outside of the region. An increase in the local population due to the presence of the construction workforce may also affect the recreational experience – for hunters specifically – at Caddo National Grasslands WMA. Caddo National Grasslands WMA is the only recreational area in Fannin County that in addition to boating, camping, swimming, hiking, fishing, and picnicking opportunities; offers hunting opportunities. As such, any increase in hunting in Fannin County would likely occur on the Bois d'Arc Creek Unit at the Caddo National Grasslands WMA. Visitor spending at restaurants, recreation outfitters, or other businesses in the local area would benefit in terms of jobs, labor income, and value added; but it could also degrade the experience for existing hunters seeking solitude and quiet.

As discussed in Section 4.12 (Transportation), congestion would increase in the immediate project area due to additional vehicles and traffic delays. FM 1396 is an existing two-lane TXDOT asphalt road that runs from Ravenna; east across the county transecting the proposed reservoir; and south to Honey Grove and Ladonia. FM 1396 would not be available during (or after) the construction phase, and as such recreationists from the south or southeastern portion of Fannin County using FM 1396 to access the Bois d'Arc Creek Unit could experience longer travel times. Recreationists accessing the Bois d'Arc Creek Unit from FM 100 could also be affected by increased traffic and time delays due to increased congestion and additional vehicles in the project area.

Recreationists accessing the Ladonia Unit from SH 34 could also experience traffic and delays during construction of the 35-mile pipeline to the Leonard WTP. Pipeline construction would not be fixed in one location but would progress along the pipeline. Any congestion or increase in traffic associated with construction of the pipeline that would increase travel time for hunters or campers accessing the Ladonia Unit would be temporary and intermittent, and last for the duration of pipeline-related construction activities but not for the full duration of the three- to four-year construction phase. Given the distance from the Ladonia Unit to the pipeline, the limited hunting that occurs on this unit, and the single camping facility available (CR 3910), there would be no impacts to hunting opportunities or the recreational experience of campers or hunters.

Regional Lakes and Reservoirs

Construction activities would directly affect visitation and the recreational experience at Bonham City Lake, which is located immediately west of the upstream edge of the proposed reservoir. Similar to Caddo National Grasslands WMA and the LRCC, adverse impacts during picnicking, camping, boating, fishing, and swimming would occur due to scenic degradation, air quality impacts, and disturbances (e.g., noise). Given the proximity to the proposed LBCR, visitation would be expected to decrease for the duration of the construction period.

Construction activities may indirectly increase visitation at regional reservoirs from the portion of the construction workforce that has relocated from outside of the region; and their spending at local reservoirs would have an economic benefit to the county. Increased visitation may also put pressure on existing recreation facilities; and degrade the experience for other visitors. Any indirect impact on the recreational experience or benefit from the revenue of additional visitor spending at or around a lake would be slight.

Operation Phase

Bois d'Arc Creek

Existing recreation activities for private landowners in Bois d'Arc Creek would permanently cease in the long-term. Similar impacts would continue to landowners and local residents as they relate to the non-use and existence values associated with Bois d'Arc Creek.

Alternative 1 would create a new, 16,641-acre water supply reservoir that would serve as a major new outdoor recreation asset for Fannin County and the region. At this stage, no specific recreational facilities, activities, designs or locations have been chosen. However, Fannin County's Draft Comprehensive Plan for the LBCR (Fannin County's Plan), published in July 2016, includes plans for public access points, opportunities for both passive and active recreation, and trail connections that are summarized below.

- *Public Access Points* – Public access points were identified to give all residents and visitors sufficient access; near areas for suitable marina locations; where nonresidential uses could potentially develop; and in areas where parkland was identified. Further site evaluations are needed to be certain that these areas are suitable for recreational areas.
- *Recreational Areas* – Develop recreational areas adjacent to the lake near proposed boat docks, marinas, and areas where major thoroughfares are located. Parks for active recreation to include camping, playgrounds, swimming areas, trails (paved and unpaved), and fitness trails/exercise areas. Parks for passive recreation to include nature preserves, bird watching, pier fishing, picnic areas, and pavilions.
- *Trail Connections* – Connect as many parks and recreational amenities as possible so that visitors can travel freely between them. The trails should also tie into the regional trail network to increase the accessibility of the lake. All trails should be multi-purpose to allow walkers, runners,

and cyclists; and can either be paved or left natural depending on the environment of the area (Fannin County, 2016).

Figure 3.9-1 below is from Fannin County's Plan, and shows the location of potential marinas, recreation areas, boat ramps, park areas, and trails.

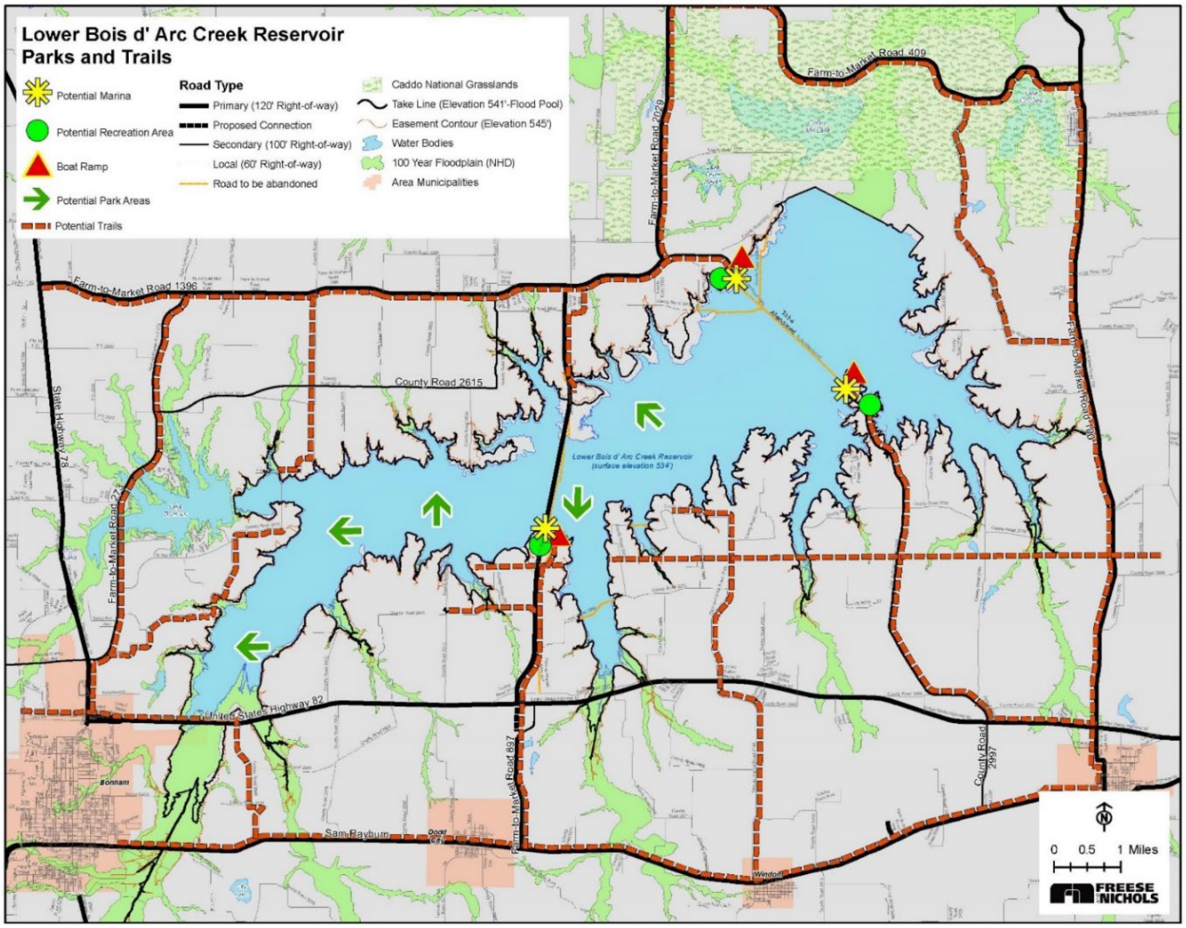


Figure 4.9-1 Potential Marinas, Recreation Areas, Boat Ramps, Park Areas, and Trails at LBCR

Source: Fannin County, 2016.

Public scoping comments and input from interested parties (Fannin County's Plan) emphasized the importance of boating and fishing at the proposed LBCR. The planned boat ramps, marinas, and fishing piers would provide facilities for new fishing and boating opportunities. The biological analysis has indicated that the reservoir should be able to support high-quality recreational fishing opportunities for species such as smallmouth buffalo, yellow bullhead, channel catfish, green sunfish, warmouth, bluegill, longear sunfish, redear sunfish, largemouth bass, and white crappie. Parks, campgrounds, parks, and trails would provide several new opportunities for swimming; camping; biking, running, and walking; and birdwatching. As discussed in the Socioeconomics section (4.13.2.3.2), once the reservoir is fully developed, non-local recreational visitors are estimated to spend between $16.7 and $21.9 million annually. This spending would generate between $21.2 and $28.2 million in economic activity, support approximately 300 to 400 new jobs, and increase local earnings by $6.2 to $8.3 million (Clower, 2012).

Residential homes (e.g., single family, two-family, manufactured home) are also planned for development around the lake, the majority on larger properties (i.e., one acre) in an effort to maintain the rural character of the area (Fannin County, 2016). At least 2,100 new dwellings would be constructed in the area surrounding the reservoir as weekend/vacation homes and investment properties. Weekend and vacation residents would be expected to bring an equivalent of $10 million in household income that would be used for local purchases (Clower, 2012). Nonresidential development would be primarily located along major thoroughfares and limited throughout the 5000-foot lake buffer or planning area surrounding the lake, and would generally include restaurants, hotels, small shops, and marinas. By modeling the combined incomes of permanent residents and the proportional income of weekend residents using regionally based estimates of spending, Fannin County would realize a net increase in economic activity of between $80.7 and $89.2 million per year once full development is reached. This activity would support 517 to 572 permanent jobs, or the equivalent of $13.3 to $14.7 million in salaries and wages. Fannin County's Plan also recommends developing standards for future recreational vehicle (RV) parks and camping areas, which would be located within the nonresidential land use since they fall within the commercial category (Fannin County, 2016). In addition to residential homes and hotels, the development of RV parks would further support overnight stays – similar to the facilities available at Lake Texoma. This could further encourage annual visitation and visitor spending; and contribute to the impact on labor income, value added, and jobs created.

Concerns were raised during scoping about whether the water level and shoreline of the new lake would fluctuate considerably. Since the primary purpose of the reservoir is water supply, not lake-based recreation, maintaining a constant shoreline is not the highest priority. There would be considerable fluctuation in lake level, as shown in Figure 4.9-2 (from Fannin County's Plan). Based on the historic hydrologic record of 50 years, the lake is projected to be between 516 and 534 feet about 80 percent of the time; over 534 feet about 10 percent of the time; and under 516 feet about 10 percent of the time. Even when lake levels are below 516 feet, the majority of the lake would still be deep enough for fishing and boating. Varying lake levels were taken into account when identifying public access points because the upper end of the lake (the western portion) would be the first part of the lake to experience limited access in a season of drought, due to higher elevations. Therefore, it is unlikely that water level fluctuation would affect access to recreational facilities and opportunities created under Alternative 1.

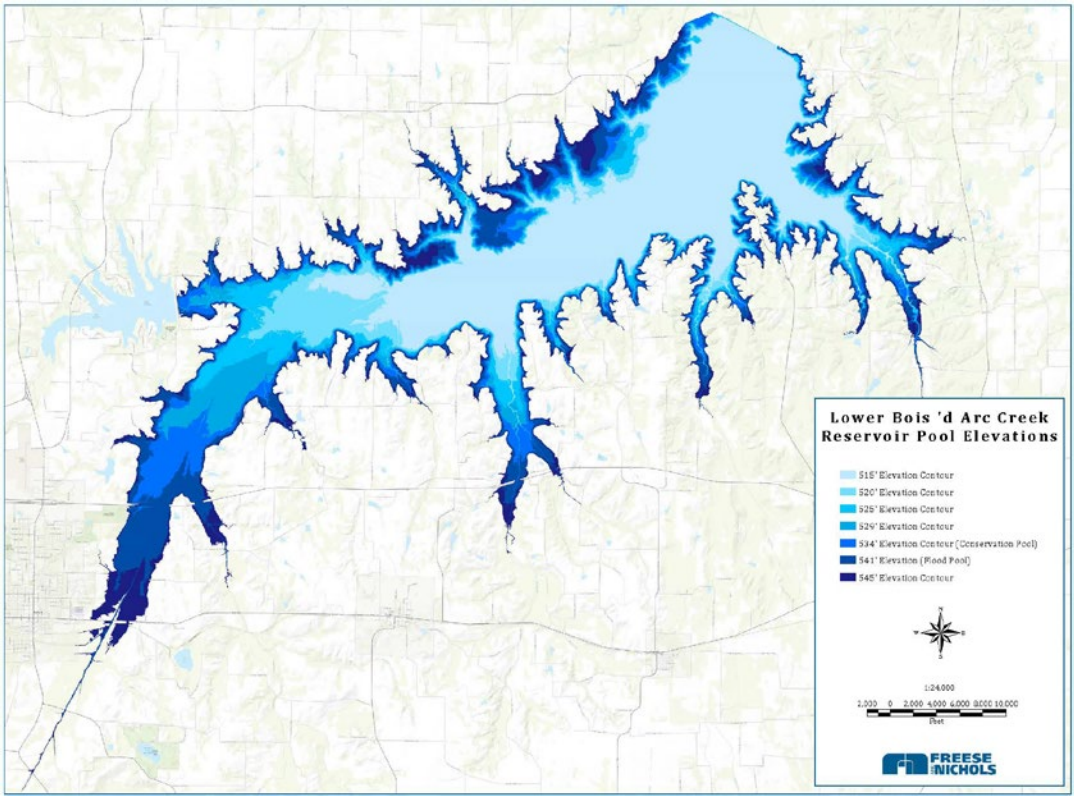


Figure 4.9-2. Lower Bois d'Arc Creek Reservoir Pool Elevations

Source: Fannin County, 2016

As shown in Table 3.7-3 and discussed in the affected environment section, water fluctuation, the number and type of recreational facilities and opportunities, and surface area vary at existing, regional reservoirs and lakes; and it is difficult to tell in these cases if any one factor directly increases or decreases visitation. Lake Texoma and Lake Tawakoni, while considerably larger than the proposed LBCR, are used as the main case studies in this analysis because both reservoirs experience considerable fluctuation and other commonalities make them comparable to each other and to the proposed LBCR. While Lake Tawakoni has about half the surface area of Lake Texoma, it received less than one percent of the visitors Lake Texoma received in FY 2012. At Lake Texoma, water fluctuation does not appear to affect visitation; in the case of Lake Tawakoni, it would appear that it might.

While not directly comparable to the proposed LBCR or regional reservoirs, it should be noted that a study on the effect of Tennessee Valley Authority (TVA) reservoir water levels on recreational fishing concluded that water levels were not a major barrier to participation but levels did affect the number of trips taken by anglers. In the case of the TVA reservoirs, lower water levels left many coves and boat ramps landlocked for much of the year, restricting the ability of reservoir anglers to launch boats (Jakus et al., 2000). As noted above, varying lake levels were taken into account when identifying public access points to avoid or minimize scenarios where access to the proposed LBCR is limited.

In these cases, it is more likely that water fluctuation does not much affect visitation at either reservoir; that instead factors such as additional housing facilities and land-based recreational opportunities and higher-quality recreational fishing at Lake Texoma increase visitation. In addition to camping, RV sites, and motels offered at Lake Tawakoni, Lake Texoma also offers cabin, lake house, and condo rentals. Hunting opportunities are available on 39,125 acres in the Tawakoni WMA compared to 90,000 acres at

Lake Texoma, not including additional opportunities at the adjacent Hagerman NWR (TPWD, 2017b; USACE, no date-c). Lake Texoma offers 25 miles of equestrian and hiking trails, while Lake Tawakoni offers five miles of hiking trails (USACE, no date-c; TPWD, no date-f). While both offer fishing, Lake Texoma is stocked with more types of fish and is one of the few reservoirs in the United States where striped bass reproduces naturally.

Based on Fannin County's Plan, the proposed LBCR is envisioned to combine elements of both Lakes Texoma and Tawakoni. In addition to developing RV sites, campsites, and multi-use trails for biking, running, and walking (but not equestrian), like Lake Texoma, LBCR would develop residential housing units and hotels. Like both lakes, LBCR would provide water-based recreational facilities (boat ramps, marinas) to support boating and fishing. And like both lakes, hunting (including deer-hunting) would be available at or near the proposed LBCR. While the proposed LBCR itself does not currently include plans for public hunting areas, the adjacent Caddo National Grasslands WMA may (perhaps inadvertently) increase visitation by appealing to all types of recreationists.

Legacy Ridge Country Club

The proposed LBCR would cause severe impacts to the "back nine" holes of the golf course after heavy rain events, which were constructed in the Lower Bois d' Arc Creek 100-year floodplain with the expectation that there would be periodic inundation. Once the proposed LBCR construction is complete, it is expected that the inundation pattern would be similar but with sustained ponding at depths that will damage the golf course's vegetation and drainage system. The water surface profile upstream of Highway 82 would be influenced by the release of the impoundment through the 150-foot wide service spillway. Depending on the volume of runoff and frequency of storm events, the inundation time on the golf course can be expected to extend seven days. With water standing on the golf course for this length of time it can reasonably be expected that the health of grass on the course would be compromised; sediment would build up within the flooded areas; and that drains for the greens and tee boxes would become blocked and increase the water table, creating saturated soils within low areas of the golf course. Minor maintenance level repairs; replacement of portions or all of the fairway grass in the "back nine" holes; and replacement of portions of the greens could be required at various elevations and locations (Boyd, 2010).

Prolonged closures and costly damage to the golf course would cause moderate to severe adverse impacts to the LRCC. Non-local visitation would likely decrease as the golf course would essentially be reduced to a nine-hole golf course part of the time. Impacts to visitation would depend on the frequency and runoff of storm events and the duration of closures. Decreased revenue at the LRCC would be expected to continue into the operations phase, as well as the associated impacts to labor income, value added, and jobs associated with non-local visitor spending.

Because the LRCC receives 80 percent of its revenue coming from out-of-town golfers and the repair costs could be high, it would be at risk of eventually closing as a result (NTEN, 2010). The closure of the LRCC would also cause adverse impacts to local golfers who account for the other 20 percent of revenue. Closure of the LRCC would adversely impact labor income, value added, and jobs associated with non-local visitor spending. Whether the LRCC closes or not, its owner would continue to have difficulty selling real estate on the west side of the golf course and country club, and would likely be forced to sell at a loss.

Caddo National Grasslands WMA

In the long-term, access to Caddo National Grasslands WMA would essentially be the same with the replacement of FM 1396 with FM 897. Visitors travelling from the south may experience slightly higher travel times given that FM 897 is west of the FM 1396, and due to potential traffic from those accessing the LBCR. The proposed LBCR would likely not directly affect the water-based recreational opportunities or experience at lakes within the Caddo National Grasslands WMA, because the LBCR is not directly upstream from these lakes. As such, the biological or hydrological characteristics of these lakes or other recreational areas would not be altered.

It is difficult to say whether visitation at the Caddo National Grasslands WMA would increase or decrease overall as a result of the proposed LBCR. Generally speaking, both LBCR and the Caddo National Grasslands WMA would offer similar recreational opportunities, including boating, swimming, fishing, picnicking, trail, camping, and wildlife watching opportunities. LBCR would offer opportunities on a much larger scale, and ultimately visitation would depend on personal preference (with the exception of hunting, discussed further below). Some Caddo National Grasslands WMA visitors may shift to the LBCR, especially if the fishing experience is deemed higher-quality. Some Caddo National Grasslands WMA visitors may continue undeterred, especially those seeking a smaller-scale, quieter recreational experience. With the projected population growth, it may be that eventually neither would be able to offer quiet experiences in solitude.

Given that Caddo National Grasslands WMA is the closest recreational area offering hunting opportunities, visitation as it relates to hunting would be expected to increase. As a result, the recreational experience for hunters may be degraded for those seeking solitude and quiet. Visitation at other regional WMAs or public hunting lands may also increase as an indirect result of the LBCR and the degraded hunting experience at Caddo National Grasslands. Local and regional outfitters would likely benefit from increased revenue in the long-term.

NTMWD has purchased and proposes to restore and enhance natural habitats at the 15,000-acre Riverby Ranch in order to mitigate the impacts of Alternative 1 to waters of the United States. Under Alternative 1, the Riverby Ranch would be transferred to the USFS and managed for conservation and recreation as part of the Caddo National Grasslands WMA. Currently, wildlife on Caddo National Grasslands WMA includes white-tailed deer, small mammals, coyotes, bobcats, red fox, waterfowl, bobwhite quail, turkey and songbirds, all of which are likely to benefit from the additional 15,000 acres of habitat. In the long-term, the additional recreational opportunities for hunting and wildlife viewing would likely cause visitation to increase.

Regional Lakes and Reservoirs

Similar to the above discussion of visitation impacts on the Caddo National Grasslands WMA, it is difficult to say if visitation at Bonham City Lake would increase or decrease overall as a result of LBCR. In general, Bonham City Lake and LBCR offer similar opportunities, including boating, fishing, swimming, camping picnicking. However, the recreational opportunities offered at LBCR would be on a much larger scale and also include trails and facilities conducive to overnight stays (e.g., RV, residential units, hotels). LBCR visitors could "spill over" into Bonham City Lake, especially existing or new residents seeking to avoid crowds on long or popular summer weekends. But Bonham City Lake visitors could also shift to LBCR if recreational opportunities are deemed higher-quality.

During the public meeting for Fannin County's Plan, one of the key takeaways was that a connection between the LBCR and Bonham City Lake is important – specifically throughout the parks (Fannin County, 2016). As shown in Figure 4.9-1, recreational areas are proposed south and east of Bonham City Lake and potential LBCR trails would connect visitors to Bonham City Lake via FM 273 and CR 2610. As described in the affected environment, both access points for Bonham City Lake – Bonham City Lake Recreation Area and North Ramp – are accessible off of FM 273. Bonham City Lake Recreation Area can be accessed via Recreation Road 3 (perpendicular to FM 273 and CR 2610), and the North Ramp can be accessed via Fannin County Road 2524 and Boat Ramp Road (directly off of FM 273). Connecting two LBCR recreational areas and Bonham City Lake access points with trails would likely increase visitation at Bonham City Lake by incorporating it into LBCR.

It is also difficult to discern whether the introduction of a new recreational reservoir in Fannin County would affect visitation at other regional reservoirs. Despite fishing, boating, camping, wildlife viewing, picnicking, and hunting opportunities currently available in Fannin County, it is possible for some Fannin County residents to visit (or continue to visit) regional reservoirs, ostensibly to experience these recreational opportunities on a larger scale. But with the introduction of a large reservoir with high-quality recreational opportunities, it is expected that Fannin County residents would visit LBCR instead of travelling to visit regional reservoirs. As such, the LBCR is expected to cause visitation to decrease at regional lakes and reservoirs. Any decrease in visitation from Fannin County residents would likely be imperceptible if projected population growth in the region is realized. Businesses located in Fannin and surrounding counties would likely offer goods and services to new permanent and weekend residents. The economic activity of these counties, including spending by households drawn to the new reservoir, would increase economic output in the broader region by $105 to $116 million, boost local income by $22 to $24 million, and support between 857 to 947 permanent jobs (Clower, 2012).

Conclusion

During the construction phase, the severity of direct, adverse impacts on recreation would be moderate overall. The use of heavy equipment, clearing and grading of land, and the construction of access roads would cause scenic degradation, decreased air quality, and distractions (e.g., noise) to nearby recreationists. Impacts would be felt most at Caddo National Grasslands WMA, Bonham City Lake, and LRCC, and as such the size or physical extent of impacts would be small (localized). Given the proximity to construction activities, the likelihood of impacts would be high. Displaced recreationists in combination with newly relocated construction workers could cause an increase in visitation at regional lakes and reservoirs. Indirect, beneficial impacts from construction workers' recreational spending would be slight. Pipeline-related construction impacts would be temporary and intermittent, and dam and reservoir-related construction impacts would last the duration of the construction phase.

Recreational activities in Lower Bois d'Arc Creek would cease during the construction and operation phase, and adverse impacts as they relate to the Bois d'Arc Creek's existence and non-use value would be felt by private landowners and local residents alike. Adverse impacts to the LRCC are highly likely in the long-term, as flooding could cause costly damage to the "back nine" holes of the golf course, prolong closures, and decrease visitation. While the likelihood would be low, if the LRCC closes due to decreased revenue, increased repair costs, and devalued real estate, adverse impacts to the owners of LRCC would be severe.

Once the reservoir is operational, the numerous recreational opportunities that would be provided with the development of boat ramps, marinas, trails, parks, and campgrounds would create direct, beneficial impacts. These benefits would be felt by residents and outfitters in Fannin County as well as in the region, therefore the size or physical extent would be medium (regional). Non-local recreational visitors are estimated to spend between $16.7 and $21.9 million annually, which would generate between $21.2 and $28.2 million in economic activity, support approximately 300 to 400 new jobs, and increase local earnings by $6.2 to $8.3 million. Economic impacts would become more and more positive or beneficial over time, especially with the development of residential units. Weekend and vacation residents would be expected to bring an additional equivalent of $10 million in household income that would be used for local purchases (Clower, 2012). Indirect, adverse impacts from decreased visitation at regional lakes and reservoirs would be slight, and economic output in the broader region would increase by $105 to $116 million, boost local income by $22 to $24 million, and support between 857 to 947 permanent jobs (Clower, 2012). It is unclear whether considerable water fluctuation would ultimately impact visitation at LBCR, but access points would be strategically sited in locations less vulnerable to changes in water level to avoid affecting access to recreational facilities and opportunities. The development of real estate, hotels, and RV sites would encourage overnight stays, and adjacent hunting opportunities at Caddo National Grasslands WMA diversifies the land-based opportunities available in the area. While the likelihood of beneficial impacts would be moderate in light of the aforementioned unknowns, overall the beneficial impacts to Fannin County would be severe due to the economic stimulus that would be associated with the recreational reservoir.

4.9.3 Alternative 2

Under Alternative 2, the reservoir's normal water surface, or conservation pool, would be maintained at 515 feet MSL, and have a surface area of approximately 8,600 acres – about half the surface area of Alternative 1. The reservoir footprint (9,390 acres) under Alternative 2 would also be roughly half the size of the reservoir footprint under Alternative 1. Many of the potential impacts on visitation, visitor spending, recreational experience and aesthetic value are would be similar to Alternative 1, and differences in impacts from the downsized reservoir under Alternative 2 are noted throughout the analysis. The size and location of the raw water transmission, storage, and treatments facilities in Leonard as well as the 35-mile pipeline connecting it to the reservoir would essentially be the same as under Alternative 1. As such, impacts associated with the 35-mile pipeline are summarized throughout the section but the detailed analysis is not repeated.

The blending portion of Alternative 2 would include a new 25-mile pipeline from Texoma to the balancing reservoir near Howe, Texas in Grayson County. Additional impacts on the recreational experience and access to opportunities in Fannin and Grayson counties are analyzed below.

<u>Construction Phase</u>

Bois d'Arc Creek

Under Alternative 2, existing recreation activities would cease in the majority of Bois d'Arc Creek once reservoir construction begins, and last the duration of the three- to four-year construction phase and beyond. Boating, bird watching, fishing, trapping, and enjoyment of scenic natural beauty would no longer be available to Bois d'Arc Creek landowners within the reservoir's footprint. Recreation activities would continue in the western portion of Alternative 1's reservoir footprint, or the area directly east of Bonham City Lake and LRCC. The size or physical extent of such adverse impacts would be smaller than under Alternative 1, but still be considered small (localized) overall, given the relatively few number of people that would be affected. Similar impacts as they relate to existence and non-use values associated with Bois d'Arc Creek and the wildlife it supports would also likely occur to affected private landowners and Fannin County residents.

Legacy Ridge Country Club

Impacts to the LRCC would be similar to those described under the No Action Alternative; impacts from construction activities under Alternative 1 would not occur. The "back nine" holes would be located about five miles southwest of the upstream edge of the proposed reservoir. Given this distance, construction activities would not affect air quality or cause scenic degradation to golfers. Locations more than 800 feet from use of heavy equipment would seldom experience appreciable levels of construction noise, so construction activities would not cause distractions to golfers, either.

For purposes of this analysis, it is assumed that the NTMWD would not lease any land from the LRCC, given that the "back nine" holes of the golf course would not be affected by the reservoir's conservation pool elevation (515 feet MSL). It would continue to be used as a semi-private golf facility, and the intermittent flooding on the "back nine" would continue to occur after heavy rain events. This is expected to continue and cause temporary impacts to golfers during closures (which generally last seven days) or until it is deemed "playable." Revenue is not expected to decrease as a result of construction activities.

The land with proposed real estate development would not be devalued and is expected to sell without uncertainty of the reservoir negatively affecting business transactions.

Caddo National Grasslands WMA

Under Alternative 2, construction activities at the reservoir would cause similar impacts at Caddo National Grasslands WMA as those described under Alternative 1. The use of heavy equipment, clearing and grading of land, and the construction of access roads could cause short-term impacts to recreationists throughout the Bois d'Arc Creek Unit. The recreational experience at campsites CR 2285 and CR2700, the hunting area surrounding CR 2285, and fishing and boating in Coffee Mill Lake would be impacted due to degraded scenery and air quality and increased distractions (e.g., noise). Visitors seeking to distance themselves from construction activities near the dam and spillway may increase the concentration of visitors in other areas and degrade the recreational experience for all visitors in the Caddo National Grasslands WMA.

As described in 4.14.3 of the socioeconomics section, the construction of Alternative 2 would be about $46 million more expensive than Alternative 1, or 7.8 percent more expensive. Given that it is unlikely that Fannin County and the surrounding counties could supply the trained construction workforce under Alternative 1, an even larger portion of labor would likely be filled from outside of the area for the construction phase of this alternative. With additional construction workers relocating from outside the region, construction activities may further indirectly increase visitation at Caddo National Grasslands WMA. As such, visitation during construction activities could be slightly higher compared to Alternative 1, especially given that Caddo National Grasslands is one of the few recreational areas in Fannin County that offers hunting opportunities on public lands. Visitor spending at restaurants, recreation outfitters, or other businesses in the local area would benefit in terms of jobs, labor income, and value added; but it could also degrade the experience for existing hunters seeking solitude and quiet. The indirect, adverse impact on the recreational experience or benefit from the revenue of additional visitor spending in the area would be more severe under Alternative 2.

FM 1396 transects the reservoir under both Alternatives 1 and 2, and would not be functional during the construction phase of either alternative. Travel times for recreationists accessing either the Bois d'Arc Creek Unit or Ladonia Unit could be prolonged under this alternative as well. The same 35-mile pipeline to the Leonard WTP that would be constructed under Alternative 1 would also be constructed under this alternative, and would not cause impacts accessing hunting opportunities or the recreational experience of campers or hunters at the Ladonia Unit.

Regional Lakes and Reservoirs

Unlike Alternative 1, construction activities under Alternative 2 would not cause direct impacts to visitation or the recreational experience of Bonham City Lake visitors. Bonham City Lake is located about three miles west of the upstream edge of the proposed reservoir under Alternative 2. Any scenic degradation, increase in noise levels, or impacts to air quality would not be seen, heard, or felt by recreationists at Bonham City Lake.

Under this alternative, construction of the additional 25-mile pipeline from Texoma to the balancing reservoir near Howe, Texas could cause temporary impacts to the access and the recreational experience of two Lake Texoma facilities. Visitors traveling west/northwest or east/southeast to access or return from Lake Texoma could experience some congestion and traffic, as they would be travelling perpendicular to the north/south directional 25-mile pipeline. The northern-most portion of the pipeline would be located within a few miles of Grandpappy Point and Eisenhower State Park, both of which offer picnic and camping areas, and construction activities could impact visitors due to scenic degradation and increased air emissions. Pipeline construction would not be fixed in one location but would progress along the pipeline. Slight, indirect impacts would be temporary and last for the duration of construction activities for the northern-most portion of the pipeline, but not for the full duration of the three- to four-year construction phase.

Construction of the eight-mile pipeline spur connecting the proposed North WTP in Leonard to the existing pipeline from Texoma to Wylie would not have any impacts because no recreational areas are located close by.

With additional construction workers relocating from outside the region, construction activities may further indirectly increase visitation at regional lakes and reservoirs. Any indirect, adverse impact on the recreational experience or benefit from the additional visitor spending at or around a lake would be more severe under Alternative 2.

Operation Phase

Bois d'Arc Creek

As under the construction phase of Alternative 2, recreational activities would continue in the western portion of Alternative 1's reservoir footprint, or the area east of Bonham City Lake and LRCC. However, existing recreational activities for private landowners in the majority of Bois d'Arc Creek would permanently cease in the long-term. Impacts to landowners and local residents as they relate to the non-use and existence values associated with Bois d'Arc Creek would be similar to those discussed under Alternative 1.

Alternative 2 would create a new, 8,600-acre water supply reservoir – about half the surface area of the reservoir under Alternative 1 – that would also serve as a major new outdoor recreation asset for Fannin County and the region. While Fannin County's Plan was developed for Alternative 1, for purposes of this analysis it is assumed that many of the same public access points, opportunities for passive and active recreation, and trail connections would also be developed in those areas overlapping with Alternative 2; but that some would be eliminated to adjust for a downsized reservoir or re-sited to apply to Alternative 2.

As such, three potential recreation areas, the proposed trails to the north, east, and south of the reservoir, the three marinas and public access points, and the new bridge crossing at FM 897 (replacing FM 1396) would presumably still be developed under Alternative 2. The reservoir under Alternative 2 would still support high-quality recreational fishing opportunities and the planned boat ramps, marinas, and fishing piers would provide facilities for new fishing opportunities.

However, it is assumed that two potential park areas included in Fannin County's Plan – one near the intersection of FM 273 and US Highway 82 and the other near Bonham City Lake – would not be developed under Alternative 2 because they would not be located on the reservoir's western shore under this alternative. Similarly, it is assumed that potential trails along CR 2610, FM 273, parts of FM 1396 located north of Bonham City Lake, and US Highway 82 near Bonham would not be developed. If an alternative trail under Alternative 2 does not connect Bonham City Lake to the proposed LBCR, the benefits of incorporating Bonham City Lake into LBCR would not occur. Generally speaking, the development of fewer park areas and trails under this alternative would create less severe beneficial impacts than Alternative 1 by providing fewer land-based opportunities for pier fishing; camping; biking, running and walking; and birdwatching. Once the reservoir is fully developed, fewer non-local recreational visitors are expected and therefore spending would be less under Alternative 2 than under Alternative 1. While their spending would still generate economic activity, support jobs, and increase local earnings, beneficial economic impacts would be less severe under this alternative.

It is also assumed that residential homes would still be planned for development around the lake under Alternative 2. Some of the larger, one-acre properties located west of FM 897 could not be developed under this alternative at the location(s) proposed in Fannin County's Plan. If these properties are not re-located (along the western boundary of the reservoir, for example), weekend and vacation residents would be expected to bring less than the equivalent of $10 million in household income that would be used for local purchases under Alternative 1. Under Alternative 1, nonresidential development including restaurants, hotels, small shops, and marinas are planned in areas that would overlap with Alternative 2, and as such are also expected to contribute to overnight stays and overall visitation. Developing standards for future RV parks and camping areas, as recommended in Fannin County's Plan under Alternative 1, would also further support overnight stays; encourage annual visitation and visitor spending; and contribute to the impact on labor income, value added, and jobs created.

The reservoir's conservation pool for this alternative would be maintained at an elevation of 515 feet MSL, but the actual water surface and shoreline would fluctuate above and below this level. Assuming the public access points planned under Alternative 1 would be the same under Alternative 2, it is unlikely that water level fluctuation would affect access to recreational facilities and opportunities under either alternative. Varying lake levels were taken into account when identifying public access points because the upper end of the lake (the western portion) would be the first part of the lake to experience limited access in a season of drought, due to higher elevations. As discussed under Alternative 1 and the affected environment, water fluctuation, the number and type of recreational facilities and opportunities, and surface area vary at existing, regional reservoirs and lakes; and it is difficult to tell if any one factor directly increases or decreases visitation. However, factors such as additional housing facilities and land-based recreational opportunities and higher-quality recreational fishing do appear to increase visitation in Lake Texoma's case. If fewer residential units, recreational areas, and trails are developed under Alternative 2, visitation is expected to be lower than under Alternative 1. The adjacent Caddo National Grasslands WMA would (perhaps inadvertently) contribute to visitation under Alternative 2 as well as under Alternative 1 by appealing to all types of recreationists.

Legacy Ridge Country Club

As discussed under the construction phase, it is assumed for purposes of this analysis that the NTMWD would not lease any land from the LRCC, given that the "back nine" holes of the golf course would not be affected with this reservoir's lower conservation pool elevation (515 feet MSL). Operation of the downsized reservoir would not cause adverse impacts to the LRCC, which would continue to be used as a semi-private golf facility. Intermittent flooding of the "back nine" would continue to occur after heavy rain events, but in contrast to Alternative 1 prolonged flooding and costly repairs would not occur. Once operational, the reservoir is expected to directly increase visitation at LRCC from "spillover" out of town LBCR visitors and golfers, benefiting LRCC as well as the local economy. The land with proposed real estate development could increase in value given its proximity to the reservoir, or at least is expected to sell without uncertainty of the reservoir negatively affecting business transactions.

Caddo National Grasslands WMA

Long-term impacts to access and visitation at Caddo National Grasslands WMA would be similar to those described under Alternative 1. Access would essentially be unaffected once FM 1396 is replaced with FM 897. The proposed LBCR would likely not directly affect the water-based recreational opportunities or experience at lakes within the Caddo National Grasslands WMA, because the LBCR is not directly upstream from these lakes. As such, the biological or hydrological characteristics of these lakes or other recreational areas would not be altered. Visitation could increase or decrease once the reservoir is operational, and would depend on personal preference because both the Caddo National Grasslands WMA and LBCR would offer the same opportunities (with the exception of hunting). As under Alternative 1, because Caddo National Grasslands WMA is one of the few recreational areas that offers hunting opportunities, visitation as it relates to hunting would be expected to increase, and the recreational experience may be degraded for those seeking solitude and quiet. Impacts would be less severe under Alternative 2 if overall visitation to the LBCR is lower than under Alternative 1.

Regional Lakes and Reservoirs

As under Alternative 1, it is difficult to say if visitation at Bonham City Lake would increase or decrease overall as a result of a new, recreational reservoir. Any increase in visitation is expected to be lower compared to Alternative 1 if trails are not developed to connect Bonham City Lake to the downsized reservoir. And as under Alternative 1, it is difficult to discern whether the introduction of a new recreational reservoir would affect visitation at other regional lakes and reservoirs. Despite the smaller size of the reservoir under this alternative, Fannin County residents would still be expected to visit LBCR instead of travelling to visit regional lakes and reservoirs. As such, any decrease in visitation at regional lakes and reservoirs is expected to the same as under Alternative 1. Spending by new permanent and weekend residents drawn to the downsized recreational reservoir would still benefit businesses located in Fannin and surrounding counties and increase economic output in the broader region, though the increase in local income and the number of jobs supported would be lower compared to Alternative 1.

Conclusion

Compared to Alternative 1, adverse impacts during the construction phase and beneficial impacts during the operation phase would generally be less severe, but overall impacts to recreation would be similar. During the construction phase, the severity of direct, adverse impacts would be slight overall – less severe than under Alternative 1. Given the smaller reservoir footprint, any scenic degradation, increase in noise levels, or impacts to air quality would not be seen, heard, or felt by recreationists at Bonham City Lake or LRCC. However, the aforementioned impacts would be felt by recreationists at Caddo National Grasslands WMA, so the size or physical extent of impacts would be small (localized). Given the proximity of Caddo National Grasslands WMA to dam and spillway construction activities, the likelihood of impacts would be high. Displaced recreationists in combination with (even more) newly relocated construction workers could cause an increase in visitation at regional lakes and reservoirs. Indirect, beneficial impacts from construction workers' recreational spending would be slight to moderate – more severe compared to Alternative 1. Pipeline-related construction impacts would be temporary and intermittent, and dam and reservoir-related construction impacts would last the duration of the construction phase.

Under Alternative 2, recreational activities would continue in the western portion of Alternative 1's reservoir footprint during both the construction and operation phases. However, existing recreational activities for private landowners in the majority of Bois d'Arc Creek would permanently cease. The size or physical extent of slightly adverse impacts in Bois d'Arc Creek would be small (localized), directly affecting a smaller number of private landowners compared to Alternative 1. Impacts to landowners and local residents as they relate to the non-use and existence values associated with Bois d'Arc Creek would be similar to those discussed under Alternative 1, and are highly likely to occur based on public scoping comments.

Once the reservoir is operational, many of the same, numerous recreational opportunities and facilities that would be provided under Alternative 1 would also be provided under Alternative 2. While the surface area of the reservoir under Alternative 2 is about half the size of the reservoir under Alternative 1, the severity of beneficial impacts is not proportional to the size of the reservoir. Local and non-local visitor spending would be somewhat less impactful to the local economy compared to Alternative 1, but would still generate millions in economic activity and support hundreds of new jobs. Therefore, direct, beneficial impacts would be severe under this alternative as well. Visitation is still expected to increase at nearby recreational areas due to "spillover" from the LBCR reservoir, including at LRCC, but beneficial economic impacts from increased visitation would be somewhat less severe than under Alternative 1 if overall visitation is lower under Alternative 2. Assuming that Fannin County residents would still visit the downsized LBCR under Alternative 2, any decrease in visitation at regional lakes and reservoirs would be the same as under Alternative 1. As under Alternative 1, it is unclear whether considerable water fluctuation would ultimately impact visitation at LBCR, but access points would be strategically sited in the same locations less vulnerable to changes in water level to avoid affecting access to recreational facilities and opportunities. While the likelihood of beneficial impacts would be medium in light of the aforementioned unknowns, either alternative is expected to transform Fannin County as a recreational destination and benefit residents and outfitters in Fannin County as well as the region.

4.10 VISUAL RESOURCES

The visual resources analysis conducted for this revised DEIS involves defining and, to the extent possible, quantifying the potential visual impacts from construction and operation of the dam and reservoir for each alternative. A summary of the visual resources impacts discussed in the following sections is provided in Table 4.10-1.

Table 4.10-1. Summary of Impacts to Visual Resources Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Construction Phase			
Size	Viewshed of the reservoir and dam footprint	Viewshed of the reservoir and dam footprint	No change from current conditions.
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Moderate	Moderate	
Operation Phase			
Size	Viewshed of the reservoir and dam	Viewshed of the reservoir and dam	Slight change to visual character of landscape likely caused by the expected population growth and development over the coming decades.
Duration	100+ years (long-term)	100+ years (long-term)	
Likelihood	High	High	
Severity	Severe	Severe	

The BLM Visual Resource Management (VRM) process, described in Section 3.8, was used to evaluate impacts to visual resources in the project area. The VRM consists of two stages, the visual resource inventory which rates the visual appeal of a tract of land (described in Section 3.8) and the visual resource contrast rating. The visual resource contrast rating involves comparing the proposed project features with the major features in the existing landscape using the basic design elements of form, line, color, and texture (BLM, 1986b):

Form – The mass or shape of an object or of objects which appear unified.

Line – The path that the eye follows when perceiving abrupt differences in form, color, or texture.

Color – The property of reflecting light of a particular intensity and wavelength to which the eye is sensitive.

Texture – The aggregation of small forms or color mixtures into a continuous surface pattern.

Table 4.10-2 outlines the criteria for the contrast rating process used in this analysis. The impacts to visual resources that would occur under each alternative were determined using these criteria and the VRM results presented in Section 3.8. A discussion of the impacts to visual resources under each alternative is provided in the following sections.

Table 4.10-2. Criteria for the Visual Resource Contrast Rating Process (BLM, no date-b)

Degree of Contrast	Criteria
None	The element contrast is not visible or perceived.
Weak	The element contrast can be seen but does not attract attention.
Moderate	The element contrast begins to attract attention and begins to dominate the characteristic landscape.
Strong	The element contrast demands attention, will not be overlooked, and is dominant in the landscape.

4.10.1 No Action Alternative

Under the No Action Alternative, the reservoir and dam would not be constructed. Therefore, the visual environment at the proposed site would remain unchanged, at least in the short term. The No Action Alternative would have no immediate impacts to visual resources. Over the long term, it is difficult to predict how land use changes may incrementally and cumulatively affect visual resources in the region. However, if the population in the region grows and development proceeds in tandem, the Bois d'Arc Valley may lose some of its existing rural appearance, in which open space is currently dominant.

4.10.2 Alternative 1

Construction

It is estimated that the construction of the proposed dam would require 3 to 4 years. The dam would be 10,400 feet long with a maximum height of 90 feet. Due to the height of the proposed dam, the viewshed of visitors to the Caddo National Grasslands and travelers on FM 1396 would be affected during construction. Tree clearing for construction of the proposed reservoir would occur prior to construction of the embankment of the dam, and would likely have less of a visual impact than the construction of the dam due to the more localized nature of the tree clearing. Tree clearing would only occur in select areas of the proposed reservoir footprint, primarily along Bois d'Arc Creek. The viewshed of travelers along County Road 2945 would be most affected by the tree clearing. The visual resource contrast rating of reservoir clearing and dam construction activities would be 'moderate' – begins to attract attention and begins to dominate the characteristic landscape. Overall, the impacts to visual resources related to construction of the proposed dam and reservoir would be moderate and end once construction activities are completed.

Operation

Based on the large size of the proposed reservoir (16,641 acres), the large size of the proposed dam (10,400 feet long, and 90 feet high), and the complete change in land use that would occur under the proposed project, the visual resource contrast rating of Alternative 1 would be 'Strong' – demands attention, will not be overlooked, and is dominant in the landscape. The form, line, color, and texture of the environment would all change noticeably if Alternative 1 is implemented.

As described in Section 3.8.2, the affected environment was divided into three SQRUs (the Bois d'Arc Creek and surrounding wetlands [SQRU-1], cropland and grassland [SQRU-2], and forested areas [SQRU-3]). Two of the units were given ratings of Class IV (SQRU-2 and -3), and the unit that includes the Bois d'Arc Creek was given a rating of Class III (SQRU-1), primarily due to the presence of water. According to BLM's standards, the change to the characteristic landscape of Class III areas should be limited to moderate changes and the level of change to the characteristic landscape of Class IV areas can be high. Because the area rated as Class III (SQRU-1) would still retain the presence of water (the proposed reservoir), and the other two SQRUs are rated as Class IV, the proposed action would meet the management objectives for each Class. However, even though the management objectives would be met, the addition of a dam and reservoir would noticeably impact visual resources of the area.

An aerial view of the existing landscape within the proposed reservoir footprint is shown in Figure 4.10-1, and an example of the type of contrast to be expected as a result of implementation of Alternative 1 is shown in Figure 4.10-2. Figure 4.10-2 depicts an existing reservoir about 60 miles southwest of the proposed project shown solely for reference purposes of what a 'Strong' contrast rating would potentially look like. Any viewer would notice the new lake environment, whether a local resident looking out a window or a commuter on a nearby road. Figure 4.10-3 shows the areas from which the proposed reservoir and associated dam would be visible. This viewshed should be interpreted as a maximum viewshed because it only accounts for topography and does not take into account tree or building obstruction. Actual visibility of the reservoir from a given site would depend on the presence or absence of obstructions. Overall, implementation of Alternative 1 would result in severe impacts to the viewshed and visual resources.

Conclusion

Due to its size and prominence, Alternative 1 (in particular, construction and operation of the proposed dam and reservoir) would have a severe, long-term impact on visual resources; however, whether this impact would be regarded as adverse or beneficial would depend on the values of each individual observer. Some individuals would regard the permanent elimination of gently rolling pastoral scenery along Bois d'Arc Creek as a loss outweighing any gain provided by a lake setting, while other individuals would regard the permanent addition of a lake on the landscape as an aesthetic asset to the community. Other members of the public would appreciate both the aesthetic loss and the aesthetic gain.

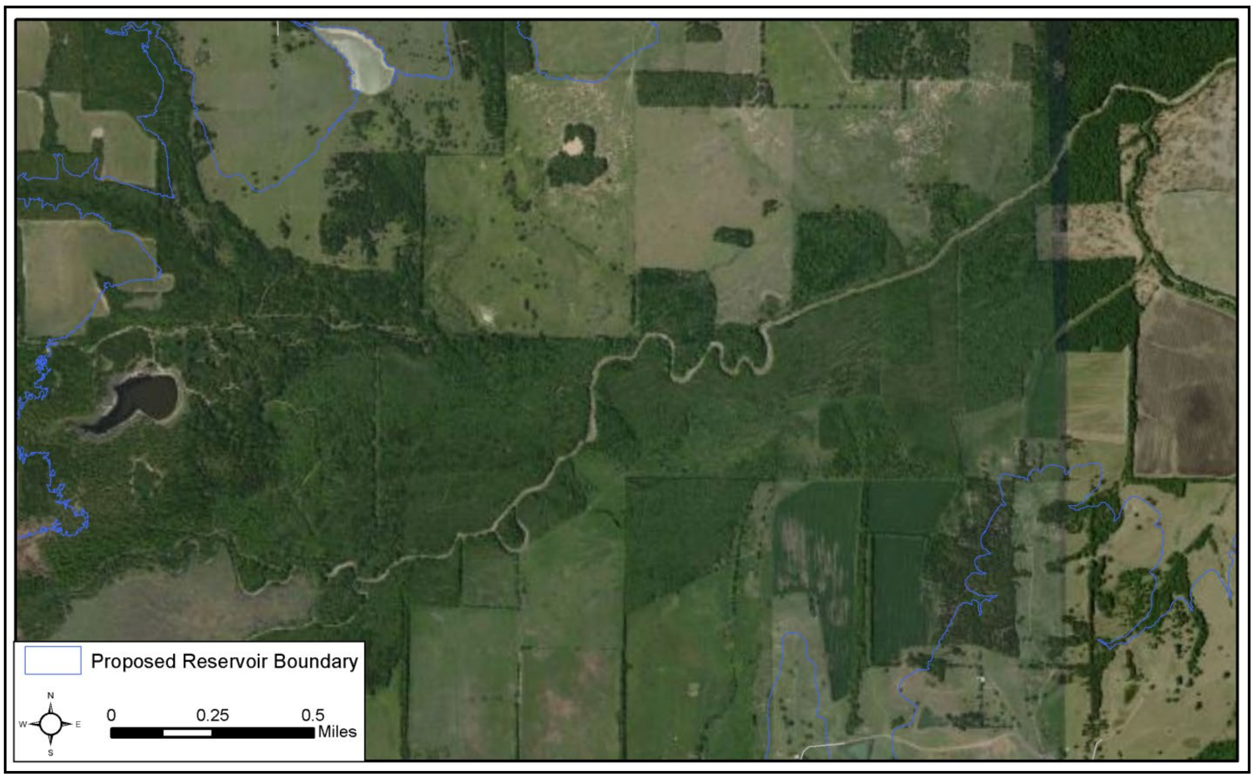


Figure 4.10-1. Aerial Imagery of the Existing Landscape Within the Proposed Reservoir Footprint (ESRI, 2010)

Figure 4.10-2. Aerial Imagery of a Portion of Nearby Lake Ray Roberts (ESRI, 2010)

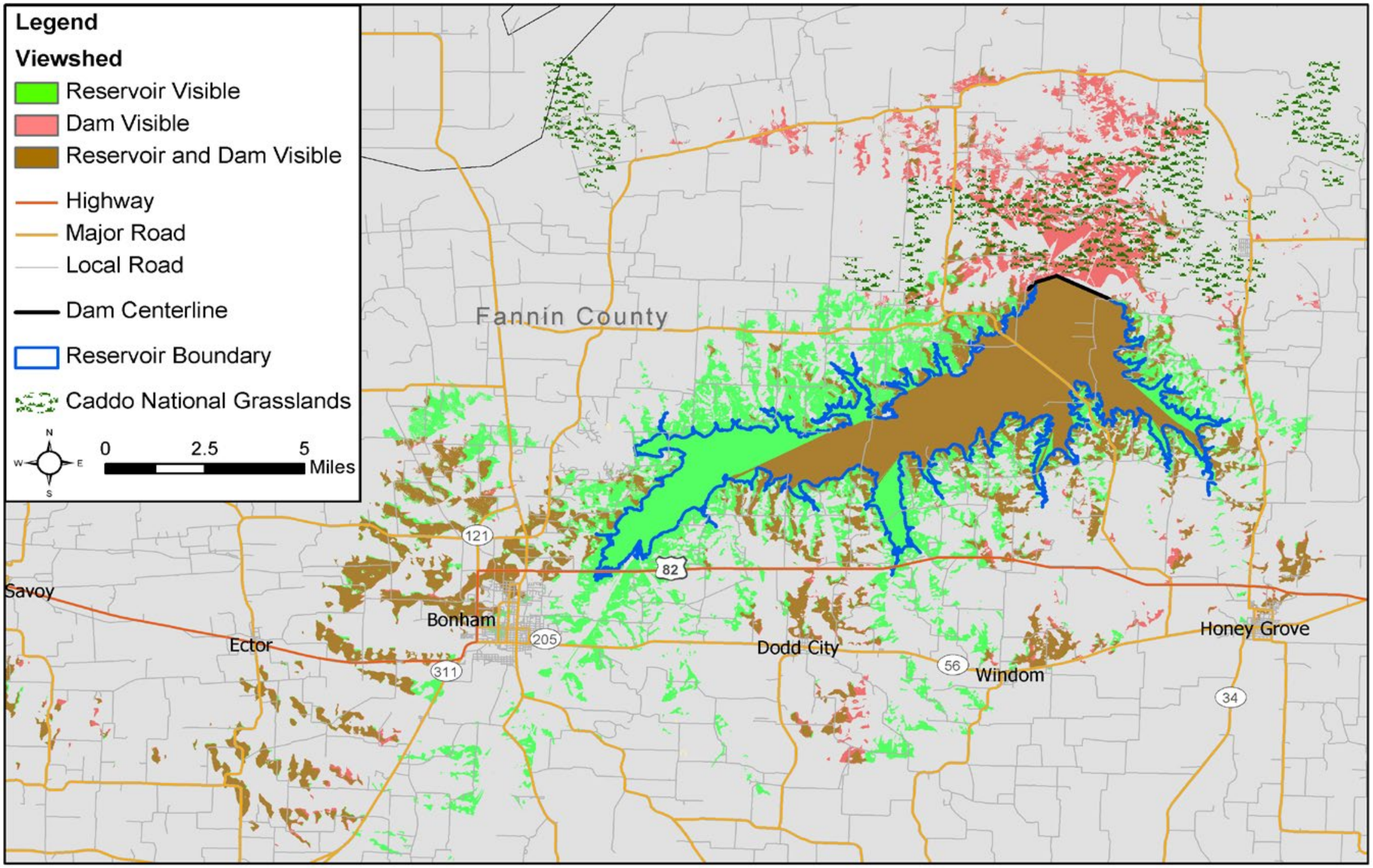


Figure 4.10-3. Viewshed of the Proposed Reservoir and Dam (ESRI, 2010)

4.10.3 Alternative 2

Construction

Alternative 2, the downsized LBCR with Lake Texoma blending, would entail dam and reservoir construction on a smaller scale than Alternative 1. The project construction would have a similar duration as Alternative 1 (estimated to be 3 to 4 years), and would be built within the same project footprint. The visual resource contrast rating of reservoir clearing and dam construction activities would be 'moderate' – begins to attract attention and begins to dominate the characteristic landscape. Overall, impacts of construction on visual resources would be similar to the impacts that would be anticipated to occur under Alternative 1. Visual impacts specific to dam and reservoir construction would be similar to but less than the impacts anticipated under Alternative 1, due to the reduced amount of reservoir clearing activity that would be required for the downsized reservoir.

Operation

While the proposed reservoir would be smaller under this alternative, it would still represent a complete change in land use/land cover and a major alteration in the viewshed. The visual resource contrast rating would be 'Strong' – demands attention, will not be overlooked, and is dominant in the landscape. The form, line, contrast, and color of the environment in view would all change dramatically due to implementation of Alternative 2. Similar to Alternative 1, the affected environment under Alternative 2 would include three SQRUs with Class III and IV inventory values and the operation of the dam and reservoir would meet the management objectives of each SQRU; however, the addition of a dam and reservoir would noticeably impact visual resources of the project area.

Conclusion

Similar to Alternative 1, Alternative 2 (in particular, dam and reservoir construction and operation) would have a major, long-term impact on visual resources. Whether this impact would be regarded as beneficial or adverse would depend on the values of each individual observer.

4.11 UTILITIES

This section discusses the impacts to utilities that would occur under each alternative. For Alternatives 1 and 2, the construction and operation activities are discussed separately to provide a more detailed analysis. A summary of the impacts discussed in the following sections is provided in Table 4.11-1.

Table 4.11-1. Summary of Impacts to Utilities Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Power lines within the proposed reservoir footprint and utilities within the footprint of the proposed pipeline (reservoir to WTP)	Power lines within the proposed reservoir footprint and utilities within the footprints of the proposed pipelines (reservoir to WTP and Lake Texoma to WTP)	No change from current conditions.
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Slight	Slight	

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Operation Phase			
Size	New utilities constructed to accommodate potential increase in area development	New utilities constructed to accommodate potential increase in area development	Likely increase in demand for local and regional utility services caused by the expected population growth and development over the coming decades. This increase is expected to be met by local and regional utility providers.
Duration	30 years	Less than or equal to 30 years	
Likelihood	High	High	
Severity	Moderate	Moderate (less than Alternative 1)	

4.11.1 No Action Alternative

The No Action Alternative would not provide the needed water supply for NTMWD's member cities and customers. As discussed in Section 1.5, the projected shortage by 2025 without implementation of any additional water supply projects is about 59,000 acre-feet per year.

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth and associated development pressure. This projected growth may result in an increase in demand for local and regional utility services. These future demands are expected to be met by local and regional utility providers.

4.11.2 Alternative 1

The NTMWD service area is projected to have water shortages of 59,000 acre-feet per year by 2025. If Alternative 1 is implemented, the resulting growth in the economy would create a demand for new utilities including electrical service, water supply services, and other municipal services that the local jurisdictions and utility companies would need to provide.

Construction

Construction activities would cause short-term, slight adverse impacts to utilities. The overhead power lines that run within the vicinity of the proposed reservoir footprint would need to be raised or removed and relocated before the proposed reservoir could be filled. Both demolition and construction of the overhead powerlines would occur within the footprint of the proposed reservoir site.

During construction of the pipeline from the proposed reservoir to the WTP, electrical transmission lines, gas/petroleum pipelines, and other minor utilities located within the pipeline footprint would be impacted. As construction progresses, these utilities would be crossed or bypassed according to the requirements of each facility's owner and permitted as required by the relevant permitting authority. These impacts would occur during the estimated 3 to 4 years of construction and would end upon completion of construction.

Operation

Moderate impacts to utilities would occur over 30 years (NTMWD, 2010a) from operation of the proposed reservoir. As a result of the potential increase in development that would likely be caused by operation of the proposed reservoir, the demand for publicly-provided utility services would also likely increase. Indirect impacts from the construction of a large reservoir in Fannin County would likely include the conversion of adjacent and nearby undeveloped areas to developed areas. Development of these areas could include the construction of large, single family residential areas, commercial uses such as retail centers to support the single family residential areas, and water-based facilities such as marinas. As a result, the existing utility services in the region would need to be expanded to accommodate the increased demand in already developed areas and to provide service to newly developed areas.

Regionally, construction of the LBCR would help ensure that future water needs of the NTMWD region are met. After completion of the proposed reservoir, treated surface water would be provided from the reservoir to present and future NTMWD customers (NTMWD, 2007a). NTMWD currently uses multiple sources of water, including Lake Lavon, Lake Texoma, Lake Chapman, Lake Tawakoni, and also practices water reuse and the use of interim supplies. NTMWD would optimize its water supplies by operating the proposed LBCR as part of its overall system, relying primarily on water supply sources closer to its service area during relatively wet times and increasing water use from sources farther away from its service area during drier times. The new water supply would be capable of meeting the demands of the new population growth directly and indirectly related to the creation of the proposed LBCR.

4.11.3 Alternative 2

Construction

Construction activities would cause short-term, slight adverse impacts to utilities. Under Alternative 2, the overhead power line within the vicinity of the proposed reservoir footprint would be located almost entirely outside the footprint of the reservoir's conservation pool. This is due to the lower conservation pool elevation and smaller reservoir footprint under Alternative 2. While the power line route may cross three very small drainage channels at the extreme edge of the conservation pool in the Bullard Creek area located in the south-central portion of the reservoir, demolition and relocation of the power line would likely not be needed.

Similar to Alternative 1, a pipeline would be constructed from the proposed reservoir to the WTP and the impacts to utilities within the pipeline footprint would be the same as those described under Alternative 1. However, under Alternative 2, an additional pipeline from Lake Texoma to the WTP would be constructed. During construction, electrical transmission lines, gas/petroleum pipelines, and other minor utilities located within the pipeline footprint would be impacted. As construction progresses, these utilities would be crossed or bypassed according to the requirements of each facility's owner and permitted as required by the relevant permitting authority. These impacts would occur during the estimated 3 to 4 years of construction and would end upon completion of construction.

Operation

The presence of a new reservoir in this location, irrespective of size, would be expected to result in increased development as described in Section 4.11.2.2, with associated demand for publicly-provided utility services. It is reasonable to conclude, however, that a smaller reservoir (with a smaller footprint and shorter length of developable shoreline) would lead to development at a reduced scope from that which may be anticipated for the larger reservoir, with a corresponding decrease in utility demands. Therefore, the impacts to utilities would be moderate but slightly less than the impacts described under Alternative 1.

Regionally, construction of the LBCR would help ensure that future water needs of the NTMWD region are met. After completion of the proposed reservoir, treated surface water would be provided from the reservoir to present and future NTMWD customers (NTMWD, 2007a). NTMWD currently uses multiple sources of water, including Lake Lavon, Lake Texoma, Lake Chapman, Lake Tawakoni, and also practices water reuse and the use of interim supplies. NTMWD would optimize its water supplies by operating the proposed LBCR as part of its overall system, relying primarily on water supply sources closer to its service area during relatively wet times and increasing water use from sources farther away from its service area during drier times. The new water supply would be capable of meeting the demands of the new population growth directly and indirectly related to the creation of the proposed LBCR. However, water supply from the reservoir under Alternative 2 would be fully utilized by approximately 2031, and other water supplies would need to be sought and developed at an earlier date than they would under implementation of Alternative 1.

4.12 TRANSPORTATION

This section discusses the impacts to transportation resources that would occur under each alternative. For Alternatives 1 and 2, the construction and operation activities are discussed separately to provide a more detailed analysis. A summary of the impacts discussed in the following sections is provided in Table 4.12-1.

Table 4.12-1. Summary of Impacts to Transportation Resources Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Construction Phase			
Size	Roadways and bridges in the immediate vicinity of the proposed reservoir and inside the reservoir footprint	Roadways and bridges in the immediate vicinity of the proposed reservoir and inside the reservoir footprint	No change from current conditions.
Duration	3-4 years	3-4 years	
Likelihood	High	High	
Severity	Moderate	Moderate	
Operation Phase			
Size	5 roadways closed and 10 roadways rerouted and/or rebuilt due to proposed reservoir operation	4 roadways closed and 7 roadways rerouted and/or rebuilt due to proposed reservoir operation	Population growth expected to occur in the region may result an increase in traffic on the local and regional transportation network. The existing road network is expected to be able to accommodate increases in traffic resulting from this growth.
Duration	100+ years	100+ years	
Likelihood	High	High	
Severity	Moderate	Moderate	

4.12.1 No Action Alternative

Under the No Action Alternative, land use changes within the region are expected to occur as a result of long-term population growth and associated development pressure. This growth may result an increase in traffic on the local and regional transportation network. The existing roadway network is expected to be able to accommodate increases in traffic resulting from this long-term growth.

4.12.2 Alternative 1

This section provides a discussion of the potential environmental impacts to transportation resources that would result from implementing Alternative 1. It is estimated that the construction phase of Alternative 1 (including all components) would last 3 to 4 years. Impacts were assessed primarily by reviewing existing traffic conditions of public roadways and the types and frequency of activities that may require use of these roadways. The closure of one or more primary or secondary roadways would constitute a moderate to major impact to traffic and transportation resources. Alternative 1 would have no impact to regional airports or passenger and freight rail services because they are not located near any project activities.

Dam and Reservoir

Construction

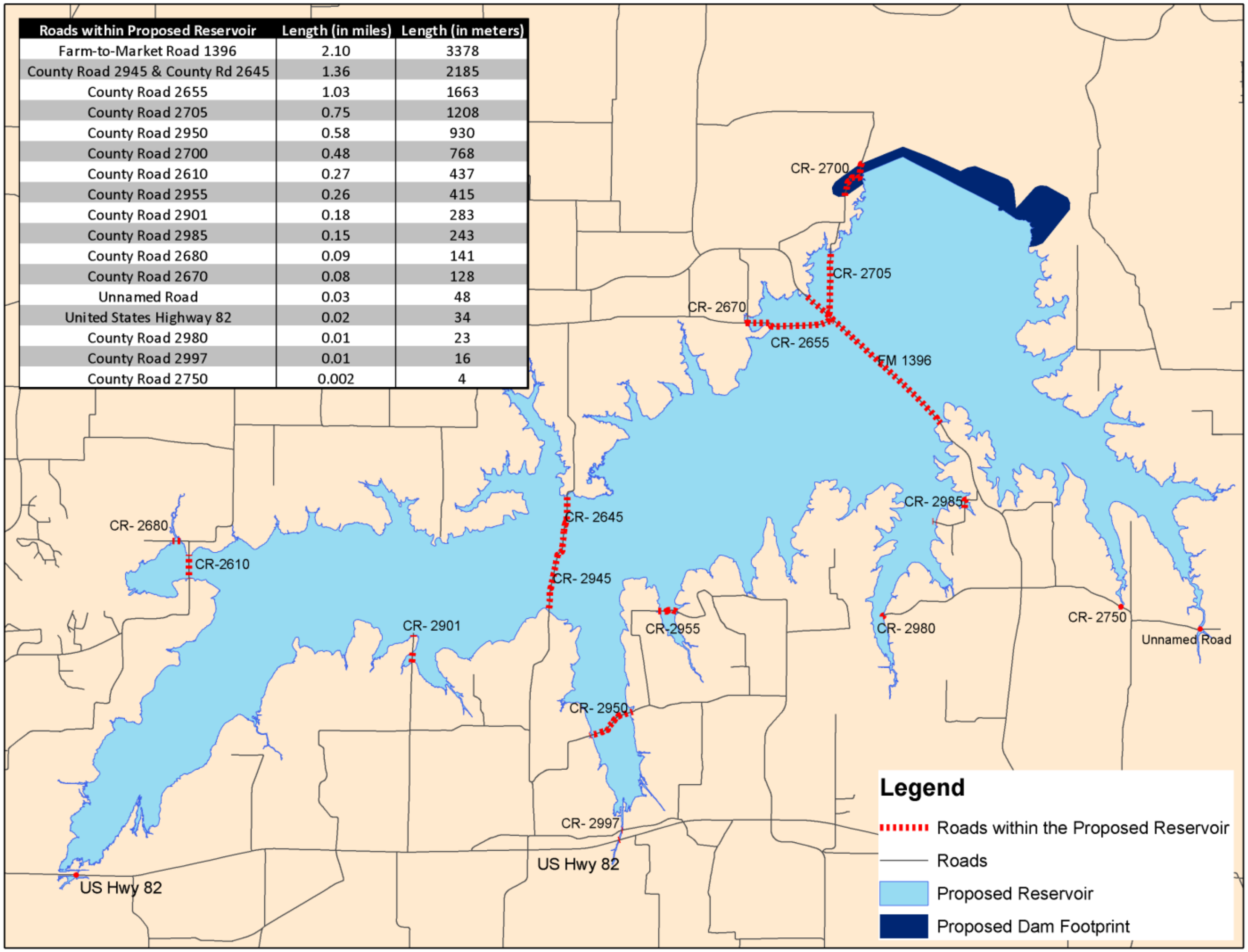
During construction of the dam and reservoir, congestion would increase in the immediate area due to additional construction vehicles, delays caused by construction activities (i.e., roads temporarily reduced to a single lane), and road closures and detours (FM 1396 in particular). While the existing transportation infrastructure not affected by construction of the dam and reservoir would be sufficient to support the increase in vehicle traffic resulting from the construction activities described above and because some roadways would be relocated, moderate impacts on traffic and transportation resources would occur. All construction vehicles would be equipped with backup alarms, two-way radios, and 'slow moving vehicle' signs when appropriate.

Operations

The establishment of the proposed dam and reservoir would have noticeable long-term beneficial and adverse effects on transportation resources and traffic. The permanent closure of roadways and rerouting of traffic from some secondary and tertiary roadways in the area would result in adverse effects, while new roads and road improvements would result in beneficial effects. NTMWD has developed a Transportation Plan (Freese and Nichols, 2011c) to provide adequate access to and across the proposed reservoir and surrounding properties. The Transportation Plan examined anticipated impacts to area residents and recommended transportation network modifications that would address these impacts while maximizing the transportation and recreational opportunities of the proposed reservoir. Information contained within the report includes geographic, geological, and cost data with respect to proposed modifications of the transportation network located within the proposed Lower Bois d'Arc Creek Reservoir footprint. The findings are preliminary in nature and a detailed topographic survey, property survey, geotechnical investigation, and design would be required to further define acceptable proposed improvements.

The primary TxDOT road that would be impacted by the proposed reservoir is FM 1396, which would be rerouted and replaced as described in section 4.12.2.4. In addition to FM 1396, there are 27 county road crossings identified within the footprint of the proposed reservoir, shown in Figure 4.12-1. These roadways would primarily have serviced residents living in the footprint of the proposed reservoir who would have relocated prior to construction. As shown in Table 4.12-2, the Transportation Plan recommended:

- Replacing and reconstructing (9 road crossings) –The existing road crossing would be inundated by the reservoir or located below the flood easement; however, continued access to the reservoir or the surrounding area would be required and a new road crossing would be constructed at a higher elevation.
- Road closure (5 crossings) – The existing road crossing would be inundated by the reservoir or located below the flood easement and closed without replacement because continued access to the reservoir or the surrounding area would not be required.
- Leave in place (13 crossings) – The existing road crossing would not be inundated and would be above the flood easement; however, the road crossing could be affected by future storm events. Gates would be installed to prevent vehicle access if the road is flooded by a future storm.



Roads within Proposed Reservoir	Length (in miles)	Length (in meters)
Farm-to-Market Road 1396	2.10	3378
County Road 2945 & County Rd 2645	1.36	2185
County Road 2655	1.03	1663
County Road 2705	0.75	1208
County Road 2950	0.58	930
County Road 2700	0.48	768
County Road 2610	0.27	437
County Road 2955	0.26	415
County Road 2901	0.18	283
County Road 2985	0.15	243
County Road 2680	0.09	141
County Road 2670	0.08	128
Unnamed Road	0.03	48
United States Highway 82	0.02	34
County Road 2980	0.01	23
County Road 2997	0.01	16
County Road 2750	0.002	4

Figure 4.12-1. Roadways Affected by Alternative 1

Table 4.12-2. Roadways Affected by Alternative 1 and Transportation Plan Recommendation[a]

Road Name	Crossing Name	Needed?	Crossing Type	Distance (feet)	Detour Distance (feet)[b]	Transportation Plan Recommendation
CO RD 2980	Ward Creek	Yes	Bridge	1,375	N/A	Replace/reconstruct[c]
CO RD 2610	Timber Creek	Yes	Bridge	1,971	1,056	Replace/reconstruct[c]
CO RD 2680	Sandy Branch	Yes	Bridge	1,400	N/A	Replace/reconstruct[c]
CO RD 2770	Honey Grove Creek Tributary	Yes	Bridge is out	626	N/A	Replace/reconstruct[c]
CO RD 2985	Unknown	Yes	Large CMP	690	N/A	Replace/reconstruct[c]
CO RD 2980	Yoakum Creek	Yes	Unknown	929	N/A	Replace/reconstruct[c]
CO RD 2900	Onslott Creek	Yes	Bridge	1,831	N/A	Replace/reconstruct[c]
CO RD 2610	Bois d'Arc Creek Tributary	Yes	Bridge	495	N/A	Replace/reconstruct[c]
CO RD 2625	Bois d'Arc Creek Tributary	Yes	2 Large CMP	1,384	N/A	Replace/reconstruct[c]
CO RD 2655	Edge of Water	No	N/A	852	60	Close road[d]
CO RD 2670	Unnamed	No	Small CMP	1,049	0	Close road[d]
CO RD 2955	Pettigrew Branch	No	Large CMP	1,847	1553	Close road[d]
CO RD 2950	Bullard Creek	No	Bridge and CMP	3,538	8492	Close road[d]
CO RD 2917	Bullard Creek	No	Bridge	2,007	0	Close road[d]
CO RD 2725	Unnamed	No	Bridge	95	3701	Leave in place[e]
CO RD 2730	Honey Grove Creek Tributary	No	Small crossing	517	926	Leave in place[e]
CO RD 2745	Honey Grove Creek Tributary	No	Large CMP	540	1180	Leave in place[e]
CO RD 2745	Bois d'Arc Creek Tributary	Yes	Small crossing	101	N/A	Leave in place[e]
FM 1396	Bois d'Arc Creek Tributary	Yes	Small RCB	441	N/A	Leave in place[e]
CO RD 2955	Unknown	No	Large CMP	1,211	2400	Leave in place[e]
US 82	Cottonwood Creek	Yes	5 multiple RCB	661	N/A	Leave in place[e]
US 82	Bullard Creek	Yes	Bridge	1,901	N/A	Leave in place[e]
CO RD 2900	Burns Branch	No	Bridge	146	882	Leave in place[e]
CO RD 2900	Onslott Creek	Yes	Large RCP	77	N/A	Leave in place[e]
CO RD 2610	Timber Creek	Yes	RCP or CMP	220	N/A	Leave in place[e]
CO RD 2615	Bois d'Arc Creek Tributary	No	Large CMP	376	7826	Leave in place[e]
CO RD 2615	Bois d'Arc Creek Tributary	No	Large CMP	297	7826	Leave in place[e]

[a] The FM 1396 crossing of Bois d'Arc Creek is not included in this table but is described in Section 4.12.2.4.

[b] The additional detour distance is calculated only if there is another feasible route to access the area. If there are no other feasible routes, then the additional detour distance is not applicable.

[c] The existing road crossing would be inundated by the reservoir or located below the flood easement; however, continued access to the reservoir or the

Road Name	Crossing Name	Needed?	Crossing Type	Distance (feet)	Detour Distance (feet)[b]	Transportation Plan Recommendation

surrounding area would be required and a new road crossing would be constructed at a higher elevation.

[d] The existing road crossing would be inundated by the reservoir or located below the flood easement and closed without replacement because continued access to the reservoir or the surrounding area would not be required.

[e] The existing road crossing would not be inundated and would be above the flood easement; however, the road crossing could be affected by future storm events. Gates would be installed to prevent vehicle access if the road is flooded by a future storm.

Additional Detour Distance = Additional distance driven to avoid the closed creek crossing (if crossing was removed); CMP = corrugated metal pipe; Crossing Type = Description of the type of creek crossing; Distance = Length of road located within the reservoir footprint (lower than elevation 542 feet MSL and between flood easements); N/A = not applicable; Needed? = Is the roadway needed to provide access to homes or businesses?; RCB = reinforced concrete box; RCP = reinforced concrete pipe

Source: Freese and Nichols, 2011c

As a result of the permanent closure of roadways and the potential increase in development that would likely occur as a result of the presence of the proposed reservoir, the number of vehicles using the surrounding roads would increase. However, design improvements would be made to the reconstructed roadways as part of the dam and reservoir construction process to accommodate this increase. For example, the replacement for FM 1396 would be built to higher speed standards than the existing road. These roadway improvements would be able to handle the increased traffic and, while some roads would be permanently closed, overall the impacts to transportation resources would be slightly beneficial when compared to existing conditions.

Raw Water Pipeline

Construction

Construction of the proposed raw water pipeline would have short-term slight adverse effects to transportation resources primarily due to construction of pipeline road crossings, additional traffic because of workers' commutes, and additional traffic associated with delivery of equipment and supplies to the proposed sites. When appropriate, use of existing roads and trails to facilitate construction activities would occur. All construction vehicles would be equipped with backing alarms, two-way radios, and 'slow moving vehicle' signs when appropriate. Although the effects would be slight, contractors would route and schedule construction vehicles to avoid conflicts with other traffic, and strategically locate staging areas to minimize traffic impacts.

Operations

Operation of the proposed pipeline would not conflict with any existing roadway or interfere with traffic. There would be some very small increases in traffic due to maintenance activities around the pipeline and pump stations; however, overall conditions would remain comparable to existing conditions. Effects on transportation resources would be negligible.

Water Treatment Plant and Terminal Storage Reservoir

Construction

Construction of the WTP and TSR would have short-term slight adverse effects on transportation resources and traffic. These effects would be similar in nature but on a smaller scale than those outlined for construction of the dam and reservoir. Congestion would increase in the immediate area due to additional vehicles and traffic delays near the site. The existing transportation resources would be sufficient to support the increase in vehicle traffic. All construction vehicles would be equipped with backup alarms, two-way radios, and 'slow moving vehicle' signs when appropriate.

Operations

Long-term negligible adverse effects to transportation resources would occur during operations under Alternative 1. Small but unnoticeable increases in traffic due to employees at the WTP would be expected in the area once it is operational.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Construction

As shown in Figure 4.12-1, FM 1396 is an existing two-lane TxDOT asphalt road located within the proposed reservoir footprint. The existing roadway and bridge would be inundated by the proposed reservoir and therefore would need to be raised or relocated as part of the proposed reservoir construction. Various options were investigated for the relocation of FM 1396 with respect to landowner impacts, cost, schedule, and travel time. The current alignment of FM 1396 spans one of the widest portions of the proposed reservoir and would impact recreational uses if rebuilt in the same location.

As discussed in Section 4.12.2.1, NTMWD has developed a Transportation Plan to provide adequate access to and across the proposed reservoir and surrounding properties (Freese and Nichols, 2011c). The Transportation Plan recommends replacing FM 1396 by extending FM 897 North out of Lannius (on US 82 south of the proposed reservoir site) with a new bridge over the proposed reservoir along the approximate alignment of the current crossing of Bois d'Arc Creek by CR 2645. It should be emphasized that at this time these plans are still preliminary; final bridge elevations and lengths have not yet been determined. Safety, recreation, conveyance of water, and a number of other considerations are being taken into account in the final design of the bridge (Freese and Nichols, 2011c).

The replacement of FM 1396 by extending FM 897 is the preferred alignment by Fannin County, TxDOT, and NTMWD. Of the various alternative alignments evaluated in the Transportation Plan, this alignment would require the shortest bridge length, have a similar travel time to the existing FM 1396 alignment, and maximize the water surface area in the future reservoir for recreational purposes. Figure 4.12-2 shows the location of the new bridge and the length of FM 1396 that would be abandoned

TxDOT has requested that the new FM 897 be designed to TxDOT Farm to Market Road standards with a 120-foot right-of-way (ROW) and a 70 mile-per-hour (mph) design speed. TxDOT would assume maintenance of the new FM 897 extension as well as the associated bridge after construction and Fannin County would assume responsibility for portions of FM 1396 not inundated by the reservoir, as shown in Figure 4.12-2. The portion of FM 1396 that would be inundated (solid purple line in Figure 4.12-2) would not be maintained.

Construction activities associated with FM 1396 relocation, FM 897 extension, and new bridge construction would result in traffic congestion from additional construction vehicles, traffic delays caused by construction activities (i.e., roads temporarily reduced to a single lane), and increased traffic on other roadways due to road closures and detours. While the existing transportation infrastructure not affected by construction activities would be sufficient to support the increase in vehicle traffic, slight short-term adverse impacts on transportation resources and traffic would occur.

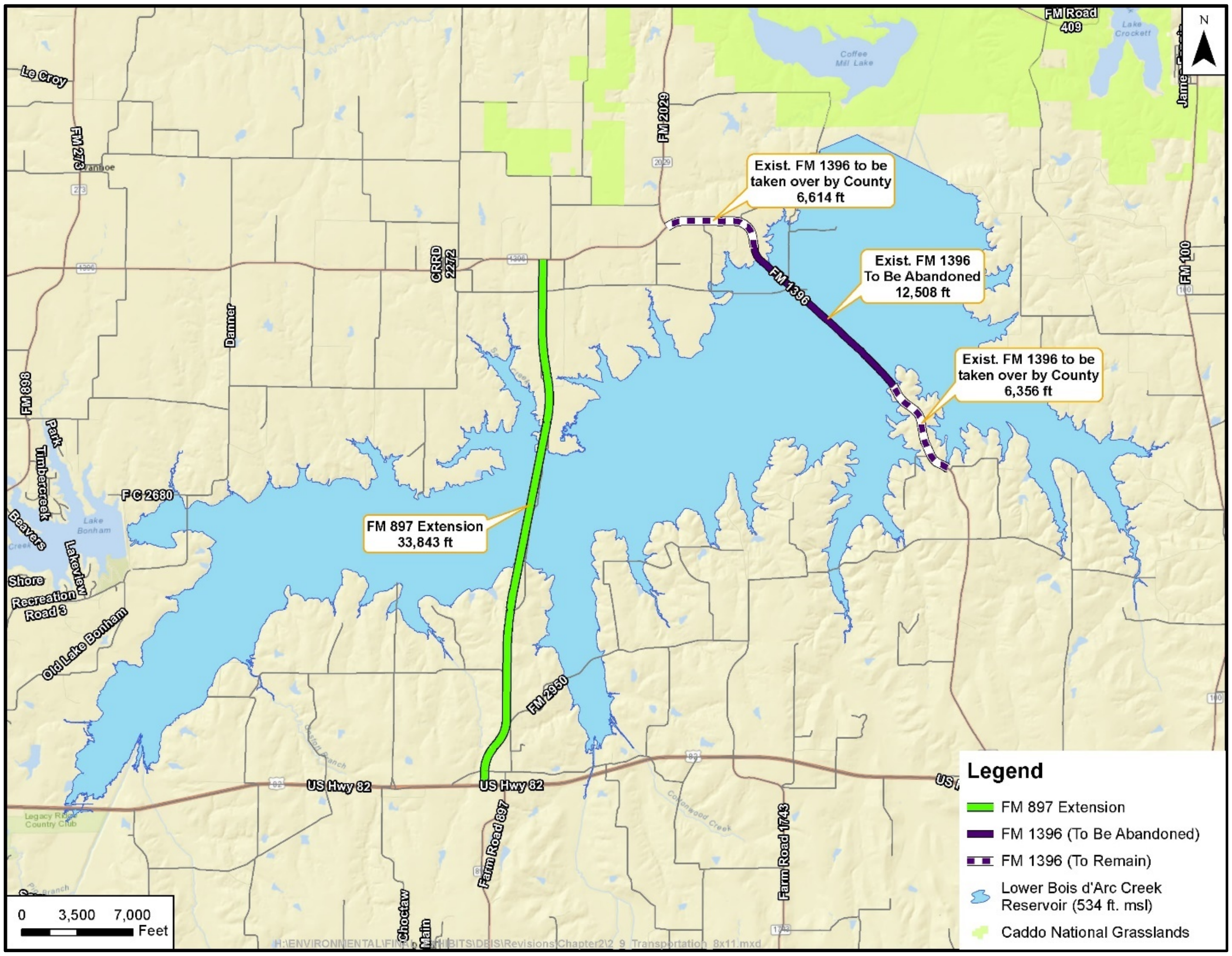


Figure 4.12-2 Proposed FM 1396 Relocation and New Bridge Construction

Operations

Operation of the FM 897 extension and the new bridge would have the same long-term beneficial and adverse effects on transportation resources and traffic discussed under Section 4.12.2.1. Although the existing FM 1396 would be closed, the replacement for FM 1396 would be built to higher speed standards than the existing road and the roadway improvements would be able to handle the increased traffic resulting from operation of the dam and reservoir.

Mitigation

Severe adverse effects to transportation resources would be expected if no relocations or reconstruction of existing roads and bridges were proposed; however, this is not the case. While there would be adverse short-term to medium-term effects, by implementing the recommended transportation mitigation measures discussed in the previous sections (i.e., equipping all construction vehicles with backing alarms, two-way radios, and 'slow moving vehicle' signs, routing and scheduling construction vehicles to avoid conflicts with other traffic, and strategically locating staging areas to minimize traffic impacts), these impacts would be moderate. Once the construction activities are completed, in particular the FM 1396 relocation, the magnitude of long-term effects would generally be moderate.

Planning, development, and implementation of the proposed roadway improvements would be coordinated through TxDOT planners and engineers as well as Fannin County authorities to minimize the magnitude of impacts to local residents and maximize the value and utility of improvements to both residents and visitors to the lake.

Conclusion

Alternative 1would have short-term adverse effects on transportation resources and traffic due to the number and length of roads requiring temporary or permanent closure and relocation. Short-term and long-term effects to Fannin County's road network would be both beneficial and adverse. After construction of the proposed dam, the reservoir would close FM 1396 and 5 secondary roadways, and motorists would be rerouted. Although these effects would be adverse, there would be an overall net benefit to roadway infrastructure for 9 road crossings that would be rebuilt at a higher elevation and the new road and bridge built to replace FM 1396. Given the mitigation measures proposed to ameliorate potential adverse impacts, the long-term effects of Alternative 1 on transportation resources and traffic would be moderate.

4.12.3 Alternative 2

Compared to Alternative 1, this alternative would have a similar construction duration (estimated to be 3 to 4 years) and similar types of adverse effects. Most of the same roads would be affected in this alternative compared to Alternative 1, with exceptions that are noted in the following sections. The closure of one or more primary or secondary roadways would constitute a moderate impact to traffic and transportation resources. The impacts of road closures under this alternative would be less than Alternative 1 due to the smaller scale of the reservoir. The impacts of pipeline construction for this alternative would be greater than Alternative 1 because an additional water pipeline would be built from Lake Texoma to the WTP. Similar to Alternative 1, this alternative would have no impacts to regional airports or passenger and freight rail services because they are not located near any project activities.

Dam and Reservoir

Construction

During construction of the dam and reservoir, congestion would increase in the immediate area due to additional construction vehicles, delays caused by construction activities (i.e., roads temporarily reduced to a single lane), and increased traffic due to road closures and detours (in particular FM 1396). While the existing transportation infrastructure not affected by construction of the dam and reservoir would be sufficient to support the increase in vehicle traffic resulting from the construction activities described above and because some roadways would be relocated, moderate impacts on transportation resources and traffic would occur. However, due to the smaller scale of the reservoir under this alternative, less earth would be moved which would require fewer vehicle trips than Alternative 1. As such, adverse effects resulting from construction activities would be slightly less than Alternative 1. All construction vehicles would be equipped with backup alarms, two-way radios, and 'slow moving vehicle' signs when appropriate.

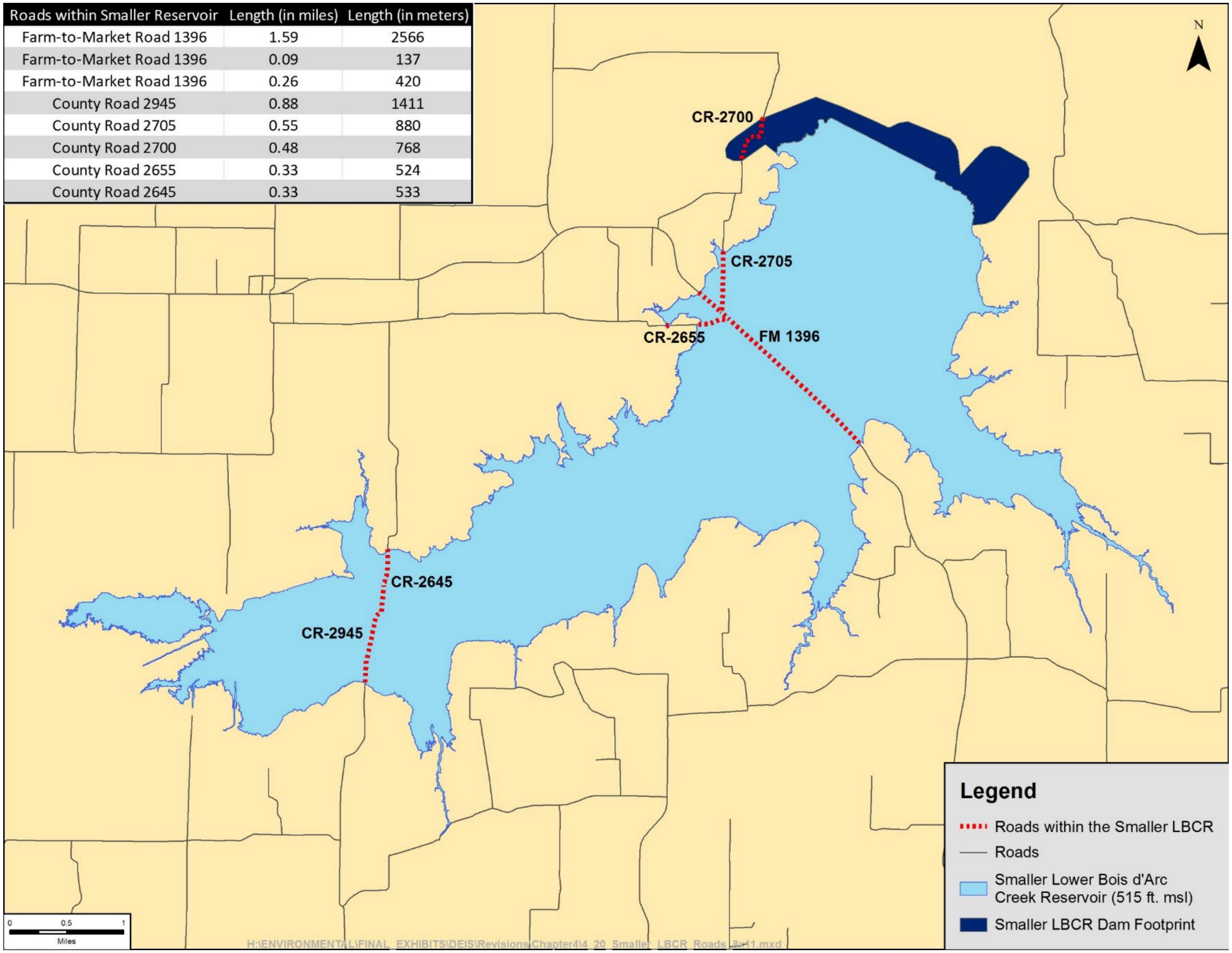
Operations

The establishment of the proposed dam and reservoir would have noticeable long-term beneficial and adverse effects on transportation resources and traffic. The permanent closure of roadways and rerouting of traffic from some secondary and tertiary roadways in the area would result in adverse effects while new roads and road improvements would result in beneficial effects. NTMWD has developed a Transportation Plan (Freese and Nichols, 2011c) to provide adequate access to and across the proposed reservoir and surrounding properties. The Transportation Plan examined anticipated impacts to area residents and recommended transportation network modifications that would address these impacts while maximizing the transportation and recreational opportunities of the proposed reservoir. Information contained within the report includes geographic, geological, and cost data with respect to proposed modifications of the transportation network located within the proposed Lower Bois d'Arc Creek Reservoir footprint. The findings are preliminary in nature and a detailed topographic survey, property survey, geotechnical investigation, and design will be required to further define acceptable proposed improvements.

The primary TxDOT road that would be impacted by the proposed reservoir is FM 1396, which would be rerouted and replaced as described in section 4.12.2.4. In addition to FM 1396, there are 21 county road crossings identified within the footprint of the proposed reservoir, shown in Figure 4.12-3. These roadways would primarily have serviced residents living in the footprint of the proposed reservoir who would have relocated prior to construction. As shown in Table 4.12-3, the Transportation Plan recommended:

- Replacing and reconstructing (6 road crossings) –The existing road crossing would be inundated by the reservoir or located below the flood easement; however, continued access to the reservoir or the surrounding area would be required and a new road crossing would be constructed at a higher elevation.
- Road closure (4 crossings) – The existing road crossing would be inundated by the reservoir or located below the flood easement and closed without replacement because continued access to the reservoir or the surrounding area would not be required.
- Leave in place (11 crossings) – The existing road crossing would not be inundated and would be above the flood easement; however, the road crossing could be affected by future storm events. Gates would be installed to prevent vehicle access if the road is flooded by a future storm.

As a result of the permanent closure or roadways and the potential increase in development that would likely occur as a result of the presence of the proposed reservoir, the number of vehicles using the surrounding roads would increase. However, design improvements would be made to the reconstructed roadways as part of the dam and reservoir construction process to accommodate this increase. For example, the replacement for FM 1396 would be built to higher speed standards than the existing road. These roadway improvements would be able to handle the increased traffic and, while some roads would be permanently closed, overall, the impacts to transportation resources would be slightly beneficial when compared to the No Action Alternative but less beneficial than Alternative 1. The adverse effects of this alternative would be less than Alternative 1 because fewer roads would be closed.



Roads within Smaller Reservoir	Length (in miles)	Length (in meters)
Farm-to-Market Road 1396	1.59	2566
Farm-to-Market Road 1396	0.09	137
Farm-to-Market Road 1396	0.26	420
County Road 2945	0.88	1411
County Road 2705	0.55	880
County Road 2700	0.48	768
County Road 2655	0.33	524
County Road 2645	0.33	533

Figure 4.12-3. Roadways Affected by Alternative 2

Table 4.12-3. Roadways Affected by Alternative 2 and Transportation Plan Recommendation[a]

Road Name	Crossing Name	Needed?	Crossing Type	Distance (ft)	Detour Distance (ft)[b]	Transportation Plan Recommendation
CO RD 2610	Timber Creek	Yes	Bridge	1,971	1,056	Replace/reconstruct[c]
CO RD 2770	Honey Grove Creek Tributary	Yes	Bridge is out	626	N/A	Replace/reconstruct[c]
CO RD 2985	Unknown	Yes	Large CMP	690	N/A	Replace/reconstruct[c]
CO RD 2980	Yoakum Creek	Yes	Unknown	929	N/A	Replace/reconstruct[c]
CO RD 2900	Onslott Creek	Yes	Bridge	1,831	N/A	Replace/reconstruct[c]
CO RD 2625	Bois d'Arc Creek Tributary	Yes	2 Large CMP	1,384	N/A	Replace/reconstruct[c]
CO RD 2655	Edge of Water	No	N/A	852	60	Close road[d]
CO RD 2670	Unnamed	No	Small CMP	1,049	0	Close road[d]
CO RD 2955	Pettigrew Branch	No	Large CMP	1,847	1553	Close road[d]
CO RD 2917	Bullard Creek	No	Bridge	2,007	0	Close road[d]
CO RD 2725	Unnamed	No	Bridge	95	3701	Leave in place[e]
CO RD 2730	Honey Grove Creek Tributary	No	Small crossing	517	926	Leave in place[e]
CO RD 2745	Honey Grove Creek Tributary	No	Large CMP	540	1180	Leave in place[e]
CO RD 2745	Bois d'Arc Creek Tributary	Yes	Small crossing	101	N/A	Leave in place[e]
FM 1396	Bois d'Arc Creek Tributary	Yes	Small RCB	441	N/A	Leave in place[e]
CO RD 2955	Unknown	No	Large CMP	1,211	2400	Leave in place[e]
CO RD 2900	Burns Branch	No	Bridge	146	882	Leave in place[e]
CO RD 2900	Onslott Creek	Yes	Large RCP	77	N/A	Leave in place[e]
CO RD 2610	Timber Creek	Yes	RCP or CMP	220	N/A	Leave in place[e]
CO RD 2615	Bois d'Arc Creek Tributary	No	Large CMP	376	7826	Leave in place[e]
CO RD 2615	Bois d'Arc Creek Tributary	No	Large CMP	297	7826	Leave in place[e]

[a] The FM 1396 crossing of Bois d'Arc Creek is not included in this table but is described in Section 4.12.3.4.

[b] The additional detour distance is calculated only if there is another feasible route to access the area. If there are no other feasible routes, then the additional detour distance is not applicable.

[c] The existing road crossing would be inundated by the reservoir or located below the flood easement; however, continued access to the reservoir or the surrounding area would be required and a new road crossing would be constructed at a higher elevation.

[d] The existing road crossing would be inundated by the reservoir or located below the flood easement and closed without replacement because continued access to the reservoir or the surrounding area would not be required.

[e] The existing road crossing would not be inundated and would be above the flood easement; however, the road crossing could be affected by future storm events. Gates would be installed to prevent vehicle access if the road is flooded by a future storm.

Additional Detour Distance = Additional distance driven to avoid the closed creek crossing (if crossing was removed); CMP = corrugated metal pipe; Crossing

Road Name	Crossing Name	Needed?	Crossing Type	Distance (ft)	Detour Distance (ft)[b]	Transportation Plan Recommendation

Type = Description of the type of creek crossing; Distance = Length of road located within the reservoir footprint (lower than elevation 542 feet MSL and between flood easements); N/A = not applicable; Needed? = Is the roadway needed to provide access to homes or businesses?; RCB = reinforced concrete box; RCP = reinforced concrete pipe Additional Detour Distance = Additional distance driven to avoid the closed creek crossing (if crossing was removed)

Source: Freese and Nichols, 2011c

Raw Water Pipelines

Construction

Alternative 2 includes an additional water pipeline from Lake Texoma to the WTP. Similar to Alternative 1, construction of the proposed raw water pipelines would have short-term slight adverse effects to transportation resources primarily due to construction of pipeline road crossings, additional traffic because of workers' commutes, and additional traffic associated with delivery of equipment and supplies to the proposed sites. When appropriate, use of existing roads and trails to facilitate construction activities would occur. All construction vehicles would be equipped with backing alarms, two-way radios, and 'slow moving vehicle' signs when appropriate. Although the effects would be slight, contractors would route and schedule construction vehicles to avoid conflicts with other traffic, and strategically locate staging areas to minimize traffic impacts. Overall, due to construction of the additional pipeline, the construction impacts under Alternative 2 would be slight but greater than Alternative 1.

Operations

Operation of the proposed pipelines would not conflict with any existing roadway or interfere with traffic. There would be some very small increases in traffic due to maintenance activities around the pipeline and pump stations, but these effects would be negligible. Overall conditions would remain comparable to existing conditions as described for Alternative 1.

Water Treatment Plant and Terminal Storage Reservoir

Construction

Construction of the WTP and TSR would have short-term slight adverse effects on transportation resources and traffic. The effects from WTP and TSR construction under this alternative would be identical to Alternative 1 and would be similar in nature but on a smaller scale than those outlined for construction of the dam and reservoir. Congestion would increase in the immediate area due to additional vehicles and traffic delays near the site. The existing transportation resources would be sufficient to support the increase in vehicle traffic. All construction vehicles would be equipped with backup alarms, two-way radios, and 'slow moving vehicle' signs when appropriate.

Operations

Long-term negligible adverse effects to transportation resources would occur during operations under Alternative 2. Small but unnoticeable increases in traffic due to employees at the WTP would be expected in the area once it is completed. Overall, the impacts under Alternative 2 would be identical to the impacts under Alternative 1.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Construction

As discussed in Section 4.12.2.4, FM 1396 is an existing two-lane TxDOT asphalt road located within the proposed reservoir limits. The existing roadway and bridge would be inundated by the proposed reservoir and therefore would need to be raised or relocated as part of the proposed reservoir construction. Various options were investigated for the relocation of FM 1396 with respect to landowner impacts, cost, schedule, and travel time. The current alignment of FM 1396 spans one of the widest portions of the proposed reservoir and would impact recreational uses if rebuilt in the same location.

As discussed in Section 4.12.2.4, NTMWD's Transportation Plan examined several options to relocate FM 1396 and build a new bridge crossing the proposed LBCR. NTMWD's preferred option would be to extend the existing rural road FM 897 two to three miles to the west of FM 1396 and build an entirely new bridge over the reservoir along that alignment. Of the various alternative alignments evaluated in the Transportation Plan, this one would require the shortest bridge length, have a similar travel time to the existing FM 1396 alignment, and maximize the water surface area in the future reservoir for recreational purposes. The existing FM 1396 and bridge crossing over Bois d'Arc Creek would be abandoned and inundated by the reservoir.

The principal difference between Alternative 2 and Alternative 1 is that the new bridge on FM 897 spanning the reservoir would be slightly shorter (because the smaller reservoir would not be as wide) and the portion of the new paved road on FM 897 would be relatively longer. However, the total length of the FM 897 extension and new bridge as a replacement for FM 1396 and the existing bridge would be the same under Alternatives 1 and 2.

Similar to Alternative 1, TxDOT has requested that the new FM 897 be designed to TxDOT Farm to Market Road standards with a 120-foot ROW and a 70-mph design speed. TxDOT would assume maintenance of the new FM 897 extension as well as the associated bridge after construction and Fannin County would assume responsibility for portions of FM 1396 not inundated by the reservoir. The portion of FM 1396 inundated by the reservoir would not be maintained.

Similar to Alternative 1, construction activities associated with FM 1396 relocation, FM 897 extension, and new bridge construction under Alternative 2 would result in traffic congestion from additional construction vehicles, traffic delays caused by construction activities (i.e., roads temporarily reduced to a single lane), and increased traffic on other roadways due to road closures and detours. While the existing transportation infrastructure not affected by construction activities would be sufficient to support the increase in vehicle traffic, slight short-term adverse impacts on transportation resources and traffic would occur.

Operations

Operation of the FM 897 extension and the new bridge would have the same long-term beneficial effects on transportation resources and traffic discussed under Section 4.12.3.1. The replacement for FM 1396 would be built to higher speed standards than the existing road and the roadway improvements would be able to handle the increased traffic resulting from operation of the dam and reservoir.

Mitigation

Severe adverse effects to transportation resources would be expected if no relocations or reconstruction of existing roads and bridges were proposed; however, this is not the case. While there would still be adverse short-term to medium-term effects, by implementing the recommended transportation mitigation measures discussed in the previous sections (i.e., equipping all construction vehicles with backing alarms, two-way radios, and 'slow moving vehicle' signs, routing and scheduling construction vehicles to avoid conflicts with other traffic, and strategically locating staging areas to minimize traffic impacts), these impacts would be moderate. Once the construction activities are completed, (in particular the FM 1396 relocation, the magnitude of long-term effects would generally be moderate.

Planning, development, and implementation of the proposed roadway improvements would be coordinated through TxDOT planners and engineers as well as Fannin County authorities to minimize the magnitude of impacts to local residents and maximize the value and utility of improvements to both residents and visitors to the lake.

Conclusion

Alternative 2 would have short-term adverse effects on transportation resources and traffic due to the number and length of roads requiring temporary or permanent closure and relocation. Short-term and long-term effects to Fannin County's road network would be both beneficial and adverse. After completing construction of the downsized dam, the reservoir would close FM 1396 and 4 secondary roadways, and motorists would be rerouted. Although these effects would be adverse, there would be an overall net benefit to roadway infrastructure for 6 road crossings that would be rebuilt at a higher elevation and the new FM 1396 road and bridge. Given the mitigation measures proposed to ameliorate potential adverse impacts, the long-term effects of this alternative on transportation resources would be moderate, although smaller in magnitude than Alternative 1.

4.13 Environmental Contaminants and Toxic Wastes

This section discusses the potential impacts from environmental contaminants and toxic wastes that could occur under each alternative. For purposes of analysis, only the footprint of the reservoir was considered because of concerns that contaminants and wastes could impact the water of the reservoir once the area was inundated. A summary of the impacts discussed in the following sections is provided in Table 4.13-1.

Table 4.13-1. Summary of Impacts from Environmental Contaminants and Toxic Wastes Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Reservoir footprint (16,641 acres)	Reservoir footprint (8,600 acres)	No change from current conditions.
Duration	3-4 years	3-4 years	
Likelihood	Low	Low	
Severity	None	None	
Operation Phase			
Size	Reservoir footprint (16,641 acres)	Reservoir footprint (8,600 acres)	No change from current conditions.
Duration	100+ years	100+ years	
Likelihood	Low	Low	
Severity	Slight	Slight	

4.13.1 No Action Alternative

Under the No Action Alternative, the construction of the dam, reservoir, WTP, TSR, and pipeline(s) would not occur. No further action is expected to be necessary to address concerns over toxic/hazardous substances or contaminants. There would be no change to the existing conditions discussed in Section 3.11.

4.13.2 Alternative 1

Construction

The desktop study described in Section 3.11 did not identify any recognized or potential environmental concerns in the project area. However, subsequent to the study a local resident informed NTMWD of suspected illegal disposal and burning of tires on property already purchased by NTMWD and located within the proposed LBCR footprint (Chambers, 2012). NTMWD arranged for an environmental investigation of the site, which indicated highly localized contamination with somewhat elevated concentrations of certain heavy metals and other chemicals of concern.

This dumping and disposal site was cleaned up by a contractor late in 2012. The contractor recycled almost 16 tons of tires and excavated, transported, and disposed over 2,000 tons of mixed soil and debris at the NTMWD landfill. All field investigations at the site were done by early 2013. Tests conducted on soil and waste samples indicate that it is eligible for "no further action" approval from TCEQ. A summary report was prepared on the investigation of the site and its cleanup and was submitted to TCEQ on September 16, 2013; however, TCEQ has not responded (Chambers, 2013; NTMWD, 2014b).

In May 2016, NTMWD's contractor, FNI, reviewed available water quality and permitting records for the Bonham Landfill to determine the likelihood of environmental contaminants from the landfill contaminating the waters of Bois d'Arc Creek. In a report published on May 10, 2016, FNI determined that, because of the landfill's location outside the proposed reservoir project area and the 500-year floodplain, as well as the continuing TCEQ supervision over the closed landfill, there was no evidence that the landfill had negatively impacted the waters of Bois d'Arc Creek. This report was based on an evaluation of nine years of water quality testing data for Bois d'Arc Creek.

No further action is expected to be necessary to address concerns over toxic/hazardous substances or contaminants at the proposed project site. No adverse effects are expected with regard to environmental contaminants and toxic waste.

Operation

If the proposed reservoir is constructed and operated, NTMWD, TCEQ, and possibly other state or federal agencies would conduct periodic assessments of water quality, so that if a source of contamination were to become evident, it would be addressed in the appropriate manner.

4.13.3 Alternative 2

Construction

The potential impacts from the downsized reservoir alternative would be similar to those from Alternative 1. As in Alternative 1, no adverse effects are expected from environmental contaminants or toxic waste for this alternative. The desktop study, which covered the downsized reservoir alternative footprint, did not identify any recognized or potential environmental concerns in the project area. As described under Alternative 1, all other sources of known environmental contamination have already been addressed in an appropriate manner. Therefore, no further action is expected to be necessary to address concerns over toxic/hazardous substances or contaminants at the proposed project site.

Operation

If the reservoir is constructed and operated, NTMWD, TCEQ, and possibly other state or federal agencies would conduct periodic assessments of water quality, so that if a source of contamination were to become evident, it would be addressed in the appropriate manner.

4.14 SOCIOECONOMICS

This section describes potential impacts to output, labor income, employment, taxes, homes, and social landscape in a region of influence (ROI) defined as Fannin, Collin, Lamar, Hunt, Grayson and Delta counties. Impacts are categorized in terms of severity, duration, size or physical extent, and likelihood.

Estimates of the economic value of the proposed project are also provided. Table 4.14-1 summarizes potential impacts to socioeconomic resources under each alternative.

Table 4.14-1. Summary of Impacts to Socioeconomic Resources Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Medium (localized) to Large (multi-county)	Medium (localized) to Large (multi-county)	Large (multi-county)
Duration	Short-term (3-4 years)	Short-term (3-4 years)	Short-term (3-4 years)
Likelihood	High	High	High
Severity	Severe (direct, beneficial) Slight to Moderate (direct, adverse)	Severe (direct, beneficial) Slight to Moderate (direct, adverse)	None
Operation Phase			
Size	Medium (localized) to Large (multi-county)	Medium (localized) to Large (multi-county)	Large (multi-county)
Duration	Medium (Intermittent), Long-term (50-100+ years)	Medium (Intermittent), Long-term (50-100+ years)	Long-term (50-100+ years)
Likelihood	Medium to High	Medium to High	High
Severity	Severe (direct, beneficial)	Severe (direct, beneficial)	Severe (direct, adverse)

4.14.1 No Action Alternative

The No Action Alternative in this EIS consists specifically of not building and operating the dam, reservoir, pipeline, or water treatment facilities. Because the NTMWD does not have a planned back-up option to pursue if the Tulsa District denies the Section 404 permit for the LBCR, the expected water deficits would ultimately remain unaddressed. The NTMWD would continue to plan and implement other strategies to meet the growing water demand.

In the short-term, neither water supply nor projected population growth in the ROI or the NTMWD service area would be directly affected under this alternative. (Grayson and Lamar are included in the defined ROI, but the NTMWD does not supply water to these two counties). If the No Action Alternative is selected, no change would occur to existing residents, businesses, or the social fabric of counties in the ROI.

In the long-term, population for the six counties would continue to grow under the No Action Alternative. Both the populations of the NTMWD service area and of Fannin, Collin, Grayson, and Hunt counties are expected to more than double in the next fifty years. NTMWD supplied 268 million gallons of water daily (mgd) in 2006 to the region it serves. By 2020, the water demand is projected to increase to an estimated 431 mgd (NTMWD, 2007a). In the absence of the proposed project, the population projections may not materialize to the fullest. Therefore, water demand could be comparatively lower and delay the inevitability of insufficient water supplies.

According to the NTMWD "an ample, dependable water supply is essential to economic stability and growth (NTMWD, 2007a)." The Texas Comptroller of Public Accounts (TCPA), citing the Texas Water Development Board (TWDB), states that "if demand is not met it could cost businesses and workers in the state approximately $9.1 billion per year by 2010 and $98.4 billion per year by 2060. Our economy always has and always will rely on clean and abundant water supplies" (TWDB, 2009). Additionally, "failure to provide that water could prove costly. The TWDB estimates that as much as $161 billion in lost income and tax revenue could occur each year in Region C (a 16-county area including Fannin County) if adequate water supplies are not developed" (NTMWD, 2007a). The job and income creation associated with the operations phase of the proposed project (discussed in 4.14.2.3 through 4.14.2.4) would not take place. Further, the expected real estate and business development (also discussed in 4.14.2.3) around the reservoir would not occur.

In the short-term, the No Action Alternative would not impact counties in the ROI or the NTMWD service area because the area's current water needs would be met. While slower population growth might delay the inevitability of insufficient water supplies, ultimately the NTMWD would be unable to supply the growing demand for water and as such adverse impacts would be severe in the long-term. The size or physical extent of both short- and long-term impacts would be large and reach the nine counties to which the NTMWD supplies water, four of which are included in the ROI. The likelihood of both short- and long-term impacts would be high, since projected population is based on trends, though these trends could decrease in rate without the ample provision of water.

4.14.2 Alternative 1

The primary purpose of the LBCR is to provide additional drinking water supply to meet the projected future demand. The LBCR would provide a 16,641-acre water supply reservoir for NTMWD and would produce an estimated firm yield of 120,655 acre-feet of water per year. The project has been studied previously for the Red River Authority and the NTMWD. The reservoir was recommended as a water supply for the NTMWD in the 2001, 2006, and 2011 Region C Water Plans; as well as the 2002, 2007, and 2012 Texas State Water Plan (TWDB, 2002, 2007, 2012).

The NTMWD has identified and prescribed the LBCR as a major source to reconcile the future population growth and the otherwise increased strain on its water resources. Ideally, by 2060 "11 percent of our projected water demand will be met by the LBCR" (NTMWD, 2007a). In addition, experience from other reservoirs in Texas indicates that all new users are not identified before the reservoir is built. After Lake O' the Pines was completed, water from the reservoir was sought by water user groups (WUGs) not identified before the reservoir was constructed and not included in the original planning. Many of these surface water demands stemmed from population growth and decreased ability to rely on groundwater (NETMWD, 2005).

Project Costs

Construction expenditures for Alternative 1 are estimated at $365 million, including design, engineering, and related costs; and conflicts in the project area that would be relocated such as gas pipelines, transmission lines, roads, and cemeteries. It is anticipated that land acquisition for the reservoir, related mitigation areas, and legal fees would cost about $174.1 million. Property owners in the impoundment area and the additional acreage that may be set aside for flood easements would be compensated. Additionally, water transmission facilities including storage facilities, the transport pipeline, and the water intake pump station would cost about $220 million. As shown in Table 4.14-2, total expenditures for the LBCR and related infrastructure would be about $586 million over a three- to four-year period. These are "one-time" costs without likelihood of persistent economic impacts over the life of the dam and reservoir.

Table 4.14-2. Project Cost Estimates for Alternative 1 (120,665 AFY)

Description	Cost
Pre-construction	
Engineering Fees	$64,043,000
Other costs (legal, land acquisition, mitigation)	$174,121,000
Construction	
Dam and Reservoir Construction Costs	$76,645,000
Conflicts	$50,573,000
Transmission Facilities	
Pipeline	$161,851,000
Intake Pump Station	$44,921,000
Terminal Storage	$13,409,000
Total Cost	$585,563,000
Annual Costs*	
Debt Service (6% for 30 years)	$42,540,515
Electricity ($0.09 per kilowatt hour (kWh)	$5,029,275
Operation and Maintenance	$3,891,210
Total Annual Cost	$51,461,000
Unit Costs (Before Amortization)*	
Per Acre-Foot	$427
Per 1,000 Gallons	$1.31
Unit Costs (After Amortization)*	
Per Acre-Foot	$74
Per 1,000 Gallons	$0.23

*Figures based on a 120,665 acre-feet/year yield, $586 million balance, 30-year term, and 6% interest rate.

Dam operation and maintenance (O&M) includes things like controlling vegetation, livestock, and animals; systematic and frequent inspections; repairs as needed; and mechanical and electrical maintenance (TCEQ, 2006). O&M would cost approximately $3.9 million per year. O&M costs were calculated based on the construction cost of the capital improvement. Engineering, permitting, and land acquisition costs were not included. O&M costs were calculated at: one percent of the construction costs for the pipeline; 1.5 percent of the construction cost for the dam; and 2.5 percent of the construction costs for the intake pump station and terminal storage. The figures presented below allow up to 20 percent for construction contingencies; and are also captured in O&M calculations. Electricity to operate the pump station would cost approximately $5 million annually. Other financial costs like annual debt payments and amortization are discussed in greater detail below in 4.14.3.2 under Financing Costs.

Short- and Long-Term Expenditures

Expenditures can be either short- or long-term. Short-term expenditures on the construction of dam, pipeline, pump station, and storage and treatment facilities in Fannin County are expected to occur over a period of three to four years. Short-term expenditures are terminated after the initial outlay or net investment.

Long-term expenditures recur over time and consist primarily of O&M of those items built with the short-term expenditures. O&M costs would recur annually and persist over the life of the dam and reservoir, including storage and treatment facilities. The categories of expenditures and their term are shown in Table 4.14-3.

Table 4.14-3. Short- and Long-Term Expenditures

Expenditures	Term
Dam Construction, Pipeline Construction, Pump Station, and Other Infrastructure	3-4 years
Pipeline, Storage, and Treatment Facilities Construction	3-4 years
Dam Operation and Maintenance	Lifetime (50-100 years)
Pipeline Maintenance	Lifetime (50-100 years)

Source: Clower, 2012.

Financing Costs

No tax revenues would be used to construct the reservoir. NTMWD would fund the construction through water sales; ultimately, financing costs are paid by the users of the water. The LBCR costs, including land acquisition, construction, transmission and treatment facilities, and any other costs would be expected to be financed with contract revenue bonds and by NTMWD.

NTMWD would plan, finance, build, and operate the reservoir coordinating with local, state and federal authorities, including the City of Bonham, Fannin County, TWDB, Texas Commission on Environmental Quality, Texas Parks and Wildlife (TPW), and the USACE, among others. Although land acquisition, permitting, funding, environmental impacts, and mitigation would conform to the standards and guidelines set by these organizations, NTMWD would solely own and operate the LBCR (NTMWD, 2009).

Based on the most recent estimated project cost figures, raw water from the LBCR would be $1.31 per 1,000 gallons. The cost per 1,000 gallons is derived as follows. The probable total cost is $585,563,000. The components of this cost are displayed in the above Table 4.14-2 (Project Cost Estimates for Alternative 1). Annual debt service is the cash required for a particular time period to cover the repayment of interest and principal on a debt. In the case of the LBCR, the annual debt payment would be about $42.5 million assuming 30 years of payments at six percent interest. This annual debt payment also assumes one bond issuance for $585,563,000. The annual O&M cost is $3,891,210, and the sum of the annual debt payment and O&M is $46,431,725. Based on the reservoir's estimated yield of 120,665 acre-feet per year (AFY), the estimated total cost of debt and O&M would be $427 per acre-foot of water, which equates to $1.31 per 1,000 gallons (see Table 4.14-2).

Because the NTMWD would be the owner of the reservoir, there would not be a contract price for the water (NTMWD, 2009). Amortization is the paying off of debt in regular installments over a period of time, or the annual debt payments as described above. Before amortization, the cost of water would be $1.31 per 1,000 gallons. After amortization, water would drop to $0.23 per 1,000 gallons, based on a yield of 120,665 AFY. Costs to deliver water to customers in Fannin County may be less, depending on their location. The projected impact of the reservoir on the NTMWD's wholesale water rate is estimated to be about six percent higher than existing rates (NTMWD, 2009).

The NTMWD impounds or receives, via contract, raw water from several North Texas reservoirs for transmission to, and treatment at, three water treatment plants it owns and operates. Each contracting customer has an unconditional obligation to meet its pro rata share of operating, maintenance, and debt service costs to NTMWD. Furthermore, the contract language allows the district to reallocate costs to its customers at any time for any revenue shortfall (S&P Financial Services LLC, 2009).

Financing costs would potentially create slightly adverse impacts due to the water price increase for NTMWD customers. The size or physical extent of impacts would be large (multi-county) since the project costs are shared by all NTMWD customers. The likelihood of rate adjustment is high, as indicated by the long-term financial plans that have been developed to establish the payment plan. Adverse impacts in the form of more expensive water per 1,000 gallons would be felt in the short-term until after amortization (30 years). In the long-term, impacts to economic resources would be beneficial because the price would drop drastically once the debt is paid off.

Input-Output Model

Estimates of the economic impacts of the proposed project are based on Terry Clower, Ph.D.'s Impact Analysis for Planning (IMPLAN) input-output economic modeling system, originally developed by the Minnesota IMPLAN Group. The figures and discussion of those figures in Tables 4.14-4 through Table 4.14-11 are taken directly from Dr. Clower's March 2012 report "Update of the Economic, Fiscal, and Developmental Impacts of the Proposed LBCR Project" prepared for the NTMWD, included in Appendix E. The economic benefits reported in Dr. Clower's report are likely understated, by the author's estimates. All results are reported in 2011 dollars.

As shown in Table 4.14-4, the modeled impacts include the direct effects of spending for construction activities and consumption spending of new recreationists and residents; the indirect effects of local vendors providing goods and services to the primary firms; and the induced impacts of employees of these firms spending wages on rent, food, entertainment, etc. in the local economy. Economic activity is measured in terms of income and employment generated (or lost) from the proposed project. With increased spending, many different sectors of the economy benefit – not only the directly impacted sector but also many sectors indirectly. For example, an increase in tourism spending at hotels would directly yield increased sales in the hotel sector. The additional hotel sales and associated changes in hotel payments for wages and salaries, taxes, and supplies and services are direct effects of tourist spending. The tourism industry, in turn, buys goods and services from other backward-linked industries (i.e. industries supplying products and services to hotels). Changes in sales, jobs, and income in the linen supply industry, for example, represent indirect effects of changes in hotel sales. Businesses supplying products and services to the linen supply industry represent another round of indirect effects, eventually linking hotels (to varying degrees) to many other economic sectors in the region. Induced effects are the changes in economic activity resulting from household spending of income earned directly or indirectly as a result of tourism spending. For example, hotel and linen supply employees, supported directly or indirectly by tourism, spend their income in the local region for housing, food, transportation, and the usual array of household product and service needs. The sales, income, and jobs that result from household spending of added wage, salary, or proprietor's income are induced effects (Stynes, 2006).

The analysis performed by an input-output model helps account for changes that may occur due to construction. There are many costs associated with building and maintaining the proposed dam and reservoir. All sides of the cost-benefit analysis are analyzed, including costs to the local community and surrounding area as well as benefits the reservoir would bring. For example, the analysis "netted out" some agricultural production that would be lost permanently as a result of impounding the proposed reservoir site; however, the analysis may actually overstate the potential loss since other areas of the county could potentially absorb the productive activities. Table 4.14-4 provides IMPLAN definitions for direct, indirect, and induced effects.

Table 4.14-4. IMPLAN Definitions

Effect	Definition
Direct	Determined by the event as defined by the user (i.e., a $10-million-dollar order is a $10-million-dollar direct effect).
Indirect	The amount of the direct effect spent within the study region on supplies, services, labor and taxes.
Induced	Measures the money that is re-spent in the study area as a result of spending from the indirect effect.

Source: IMPLAN, 2012.

Each of these steps (direct, indirect, and induced) recognizes an important "leakage" from the economic study region spent on purchases outside of the defined area. "Leakage" is the non-consumption uses of income, including savings, taxes, and imports that "leak" out of the main flow between output, factor payments, national income, and consumption. Eventually these leakages stop the cycle (IMPLAN, 2012).

Economic impact assessments for the dam and reservoir and related infrastructure construction projects are examined in two models. The first examines direct, indirect, and induced impacts likely to remain in Fannin County. The second model estimates economic impacts based on the size of the development projects, businesses and residents of nearby counties that would also benefit from the economic activity associated with the construction of the dam. For purposes of this analysis, estimates of the total impacts that would likely occur in a wider economic area are defined by Fannin, Collin, Delta, Lamar, Grayson and Hunt counties.

4.14.2.3.1 Construction Phase

Based on the relative presence, or absence, of industries providing materials and supporting services to dam construction projects, some of the economic activity would "leak" out of the local area. Even still, expenditures that would not leak out would increase total economic activity in Fannin County by $509 million to $563 million. Expenditures would also boost gross county product, or the total value of the goods and services produced by the people of a county during a year (not including the value of income earned outside the county), by $211 million to $233 million (see Table 4.14-5). This new activity would create over 5,000 person years of employment, or 5,000 full-time jobs for one year. Local labor income (salaries, wages, and work benefits) would increase by $165 million to $182 million. Property incomes in the form of rent, royalties, corporate profits, and dividends would increase by $36 million to $40 million. Business taxes from indirect transactions would boost state and local tax revenues by $9.7 million to $10.8 million (Clower, 2012).

Table 4.14-5. Local Economic Construction Impacts in Fannin County

Dam, Pipeline, Water Treatment Plant, Pump Station & Other Infrastructure		
Description	Range of Impacts	
Total Economic Activity	$509,330,002	$562,943,686
Total Gross County Product	$211,355,290	$233,603,216
Total Salaries and Wages	$165,237,561	$182,630,989
Total Person-Years of Employment	4,999	5,525
Property Income*	$36,367,192	$40,195,318
Indirect Business Taxes**	$9,750,537	$10,776,909

* Includes rents, royalties, dividends, and corporate profits. ** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from Water District spending.

Source: North Texas Municipal Water District; Clower, 2012.

When compared with the construction impacts, the non-recurring impacts of developing the LBCR would boost economic activity in Fannin County by an additional $10 million, increase county gross product by $7 million, and support another 100 person-years of employment. Labor income associated with these jobs would increase by $20 million. Property income in the form of rents, royalties, dividends, and corporate profits would increase by $3 million. Indirect business taxes in the form of property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending would increase by approximately $1 million (see Table 4.14-6).

Table 4.14-6. Temporary Local Economic Impacts of Development in Fannin County

Includes Dam, Pipeline, Water Treatment Plant, Pump Station, and Land Acquisition Costs		
Description	**Range of Impacts[1]**	
Total Economic Activity	$521,000,000	$574,000,000
Total Gross County Product	$219,000,000	$241,000,000
Total Salaries and Wages	$169,000,000	$186,000,000
Total Person-Years of Employment	5,100	5,600
Property Income*	$39,000,000	$43,000,000
Indirect Business Taxes**	$10,600,000	$11,700,000

[1]Rounded

* Includes rents, royalties, dividends, and corporate profits.

** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending.

Source: North Texas Municipal Water District; Clower, 2012.

It is difficult to estimate what portion of labor, materials, and equipment would be provided by each county or by the state. Ideally, 100 percent of the labor force would be filled by the local population. As discussed in the affected environment under 3.12.2 (Labor), Fannin County's 2010 labor force consists of approximately 14,005 people, of which 12,698 were employed. It would seem unlikely that Fannin County could supply the entire trained construction workforce for a project of this magnitude. In IMPLAN, the multipliers for new construction sectors reflect what materials could likely be bought locally versus being imported. NTMWD would recruit locally, state-wide and nationally to fill labor and/or professional needs. Equipment and materials would be procured locally as much as possible. However, a substantive amount of specialized equipment and materials required for dam construction would not be available locally. Such items would be shipped from other areas.

Construction of the dam would also create a number of indirect or induced jobs from project-related spending and the spending decisions of workers. This effect, known as the employment multiplier effect, takes the impacts from project-related spending into account to determine the number of indirect or induced jobs created in the local economy by an action.

The Employment Multiplier

A "multiplier" is a number used by economists to determine the impact of a project on the economy. It is the ratio of total change in output or employment to initial change (or direct change). For example, if an industry were to create 100 new jobs it would require materials and services from its supplying industries. If this increase in demand created 50 new jobs in the supplying industries, the employment multiplier would be 1.5 [i.e., 100 (direct) + 50 (indirect and induced)].

These temporary jobs would generate additional wages and benefits to be spent in the local economy. Businesses such as hotels, restaurants, gas stations, and grocery stores in the project area might see some beneficial economic effects from per diem expenditures (meals, lodging, incidentals, etc.) by workers during their time in the local area. Current per diem levels in Fannin, Lamar, and Grayson counties are the standard rate: $77 for lodging and $46 for meals and incidental expenses. Per diems in Hunt and Collin counties are $85 and $99 for lodging and $51 and $61 for meals and incidental expenses, respectively (GSA, 2011). This amounts to $123 a day in Fannin, Lamar, and Grayson counties, $136 per day in Hunt County, and $160 per day in Collin County per person.

Based on the IMPLAN study, the proposed project would have an employment multiplier of 1.1. For every one job as a direct result of the proposed dam and reservoir, an additional 0.1 indirect or induced jobs would be created in the larger economic area defined by Fannin, Hunt, Lamar, Delta, and Grayson counties. Thus, the approximately 5,000 jobs that would be created during construction would ostensibly result in the creation of 500 additional indirect or induced jobs. Most of the approximately 5,500 direct, indirect, and induced jobs created by the project would last only for the duration of the three- to four-year construction phase.

A comparison of figures in Table 4.14-7 below to the Table 4.14-6 above indicates that impacts to the expanded economic region defined by Fannin, Collin, Lamar, Delta, Grayson and Hunt counties would be greater than in Fannin County alone during the same three- to four-year construction period. This spillover reflects these additional counties' abilities to attract a portion of the jobs and business activity related to the development of the reservoir. Total economic activity associated with property acquisition and the construction of the proposed dam, reservoir, and other infrastructure would increase by more than $150 million during the construction phase when compared to Fannin County. Gross area product would also increase by more than $150 million during the same three- to four-year phase. Total labor income paid in the five-county region would potentially be $100 million more than in Fannin County alone. Property income would also rise by about $40 million in Fannin County, while state and local government revenue would increase by about $10 million from indirect business taxes including sales taxes, property taxes, and fees for permits and licenses.

Table 4.14-7. Temporary Economic Impacts of Development in Fannin, Collin, Delta, Lamar, Grayson and Hunt Counties

Includes Dam, Pipeline, Water Treatment Plant, Pump Station and Land Acquisition Costs		
Description	**Range of Impacts**	
Total Economic Activity	$681,688,798	$833,175,198
Total Gross County Product	$347,401,467	$424,601,793
Total Salaries and Wages	$255,942,255	$312,818,275
Total Person-Years of Employment	6,110	6,726
Property Income*	$72,807,443	$88,986,875
Indirect Business Taxes**	$18,651,798	$22,796,642

* Includes rents, royalties, dividends, and corporate profits.

** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending.

Sources: North Texas Municipal Water District; Clower, 2012.

Potentially beneficial impacts from construction costs would be severe due to the creation of jobs, property income, and indirect business taxes. The size or physical extent of impacts would be medium (localized) to large (multi-county), because all of the jobs would not be filled by area residents, a portion would travel from outside of the economic region. The likelihood of impacts would be high, because the relationship between an infusion of capital and direct, indirect, and induced impacts is well-established. Impacts would be short-term and last not much longer than the three- to four-year year construction phase.

Impacts to Homes and Social Landscape

While no social surveys have been conducted for this EIS, the scoping process, other public meetings, and media indicate there are at least some residents who generally oppose or opposed the project on certain grounds, including for socioeconomic, cultural, natural, and historic reasons (USACE, 2010c; NTEN, 2009a). Alternative 1 has the potential to alter the socioeconomic landscape by increasing the total population, real estate and business development, and recreational visitors and their spending.

During a 2009 Fannin County Commissioners Meeting, Commissioner Dewayne Strickland voiced several concerns on behalf of his constituents, including whether county residents are being fairly compensated for the land currently being purchased for the lake (NTEN, 2009a). However, the fact that the NTMWD has already acquired 82 percent of the property within the reservoir footprint from landowners suggests that the majority have been willing to sell for the compensation offered.

Although there are some homes – approximately a dozen – in the area, most of the land is currently agricultural or undeveloped. Very few occupied houses have been or will be purchased as part of the project, but those approximately dozen homes were or will be paid fair market value. Some homeowners were paid up to $15,000 for relocation costs as part of the purchase negotiations (McCarthy, 2011b). Land would be purchased outright to an elevation of 541 feet mean sea level (msl) around the proposed reservoir site. Flood easements around the site would be purchased for land with elevations between 541 and 545 feet msl. The proposed permanent easement for the pipeline would be a width of 100 feet. A temporary construction easement would increase the total width of easements along the alignment to 120 feet.

An easement is the right of a person, government agency, or public utility company to use or restrict public or private land owned by another for a specific purpose. Utility easements are strips of land used by utility companies to construct and maintain overhead electric, telephone, and cable television lines as well as underground electric, water, sewer, telephone, and cable television lines. When an easement is obtained, it is added to the title of the property, and it travels with the title through ownership transfers, forever restricting its use. They are usually valid for an indefinite period of time. In fact, it is most common for easements to be valid in perpetuity, and the entity holding it determines the period of time. In the event that neither party can agree on a mutually acceptable price for an easement or sale in fee simple, the proponent, working with the state or county, would have the option of resorting to eminent domain.

The NTMWD has notified the people who own the land needed for this project in writing. Prices for the land are negotiated with each landowner based on the value of their individual property. The NTMWD is required to negotiate with property owners in an effort to reach an agreement on the amount of compensation for property required for this project, which is based on the market value of the land at that time. If negotiations are unsuccessful, the NTMWD must acquire the property required for the project through eminent domain proceedings, and Texas law sets forth specific procedures to determine the final compensation. Whether the property is acquired through negotiation or through eminent domain, a property owner is paid market value for their land (NTMWD, 2007b).

Eminent domain is a power reserved by a government agency, usually at the state or local level, to use its legislatively-granted police power to condemn a piece of property for the "public use," which can include anything furthering the health, safety, and welfare of the general public. It is required that the exercise of the eminent domain power be rationally related to a conceivable public purpose (Callies et al., 1994), and local governments can also condemn private property on behalf of private developers whose actions are purportedly fostering broad economic development aims in an area (MDN, 2005). If eminent domain were to be used by local or state government on behalf of an entity like the NTMWD, the land would then be fully owned by that entity.

In 2010 brothers Russell and William Graves released a documentary entitled "Bois d'Arc Goodbye," "…a story about how a creek…transforms. The transformation affects not only the landscape, but people as well. This is a story about a creek's cultural, natural, and historic importance to a rural part of Texas" (Graves, 2010). This documentary appears to also reflect public comments submitted during the scoping period regarding socioeconomics. This concern, while real, is voiced by a few residents and does not necessarily reflect the beliefs of the majority of those affected. Concerns include the displacement of multi-generational residents, farmers, and ranchers; loss of farming, ranching, family businesses, and rural heritage; and that the culture of the area would change against wishes of longtime residents due to influx of outsiders who do not share values, therefore eroding the social cohesion of the area (USACE, 2010c).

Fannin County has a medium level of community cohesion based on the indicators evaluated in the affected environment (i.e. length of residency, the presence of families or the elderly in communities, ethnic homogeneity, working class families, etc.). However, the social landscape and rural culture in Fannin County have already been changing. Spillover growth from the Dallas-Fort Worth Metroplex is reaching the Bonham area, which is still within reasonable reach of big-city amenities (Clower, 2012). Householders moved into 55 percent of the total 11,824 occupied housing units in 2000 or later. Said otherwise, 6,508 occupied units in Fannin County changed residents in the last decade (USCB, 2010b). The reservoir itself would provide amenities such as convenient access to recreation. The Bonham area is also removed from most urban disamenities such as traffic jams, air pollution, noise, and trash.

Impacts to the local homes and the social landscape would create slight to moderate adverse impacts on the Fannin County's community cohesion. Spillover from the Dallas Fort-Worth metropolitan area has already infused a new class of workers into Fannin County. Drought has further exacerbated already failing farms. The size or physical extent of impacts would be medium (localized) by definition, because the homes that would be impounded are located within the reservoir's footprint. Impacts would be felt in both the short-term and long-term.

4.14.2.3.2 Maintenance and Operation Phase

As displayed above in Table 4.14-2, Project Cost Estimates for Alternative 1, the annual O&M cost is an estimated $3,891,210. Machinery and materials are needed to conduct activities such as controlling vegetation, livestock, and animals; systematic and frequent inspections; repairs as needed; and mechanical and electrical maintenance (TCEQ, 2006). These activities would support 24 direct and indirect jobs paying about $769,000 in annual wages and salaries and increase local economic activity by $2.1 million each year in Fannin County (see Table 4.14-8). The recurring impacts in Table 4.14-8 are net, that is, they account for a small reduction in recurring agricultural activity within Fannin County that would occur as a result of permanently losing agricultural production on the farmland within the reservoir footprint.

Table 4.14-8. Temporary Local Economic Impacts of Development in Fannin County

Description	Impact
Total Economic Activity	$2,137,000
Total Gross County Product	$1,346,000
Total Labor Income	$769,000
Total Jobs	24
Property Income*	$486,000

Description	Impact
Indirect Business Taxes**	$91,000

* Includes rents, royalties, dividends, and corporate profits.

** Includes property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending.

Sources: North Texas Municipal Water District; Clower, 2012

The severity of potential beneficial impacts from maintenance costs would be slight due to the creation of jobs and recurring expenditures. The size or physical extent of impacts would be medium (localized), because long-term jobs and economic benefits would be felt most by the NTMWD service area. The likelihood of impacts would be high as the required O&M of a dam and reservoir is established in order for it to serve its main purpose. Impacts would be long-term and last as long as the dam's lifetime (50-100 years).

Impacts of Recreational Users

Few studies offer specific guidance on estimating the magnitude of the economic impacts to Fannin County from increased recreational visitors when the proposed reservoir is operational. However, a mid-1990s survey by Texas A&M, Texas Parks and Wildlife Department (TPWD), and the Sabine River Authority assessed anglers' levels of local spending. Results indicated that two-thirds of the survey respondents were non-local residents, with about one-third hailing from outside of Texas. Non-local angler visitors to Lake Fork spent an estimated $14.5 million in Wood, Rains, and Hopkins counties during their fishing trips for goods, lodging, and supplies. This level of spending encourages business development and supports jobs. While some of this employment would be seasonal, North Texas weather patterns permit water-based recreation on a year-round basis (Ditton and Hunt, 1996).

Other lake-based recreational activities like boating and camping would draw additional out-of-area visitors to the region. When combined with non-angler spending, non-local recreational visitors would add $16.7 million to $22 million in new spending for dining, retail goods, and lodging to the Fannin County economy annually (see Table 4.14-9). This spending would generate between $21.2 and $28.2 million in economic activity, support approximately 300 to 400 new jobs, and increase local earnings by $6.2 to $8.3 million. The proposed reservoir is expected to attract at least 1,100 full-time resident households over and above anticipated growth for the area over the next 30 years. Lastly, new households are expected to bring almost $60 million in new income to the area (Clower, 2012).

Table 4.14-9. Recurring Annual Local Economic Impacts of Recreational Out-of-Area Visitor Spending at Lower Bois d'Arc Creek Reservoir

Description	Range of Impact	
Total annual spending: recreational visitors	$16,748,000	$21,982,000
Total economic activity	$21,176,000	$28,233,000
Total salaries and wages	$6,235,000	$8,344,000
Total full-time-equivalent employment	295	393

Source: Clower, 2012

Potentially beneficial impacts to recreation and business development would be severe due to spending from recreational visitors. The size or physical extent of impacts would be large since the reservoir might attract recreationists from outside the immediate region. Given the experience of other reservoirs like Lake Fork, the likelihood of recreational spending impacts would be medium to high. Impacts would be long-term and last as long as the reservoir's lifetime (50-100 years).

Impacts of New Permanent and Weekend Residents

One trend clearly evident in north and northeast Texas is that counties with substantial reservoirs have experienced greater population growth than counties without. According to the Northeast Texas Municipal Water District (NETMWD), population growth and water availability in northeast Texas are positively correlated. They attribute this population growth to people wanting to live near a lake and also a growth in industry and jobs because of additional available water. From 1960 to 2000, the 19 counties in northeast Texas grew by 66.5 percent. Every county that at least doubled its population during that time contains a major reservoir with at least 10,000 acre-feet of water capacity. Every county that decreased in population did not have a reservoir in it for at least part of the 40 years. In counties where reservoirs were constructed, growth rates either reversed (if declining) or increased after completion of the reservoir (NETMWD, 2005). Many recreational lake visitors eventually decide to relocate close by the lake or reservoir. Carefully managed residential development can prove to be a tremendous economic boon for lake county economies (Clower, 2012).

The proposed dam and reservoir would be approximately 50 miles from McKinney and 80 miles from downtown Dallas. Already, spillover growth from the Dallas-Fort Worth Metroplex is reaching the Bonham area. Within reasonable reach of big-city amenities yet removed from most urban disamenities, the proposed reservoir is expected to attract at least 1,100 full-time resident households over and above anticipated growth for the area over the next 30 years. Potential growth would be substantial assuming the reservoir would not be impounded until well after the local housing markets have recovered from the Great Recession and sub-prime lending crisis. New households would be expected to bring almost $60 million in new income to the area (Clower, 2012).

In addition, at least 2,100 new dwellings would be constructed in the area surrounding the reservoir as weekend/vacation homes and investment properties. While relative proximity to the Metroplex might encourage permanent residents; that same proximity might also lower demand for weekend/vacation housing for those only an hour's drive away. Nonetheless, weekend and vacation residents would be expected to bring an equivalent of $10 million in household income that would be used for local purchases (Clower, 2012).

By modeling the combined incomes of permanent residents and the proportional income of weekend residents using regionally based estimates of spending, Fannin County would realize a net increase in activity of between $80.7 and $89.2 million per year once full development is reached. This activity would support 517 to 572 permanent jobs, or the equivalent of $13.3 to $14.7 million in salaries and wages (see Table 4.14-10).

Businesses located in Fannin, Hunt, Lamar, Grayson, and Delta counties would likely offer goods and services to new permanent and weekend residents. As shown in Table 4.14-10, the economic activity of these counties, including spending by households drawn to the new reservoir, would increase economic output in the broader region by $105 to $116 million, boost local income by $22 to $24 million, and support between 857 to 947 permanent jobs (Clower, 2012).

The pace and quality of development would depend on many market-related factors. One critical factor would be the extent to which counties, cities, and towns adopt development plans to promote quality growth while also ensuring that infrastructure development and publicly-provided services keep pace with new demand. Examples of infrastructure developments would include such things as electric services, roads, water services, public safety, and other municipal services (Clower, 2012).

Table 4.14-10. Recurring Annual Economic Impacts of New Resident Spending

Description	Range of Impacts	
Fannin County		
Annual Spending	$70,891,000	$77,764,000
Economic Activity	$80,726,000	$89,223,000
Labor Income	$13,332,000	$14,735,000
Jobs	517	572
Fannin, Hunt, Delta, Grayson, & Lamar Counties		
Economic Activity	$105,294,000	$116,378,000
Labor Income	$21,940,000	$24,250,000
Jobs	857	947

Source: Clower, 2012

New permanent and weekend residents would potentially create beneficial impacts of moderate severity due to increased spending on homes and goods and services. The size or physical extent of impacts would be medium (localized) because the homes and goods and services would be offered in the immediate area. The likelihood of impacts would be high, because the relationship between reservoirs and recreational real-estate development in Texas is well-established. The setting is unique but not entirely unpredictable given its proximity to the Dallas Fort-Worth Metroplex, making the likelihood of potential impacts medium to high. Impacts would be both short- and long-term.

Impacts of New Housing Construction

It was assumed that the new permanent and weekend resident households would be single-family units, which is consistent with most of the development trends experienced in other lake counties. Even if residential real estate demand shifts to the inclusion of multi-family properties, the costs of development would be within the range of possibilities projected below. Consequently, the economic and fiscal impacts of the multi-family properties would be within the projections discussed herein. Because of recent housing market volatility, the estimates of housing prices have been retained from the 2007 study, but results are presented in 2011 dollars. The average cost of land and improvements for permanent resident dwellings would be approximately $127,000 (Clower, 2012). Based on nationwide housing studies, vacation and weekend homes would likely be valued somewhat lower than those of permanent residences. As such, an average market value is estimated at $115,000 per weekend dwelling. Residential construction activity was estimated by assuming a 30-year period, and that 25 percent of the housing values would be represented by land. Almost $288 million in new residential construction activity is expected to occur primarily in Fannin County, as presented below in Table 4.14-11. These construction activities would boost the local economy by about $14.5 million per year, on average (housing construction will not be evenly distributed across the period of development), support an average of 133 long-term full-time equivalent (FTE) jobs, and boost local income by $3.4 million for a 30-year period (Clower, 2012).

Table 4.14-11. Local Economic Impacts of Housing Construction

Description	Impact[1]	
	Total	Average Annual
Construction Spending	$287,805,000	$9,594,000
Economic Activity	$432,538,000	$14,418,000
Labor Income	$102,123,000	$3,404,000
Jobs	3,997	133

[1]30-year development
Source: Clower, 2012

New housing construction would potentially create moderately beneficial impacts due to the creation of jobs. The size or physical extent of impacts would be medium (localized) to large (multi-county), because ostensibly many of the jobs would be filled by area residents, but a portion still would travel from outside of the economic region. The likelihood of impacts would be high, since the relationship between an infusion of capital and direct, indirect, and induced impacts is well-established. Impacts would be medium (intermittent) to long-term and last approximately 30 years.

Business Development and Recruitment

One key attraction for businesses looking to open plant sites, distribution centers, and other industrial land uses which might also be looking to relocate themselves is the presence of recreational amenities and quality-of-life features. The presence of a new, reliable source of water would enhance the county's ability to attract and retain businesses, in addition to its strategic location (so close to the Dallas Fort-Worth Metroplex). Projected water demand estimates from the TWDB and the previously described IMPLAN model are used in tandem to estimate the severity of economic activity that could be gained through expanded business activities.

The TWDB expects manufacturing industry water use to rise in Fannin County by eight AFY between 2020 and 2030. Water used for steam electricity generation is expected to increase by 436 AFY. Livestock and irrigation uses are not expected to increase over this period, which is reasonable given much of the land that would be impounded is currently grazing and agricultural land. (Projected water usage for livestock and irrigation are substantially lower than current usage estimates.) Mining industry activities are also not expected to increase. Municipal uses are expected to rise by 1,326 AFY, partly to account for the potential increase in households, but also for potential commercial and other non-manufacturing business activities (Clower, 2012).

Using 2000 usage data for Fannin County and adjusted commodity production estimates from IMPLAN, the current economic value of production per acre-foot of water used by use-category was multiplied by projected increase in water usage. The results indicate that manufacturing, commercial (no more than 20 percent of municipal water usage assumed for commercial business activities), and electricity generating activities would increase by $117.9 million annually (Clower, 2012).

An increase in Fannin County's direct economic activity would also create spin-off indirect and induced economic impacts. To improve the accuracy of estimating these indirect and induced impacts, two adjustments were made to the model. First, the induced (household spending) impacts were not included in order to avoid double counting the impacts of permanent resident spending that would be employed by potentially new business activity. Second, current economic models of Fannin County do not adequately represent how the economy would operate 25 years from now. Therefore, the nearby Rockwall County impact multipliers were used, since it currently has a population about equal to TWBD's projected population for Fannin County. As shown in Table 4.14-12, a $117.9 million industrial and commercial output in Fannin County would indirectly create $145 million in economic activity, boost area labor income by $48 million, and support over 1,600 jobs (Clower, 2012).

Table 4.14-12. Economic Impacts of New Industrial and Commercial Activities

Description	Annual Impact[1]
New Direct Activity	$117,866,000
Total economic activity	$145,197,000
Total salaries and wages	$48,111,000
Total full-time equivalent (FTE) employment	1,607

[1]10-year increase after reservoir development
Source: Clower, 2012

Beneficial impacts from business development and recruitment would potentially be severe due to infusion(s) of capital and their ripple effects. The size or physical extent of impacts would be large, because the proposed project might attract investors from outside the previously defined region. The likelihood of impacts would be high, because the relationship between water supply and development is well-established. Impacts would be long-term and last at least as long as the dam and reservoir's lifetime (50-100 years).

Local Fiscal Impacts

The proposed project would increase economic activity in the area by creating jobs for construction and O&M of the proposed dam and reservoir. These jobs would create additional sales tax revenue, and new residents would pay property taxes that would benefit government operations. As the population grows with economic development from construction and O&M of the dam and reservoir, the tax base would also expand. Although tax revenues would initially decrease due to taxable land in the proposed reservoir site that would be impounded, ultimately the reservoir could attract residential, commercial, and industrial property development that would substantially boost property tax revenues in local taxing jurisdictions.

NTMWD has committed to keeping local tax agencies whole by making payments equal to any lost revenues until such time as growth in the tax base makes up for any initial lost tax revenues. Most of the funding for these payments in lieu of taxes (PILT) comes from payments to NTMWD from leaseback agreements by former property owners whose properties were purchased by NTMWD (McCarthy, 2017).

Fannin County would eventually experience a net increase in tax revenue from the associated or "ancillary" development likely to occur in conjunction with the dam and reservoir. This net increase in tax revenue would enable the cities and county to build more roads, increase the number of schools and teachers, and provide community services for the increased population. While increased population generates the need for more services, it should be noted that it is unclear whether the increased revenue would be in fact used to address these needs. Those decisions are a function of the political process of local government and may also depend on other outstanding needs.

PILT have already offset lost tax revenue as NTMWD has acquired property for the reservoir; these would have reduced local tax rolls before much of the development occurs were it not for PILT. The area of land to be acquired by NTMWD can generally be described as southwest of the proposed dam and reservoir, at or below 541 feet msl. The affected land parcels were identified using GIS data and software that was provided by the consulting engineers on the LBCR project. Data were obtained from the Fannin County Appraisal District (FCAD) showing the size and taxable value in 2007 for each parcel that would lose land to the reservoir. This includes those parcels that would lose only a portion of their land to the lake and/or floodplain area. In all, about 556 unique parcels were identified between the 541 and 545-foot elevation level. Of these, data for 502 parcels are available on the FCAD online database.

Land valuations for these parcels are based on the average taxable value of land for all other parcels, about $305 per acre including exemptions in 2007. Since 2007, taxable property values in Fannin County, like most areas, have been affected by the downturn in the real estate market. Real property valuations net of new development have increased by an estimated 0.67 percent per year since 2007 for an average taxable value of about $313 per acre. This estimated valuation was assigned to each school district based on their relative portion of land in the project area (Clower, 2012). The analysis of foregone property tax revenues is based on the 2007 analysis with this increased property valuations to reflect estimated average growth of valuations in Fannin County through 2011. Estimates of potential tax losses for Fannin County, the City of Bonham, and affected school districts in the near term are presented below in Table 4.14-13 (Clower, 2012). NTMWD is prepared to be contractually obligated to compensate the county and impacted school districts for any loss in tax revenue as a result of land acquired for the reservoir being taken off tax rolls (NTEN, 2009b).

For those 54 parcels not wholly within the land purchase area, aerial photography and tax records were used to assess the potential loss of taxable improvements on each parcel in the reservoir and flood plain area. For purposes of this analysis, no allowances were made for moving structures. If a structure is located within the 545' elevation line, it is considered lost for taxation purposes. The estimates presented represent taxable values and not market values. The assessed values do not include agricultural and homestead exemptions. It is assumed these same exemptions would continue after the reservoir land purchase (Clower, 2012).

Two parcels, 47 acres of the Legacy Ridge Country Club (LRCC), were treated differently. Table 4.14-13 shows the estimated taxable value of the LRCC for Fannin County, the City of Bonham, and the Bonham Independent School District (ISD) that includes an estimated taxable value of the LRCC. However, it is possible that the LRCC would still be operationally viable upon redrawing of flood plain lines. Therefore, the actual impact on tax revenues may be substantially less than shown when the full value of the LRCC is removed from the tax rolls (Clower, 2012).

As property values begin to rise based on new development near the proposed reservoir, the annual tax losses offset by PILT would diminish and turn to net new revenues for local taxing jurisdictions. The temporary tax losses are shown in Table 4.14-13.

Table 4.14-13. Temporary Annual Tax Revenue Impacts of Land Acquisition[1]

Entity	Value Before	Value After	Difference	Tax rate	Temporary Tax Loss
Bonham ISD	$1,545,679	$1,206,037	$339,643	0.011505	$3,908
Including golf course	$2,593,067	$1,206,037	$1,387,030	0.011505	$15,958
Dodd City ISD	$3,429,167	$2,318,673	$1,110,493	0.01115	$12,382
Honey Grove ISD	$3,965,947	$2,114,933	$1,851,014	0.0135912	$25,158
Sam Rayburn ISD	$7,696,517	$1,550,066	$6,146,451	0.012039	$73,997
Fannin County	$16,641,590	$7,194,981	$9,446,608	0.006081	$57,445
Including golf course	$17,678,708	$7,194,981	$10,483,726	0.006081	$63,752
City of Bonham	$36,909	$29,571	$7,338	0.0067	$49
Including golf course	$1,074,027	$29,571	$1,044,456	0.0067	$6,998
Total loss not including golf course					$172,938
Total loss including golf course					$198,244

[1]2011 valuation estimates including mitigation area

Sources: FCAD, 2010; North Texas Municipal Water District; Clower, 2012

At full development, the taxable value of permanent and weekend residences is approximately $326.2 million[6] generating $5.9 million in county and school district revenues. As such, the net increase in tax revenues would be about $5.7 million at full development, of which $3.9 million would be allocated for Fannin County school districts. Much of this gain in school district revenues would not be accompanied by a proportionate increase in students since a large percentage of the potential property tax revenue would be from weekend or vacation properties. Area municipalities and townships could also benefit from increased property tax revenues depending on the degree to which their taxing jurisdictions are expanded to include land adjacent to the proposed project (See Table 4.14-14).

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[1] The average value of homestead, senior citizen, disabled, veteran and other exemptions is estimated at 15 percent of total valuation.

Table 4.14-14. Recurring Annual Fiscal Impacts of New Housing Developments and Resident and Recreational Out-of-Area Visitor Spending

Description	Impact
Total Taxable Value of Housing (permanent & weekend residents)	$326,200,000
Reduction in Property Value due to Inundation and Mitigation*	($10,484,000)
Net gain in Taxable Property Values	$315,716,000
Estimated New County Property Tax Revenues	$1,920,000
Estimated New School District Property Tax Revenues	$3,910,000
Total Potential** Municipal Sales Taxes (0.01 rate)	$303,000
Hotel Occupancy Tax Revenues**	$183,000

* Includes golf course.

** Value will be impacted by land annexation and business location decisions.

Source: Clower, 2012

Taxable retail sales in Fannin County would increase with new residents and visitors. Local sales tax revenues could potentially increase by upwards of $303,000 per year. Hotels could expect revenues of at least $3.7 million per year for room rentals. Based on a local bed-tax rate of five percent, these expenditures would boost local tax receipts by an additional $183,000 annually. These estimates do not consider the additional taxable property value from stores, bait shops, hotels/resorts, restaurants, and other businesses that might open around the proposed reservoir (Clower, 2012).

Fiscal impacts would likely be slight due to the extraction of property taxation in the short-term, because the affected landowners would be compensated at fair market value, and because NTMWD has committed to keeping local tax agencies whole by making payments equal to any lost revenues until such time as growth in the tax base makes up for any initial lost tax revenues. The size or physical extent of impacts would be medium (localized) because town and county fiscal operations would be most affected. The likelihood of impacts would be high, because the relationship between local taxes and fiscal health is well-established. Long-term impacts would be beneficial pending development, new permanent and weekend residents, and business investments.

Conclusion

Overall socioeconomic impacts of Alternative 1 on Fannin County and the ROI are multi-faceted and would be both short- and long-term as well as adverse and beneficial. Both the adverse and beneficial impacts would be considered severe. Adverse fiscal and social impacts are more weighted toward the short-term and the fiscal impacts are largely mitigated through NTMWD's payment of PILT to the county; at the same time, there would also be a major short-term economic stimulus associated with construction of the dam, reservoir and related facilities. Over time, socioeconomic impacts associated with Alternative 1 would become more and more positive or beneficial.

On net, over the long-term and the life of the proposed facility (50-100 years or more), socioeconomic effects would be positive for Fannin County. Most but not all Fannin County residents would welcome the short- and long-term economic stimulus provided by the project, in terms of direct added jobs, income, and induced economic activity. As a result of the project, in the future, Fannin County would be more populated, developed, and less rural than it is today (constituting a change in its existing predominantly rural character) or than it would be in the absence of the project. Residents would also enjoy a wider range of recreational and commercial opportunities than at present. Whether or not one sees this tradeoff as good or bad is a question of one's personal values and interests.

4.14.3 Alternative 2

Under Alternative 2, the reservoir's surface area would be approximately 8,600 acres – about half the surface area of Alternative 1. The reservoir footprint (9,390 acres) under Alternative 2 would also be roughly half the size of the reservoir footprint under Alternative 1. The size and location of the raw water transmission, storage, and treatments facilities in Leonard as well as the 35-mile pipeline connecting it to the reservoir would essentially be the same as under Alternative 1. Alternative 2 would also include two additional pipeline segments: an eight-mile pipeline from the existing pipeline in Wylie to the Leonard WTP and a 25-mile pipeline from Texoma to the balancing reservoir near Howe in Grayson County. Many of the potential socioeconomic impacts would be similar to Alternative 1, and differences in impacts from the downsized reservoir or additional pipeline segments are noted throughout the analysis.

Project Costs

Alternative 2 would produce an estimated firm yield of 114,800 AFY. The downsized LBCR would provide 86,100 AFY and the water from Lake Texoma would provide an additional 28,700 acre-feet of water per year. Lake Texoma is a recommended source of additional water supply for the NTMWD in the 2016 Region C Water Plan (Region C Water Planning Group, 2015). Project costs for this alternative are summarized below in Table 4.14-15.

Table 4.14-15. Project Cost Estimates of Smaller LBCR with Blending Alternative (114,800 AFY)

Description	Smaller LBCR (86,100 AFY)	Texoma Blending (28,700 AFY)	Smaller LBCR with Texoma Blending (114,800 AFY)
Project Costs			
Engineering fees	$64,043,000	-	$64,043,000
Other costs (legal, land acquisition, mitigation)	$122,935,300	-	$122,935,300
Dam and reservoir	$68,980,500	-	$68,980,500
Conflicts	$50,573,000	-	$50,573,000
Pipeline	$145,665,900	$107,387,000	$253,052,900
Pump station	$40,428,900	$17,781,000	$58,209,900
Terminal storage	$13,409,000	-	$13,409,000
Permitting and Mitigation – Conveyance System	-	$376,000	$376,000
Total Project Cost	$506,036,000	$125,544,000	$631,579,600
Annual Costs			
Debt Service (6% for 30 yrs)	$36,762,965	$9,120,635	$45,883,570
Electricity ($0.09 per kilowatt hour (kWh)	$3,060,000	$1,330,000	$4,390,000
Operation and Maintenance	$3,671,000	$1,082,000	$4,753,000
Total Annual Cost	$43,494,000	$11,532,635	$55,026,570
Unit costs (before amortization)			
Per acre-foot	$505	$402	$479
Per 1,000 gallons	$1.55	$1.23	$1.47

Description	Smaller LBCR (86,100 AFY)	Texoma Blending (28,700 AFY)	Smaller LBCR with Texoma Blending (114,800 AFY)
Unit costs (after amortization)			
Per acre-foot	$78	$84	$79
Per 1,000 gallons	$0.24	$0.25	$0.24

Additional infrastructure would need to be constructed for the blending portion of this alternative. There is existing infrastructure that conveys Texoma water to the Wylie water treatment plant – the pipeline from the existing Texoma intake and pump station to the Texoma balancing reservoir near Howe, Texas, and a recently built pipeline from the balancing reservoir to Wylie. There is no additional capacity in the pipeline segment from Texoma to the balancing reservoir, so a new, parallel pipeline from Texoma to the balancing reservoir would be needed. The cost of this new parallel pipeline is estimated at about $61 million and right of way (ROW) easements would cost almost $3 million. Improvements at the Texoma pump station, power improvements, and engineering and contingencies would cost approximately $17.8 million. A new pipeline spur from the existing pipeline to Wylie to Leonard terminal storage facility would cost approximately $33.4 million. These costs are included in both tables 4.14-15 (above) and 4.14-16 (below). This additional infrastructure would not conflict with any existing infrastructure (i.e. no need to relocate any gas pipelines, transmission lines, roads, and cemeteries), and therefore would not incur additional conflict costs.

As shown below in Table 4.14-16, engineering fees, conflicts, and terminal storage costs would be the same under both action alternatives. Dam and reservoir costs and other costs (legal, land acquisition, and mitigation) would be higher under Alternative 1, which is to be expected given that the reservoir is about twice the size of the reservoir under Alternative 2. Land acquisition costs under Alternative 2 are assumed to be about 70 percent of the land costs under Alternative 1.

Table 4.14-16. Comparison of Project Costs by Alternative

Description	Alternative 1*	Alternative 2
Project Costs		
Engineering fees	$64,043,000	$64,043,000
Other costs (legal, land acquisition, mitigation)	$174,121,000	$122,935,300
Dam and reservoir	$76,645,000	$68,980,500
Conflicts	$50,573,000	$50,573,000
Pipeline	$161,851,000	$253,052,900
Pump station	$44,921,000	$58,209,900
Terminal storage	$13,409,000	$13,409,000
Permitting and Mitigation – Conveyance System	-	$376,000
Total Project Cost	$585,563,000	$631,579,600
Annual Costs		
Debt Service (6% for 30 years)	$42,540,515	$45,883,570
Electricity ($0.09 per kilowatt hour (kWh)	$5,029,275	$4,390,000

Description	Alternative 1*	Alternative 2
Operation and Maintenance	$3,891,210	$4,753,000
Total Annual Cost	$51,461,000	$55,026,570
Unit costs (before amortization)		
Per acre-foot	$427	$479
Per 1,000 gallons	$1.31	$1.47
Unit costs (after amortization)		
Per acre-foot	$74	$79
Per 1,000 gallons	$0.23	$0.24

*March 2011 costs for Alternative 1 have been adjusted to 2013 dollars for comparison purposes.

Short-term expenditures on the construction of Alternative 2 (including all components) would likely last almost as long as Alternative 1, which was estimated to last three to four years. Actual time to design and construct the infrastructure for the blending portion of this alternative would be less than three years. It is assumed that the design and construction of the additional infrastructure needed for this alternative would occur during the same timeframe as the construction phase. Said otherwise, the design and construction of the additional infrastructure needed for this alternative would not extend the duration of the construction phase for Alternative 2.

The costs for Alternative 2 would be about $46 million more expensive than Alternative 1, or 7.8 percent more expensive. Alternative 2 would cost an additional $3.6 million annually, almost seven percent higher than Alternative 1. Annual debt payments and amortization are discussed further in the 4.14.3.2 under Financing Costs.

Financing Costs

The financing arrangement would be similar to what is described under Alternative 1. No tax revenues would be used to construct the reservoir. NTMWD would fund the construction through water sales; ultimately, financing costs are paid by the users of the water. The LBCR costs, including land acquisition, construction, transmission and treatment facilities, and any other costs would be expected to be financed with contract revenue bonds and NTMWD. NTMWD would solely own and operate the LBCR (NTMWD, 2009).

Under Alternative 2, the total project cost would about $46 million more than Alternative 1 and cost an additional $3.6 million annually. This leads to a 12 percent higher unit cost (before amortization) than under Alternative 1 – $1.47 vs. $1.31 per 1,000 gallons – for the water that Alternative 2 would make available (see Table 4.14-16). The cost per 1,000 gallons is derived as follows. With a probable total cost of $631,579,600 under this alternative, the annual debt payment would be about $45.8 million assuming 30 years of payments at six percent interest. The total annual cost is about $55 million: in addition to the annual debt payment, the annual O&M cost is $4.7 million and electricity is about $4.4 million. Based on the reservoir's estimated yield of 114,800 AFY, the estimated unit costs before amortization would be $479 per acre-foot of water, which equates to $1.47 per 1,000 gallons (see Table 4.14-16).

After amortization (once interest has been repaid and principal on the debt has been paid), the annual costs would consist of those for electricity and O&M, or about $9.1 million. Based on the reservoir's estimated yield of 114,800 AFY, the estimated unit costs after amortization would be $79 per acre-foot of water, which equates to $0.24 per 1,000 gallons. Ultimately the different in unit cost is about one cent per 1,000 gallons, or four percent higher than Alternative 1.

The effects on financing costs of constructing Alternative 2 would be slightly adverse. Potential impacts of Alternative 2 would be slightly more adverse than those of Alternative 1 because water prices for NTMWD customers would be higher than under Alternative 1 – especially before amortization. The likely size or physical extent of impacts would again be medium (localized), because the project costs are shared by all NTMWD customers. The likelihood of rate adjustment is high. Adverse impacts in the form of more expensive water per 1,000 gallons would be felt in the short-term until after amortization (30 years). In the long-term, impacts to economic resources would be beneficial because the price will drop drastically once the debt is paid off – and the cost per 1,000 gallons would be similar to the cost under Alternative 1.

Impacts Based on Input-Output Model

An IMPLAN model was not conducted to estimate economic impacts under this alternative. Economic impacts are compared qualitatively for the dam, reservoir, and related infrastructure construction. The relative impact to the size of the development projects, businesses and residents of nearby counties that would benefit from the economic activity associated with the construction of the dam and reservoir is also compared qualitatively to Alternative 1. Potential impacts would likely occur in a wide economic area and are again defined by Fannin, Collin, Delta, Lamar, Grayson and Hunt counties.

4.14.3.3.1 Construction Phase

Based on the relative presence, or absence, of industries providing materials and supporting services to dam and reservoir construction projects, some of the economic activity would "leak" out of the local area. However, the additional $46 million in expenditures during a shorter timeframe would create greater economic activity compared to Alternative 1. Expenditures would further boost gross county product, or the total value of the goods and services produced by the people of a county during a year not including the value of income earned outside the county. This would create additional person-years of employment and increase local labor income (salaries, wages, and work benefits). Property incomes in the form of rent, royalties, corporate profits, and dividends would further increase, as would business taxes from indirect transactions, state and local tax revenues.

The non-recurring impacts of developing Alternative 2 would boost economic activity in Fannin County, but comparatively less so than under Alternative 1. County gross product; person-years of employment; labor income associated with these jobs; property income in the form of rents, royalties, dividends, and corporate profits; indirect business taxes in the form of property taxes, sales taxes, and fees for permits and licenses paid on secondary transactions from water district spending would all still be expected to increase, but are expected to increase less than under Alternative 1.

Given that it would seem unlikely that Fannin County and the surrounding counties could supply the trained construction workforce under Alternative 1, an even larger portion of labor would likely be filled from outside of the area for the construction portion of Alternative 2. This would also mean that a larger portion of the construction expenditures (occurring during a shorter period) would likely leak out of the local economy. As such, the higher construction cost would not have a proportionally higher benefit to the local economy; NTMWD would recruit locally, state-wide and nationally to fill labor and/or professional needs. Similarly, equipment and materials would be procured locally as much as possible, but a large amount of specialized equipment and materials would not be available locally and would be shipped from other areas.

That said, the additional workers needed to fulfill construction of the downsized reservoir and additional pipeline and transmission facilities would create a greater number of indirect or induced jobs from project-related spending and the spending decisions of workers. These temporary jobs would generate additional wages and benefits to be spent in the local economy. Under this alternative, businesses such as hotels, restaurants, gas stations, and grocery stores in the project area might see some additional beneficial economic effects from per diem expenditures (meals, lodging, incidentals, etc.) by workers during their time in the local area. A higher portion of the indirect and induced jobs created by the project would last only for the (shorter) duration of the construction phase compared to Alternative 1.

Impacts from the construction phase would be greater than those described under the Alternative 1, but the overall impact ratings would be the same. The construction phase would potentially create severe beneficial impacts. The size or physical extent of impacts would be medium (localized) to large and the likelihood would be high. Impacts would be short-term and would last as long as the three- to four- year construction phase under Alternative 1.

Impacts to Homes and Social Landscape

Alternative 2 also has the potential to alter the socioeconomic landscape by increasing the total population, real estate and business development, and recreational visitors and their spending – though impacts would be slightly less than those described under Alternative 1. Most of the property within the reservoir footprint (under Alternative 1) from landowners has already been purchased, therefore potential impacts would be the same as those discussed under Alternative 1. The number of occupied and unoccupied homes that have been or will be purchased as part of the project would not change under this alternative.

The severity of potential impacts to homes and the social landscape would be almost identical to those described under Alternative 1. Potential adverse impacts would be slight to moderate. The size or physical extent of impacts would be medium (localized) by definition, because the homes that would be impounded are currently located in the reservoir's footprint and would not change under this alternative. Impacts would be felt in both the short- and long-term and would be permanent and irreversible.

4.14.3.3.2 Maintenance and Operation Phase

As displayed above in Table 4.14-16, the annual operating maintenance cost is an estimated $4,753,000, approximately $1 million higher than under Alternative 1. The additional cost for O&M activities would support additional direct and indirect jobs and wages and salaries; and further increase local economic activity in Fannin County as well as surrounding counties. Beneficial impacts described under Alternative 1 would also occur under Alternative 2, and could be slightly more beneficial but overall would not differ from the impact ratings under Alternative 1. The potential beneficial impacts from O&M costs would be slight. The size or physical extent of impacts would be medium (localized). The likelihood of impacts would be high. Impacts would be long-term and last as long as the dam's lifetime (50-100 years).

Impacts of Recreational Users

Alternative 2 would create a new, 8,600-acre water supply reservoir that, like Alternative 1, could potentially serve as a major new outdoor recreation asset for Fannin County and the region. It is anticipated that even with the reservoir's smaller surface area, the majority of the lake would still be deep enough for fishing and boating. As such, Fannin County would benefit from increased recreational visitors once the reservoir is operational. However, since Alternative 1 would provide a lake surface area about twice as large, the severity of impacts would likely be lower compared to Alternative 1. Beneficial impacts would not decrease proportionally with lake surface area, as the level of spending for a project this size would still encourage business development and supports jobs. Other lake-based recreational activities like boating and camping would draw additional out-of-area visitors to the region. Non-angler spending and non-local recreational visitors would add less in new spending for dining, retail goods, and lodging to the Fannin County economy than under Alternative 1. This spending would also generate less in economic activity, support comparatively fewer new jobs, and increase local earnings by less than the amount described under Alternative 1. The reservoir is expected to attract fewer full-time resident households over and above anticipated growth for the area over the next 30 years than under Alternative 1. The new income associated with the comparatively fewer full-time resident households would also be lower.

Recreation and business development would potentially create moderate to severe beneficial impacts due to spending from recreational visitors, compared to severe beneficial impacts under Alternative 1. As under Alternative 1; the size or physical extent of impacts would be large and the likelihood of impacts would be medium to high. Impacts would be long-term and last as long as the dam and reservoir's lifetime (50-100 years).

Impacts of New Permanent and Weekend Residents

As described under Alternative 1, one trend clearly evident in north and northeast Texas is that counties with substantial reservoirs have experienced greater population growth than counties without. From 1960 to 2000, the 19 counties in northeast Texas grew by 66.5 percent. Every county that at least doubled its population during that time contains a major reservoir with at least 10,000 acre-feet of water capacity. Carefully managed residential development around the downsized reservoir under Alternative 2 could also prove to be a tremendous economic boon for Fannin County. Comparatively fewer new dwellings would be constructed in the area surrounding the reservoir as weekend/vacation homes and investment properties. As such, local purchases from weekend and vacation residents would be lower than under Alternative 1. The combined incomes of permanent residents and the proportional income of weekend residents would result in a relatively lower net increase in activity than under Alternative 1 once the reservoir is operational. This economic activity would support fewer permanent jobs (and salaries and wages) than under Alternative 1. Businesses located in Fannin, Hunt, Lamar, Grayson, and Delta counties offering goods and services to new permanent and weekend residents would still increase economic output in the broader region, boost local income, and support permanent jobs – though less than under Alternative 1.

New permanent and weekend residents would potentially create slight to moderate beneficial impacts due to increased spending on homes and goods and services, or slightly less than those described under Alternative 1. Other impact ratings would be the same as those described under Alternative 1; the size or physical extent of impacts would be medium (localized) and the likelihood of impacts would be high. Impacts would occur in both the short- and long-term.

Impacts of New Housing Construction

As under Alternative 1, new residential construction activity is expected to occur primarily in Fannin County, though spending is expected to be lower under this alternative. These construction activities would still boost the local economy, support long-term full-time equivalent (FTE) jobs, and boost local income for a 30-year period. Potential impacts from new housing construction would be similar to those described under Alternative 1. The potential impacts would be moderate, the size or physical extent of impacts would be medium (localized) to large, and the likelihood of impacts would be high. Impacts would be medium (intermittent) to long-term and last approximately 30 years.

Business Development and Recruitment

As described under Alternative 1, the presence of a new, reliable source of water would enhance the county's ability to attract and retain businesses. It is assumed that TWDB's water use expectations would not generally change for the manufacturing industry, steam electricity generation, livestock and irrigation, mining industry activities, and municipal uses. As such, Fannin County's direct economic activity, area labor income and jobs would still increase from industrial and commercial output in Fannin County, though potential impacts could be less severe due to the decreased water supply under this alternative.

Impacts would be similar to those described under Alternative 1. Business development and recruitment would potentially create severe beneficial impacts; the size or physical extent of impacts would be large; and the likelihood of impacts would be high. Impacts would be long-term and last at least as long as the reservoir's lifetime (50-100 years).

Local Fiscal Impacts

In the short-term, local fiscal impacts would be the same as those under Alternative 1. NTMWD has committed to keeping local tax agencies whole by making payments equal to any lost revenues until such time as growth in the tax base makes up for any initial lost tax revenues. As described under Alternative 1, new construction would increase economic activity in the area by creating jobs for construction and O&M of the dam and reservoir. These jobs would create additional sales tax revenue, and new residents would pay property taxes that would benefit government operations. Revenue from property taxes and from an expanded tax base would be somewhat less than under Alternative 1. Although tax revenues would initially decrease due to taxable land in the proposed reservoir site that would be impounded, ultimately the reservoir could attract residential, commercial, and industrial property development that would boost property tax revenues in local taxing jurisdictions.

As property values begin to rise based on new development near the proposed reservoir, the annual tax losses offset by PILT would diminish and turn to net new revenues for local taxing jurisdictions. In the long-term, Fannin County would eventually experience a net increase in tax revenue from the associated or "ancillary" development likely to occur in conjunction with the dam and reservoir, though this net increase is expected to be smaller under Alternative 2. This net increase in tax revenue would still enable the cities and county to build more roads, increase the number of schools and teachers, and provide community services for the increased population; though again it is unclear whether the increased revenue would be in fact be used to address these needs, as those decisions are a function of the political process of local government and may also depend on other outstanding needs.

Fiscal impacts would be similar to those described under Alternative 1: potential impacts would be slight and the likelihood of impacts would be high. Long-term impacts would be beneficial pending development, new permanent and weekend residents, and business investments.

Conclusion

Overall, socioeconomic impacts of Alternative 2 on Fannin County and the ROI would be similar to those discussed under Alternative 1. Impacts would be both short- and long-term as well as adverse and beneficial. As under Alternative 1, Alternative 2 would result in a more populated, developed, and less rural Fannin County. The local economy would benefit from direct added jobs, income, and induced economic activity. A wider range of recreational and commercial opportunities would be available to residents, though economic benefits are not assumed to outweigh adverse impacts to the social or rural character of Fannin County; and are ultimately a question of one's personal values.

Compared to Alternative 1, beneficial impacts from the additional short-term stimulus to construct the pipeline and transmission facilities would be greater under this alternative due to additional job creation, spending of those wages, and related increases in economic activity. Annual debt payments and O&M costs would increase the unit cost of water to NTMWD customers (before amortization) by 12 percent. In the long-term, impacts to economic resources would be beneficial since the price will drop drastically once the debt is paid off – and the cost per 1,000 gallons would ultimately be almost the same as under Alternative 1.

Adverse short-term fiscal and social impacts would be the same as those described under Alternative 1. Over time, socioeconomic impacts associated with Alternative 2 would become more and more positive or beneficial, though the severity of the beneficial impacts would be comparatively lower than under Alternative 1. The smaller reservoir under Alternative 2 would attract presumably fewer new permanent and weekend residents and stimulate less new construction and business development. Impacts from recreational users would be less beneficial than under Alternative 1. While Alternative 1 would provide a lake surface area about twice as large, beneficial impacts would not decrease proportionally with lake surface area. Overall, short- and long-term beneficial economic impacts would still occur under Alternative 2.

4.15 Environmental Justice and Protection of Children

Consideration of the potential consequences of Alternatives 1 and 2 for environmental justice requires three main components:

1. A demographic assessment of the affected community to identify the presence of environmental justice populations that may be affected;
2. An assessment of all potential impacts to determine if any could result in adverse impacts to the affected community; and
3. An integrated assessment to determine whether any disproportionately high and adverse impacts exist for environmental justice populations present in the project area.

Alternatives 1 and 2 would include the construction of a dam and reservoir, and a 35-mile pipeline from the proposed reservoir site to a water treatment plant (WTP) and terminal storage reservoir (TSR) near the City of Leonard in southwest Fannin County. As such, Fannin County represents the primary focus and Region of Influence (ROI) for any direct and indirect impacts to environmental justice populations associated with the implementation of either alternative. However, the blending portion of Alternative 2 would also include a 25-mile pipeline from Texoma to the balancing reservoir near Howe, Texas in Grayson County. Therefore, for Alternative 2, Grayson County is also considered part of the ROI for any direct and indirect impacts related to the construction and operation of that pipeline. Both Fannin and Grayson counties represent the primary focus and ROI for any direct and indirect impacts related to environment justice and protection of children that may be associated with the implementation of Alternative 2.

Where minority, low-income, and/or youth populations are found to represent a high percentage of the ROI, the potential for these populations to be displaced, suffer a loss of employment or income, or otherwise experience adverse effects to general health and well-being is evaluated for potential environmental justice concerns. Impacts are categorized in terms of severity, duration, size or physical extent, and likelihood under each alternative, and are summarized in Table 4.15-1 below.

Table 4.15-1. Summary of Impacts to Environmental Justice and Protection of Children Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Construction Phase			
Size	Small (localized)	Small (localized)	No change from current conditions.
Duration	Short-term, Temporary and intermittent	Short-term, Temporary and Intermittent	
Likelihood	Low to Medium	Low to Medium	

Impact Factors	Magnitude of Impacts		
	Alternative 1	Alternative 2	No Action Alternative
Severity	None (direct, adverse); Slight (indirect, adverse)	None (direct, adverse); Slight (indirect, adverse)	
Operation Phase			
Size	Medium (localized)	Medium (localized)	No change from current conditions.
Duration	Long-term (50-100+ years)	Long-term (50-100+ years)	
Likelihood	Low (adverse); High (beneficial)	Low (adverse); High (beneficial)	
Severity	None to slight (adverse); Moderate (beneficial)	None to slight (adverse); Moderate (beneficial)	

4.15.1 No Action Alternative

If the No Action Alternative is selected, no change would occur to the existing counties. Because ongoing activities would be substantially the same as those already occurring, no additional change in community character and setting would be anticipated. Current water distribution operations would be expected to have no effect on the populations of concern. Existing conditions would remain substantially unchanged.

4.15.2 Alternative 1

Alternative 1 would include the construction of a 16,641-acre reservoir and a 35-mile pipeline from the proposed reservoir site to a water treatment plant (WTP) and terminal storage reservoir (TSR) near the City of Leonard in southwest Fannin County. Fannin County represents the primary focus and ROI for any direct and indirect impacts that may be associated with the implementation of Alternative 1.

Minority Populations

Fannin County does not constitute an environmental justice population because the percentage of minority population neither exceeds 50 percent nor is substantially higher than the percentage of minorities in the five surrounding counties. As such, there would be no disproportionate environmental justice impacts to Fannin County overall.

However, a closer look at the distribution of minority populations within Fannin County using block group (BG) data reveals that Honey Grove, Ladonia, and Bonham consist of environmental justice populations, as established in Section 3.13.1.1 (Minority Populations) and shown in Figure 3.13-1: Distribution of Minorities Within Fannin County. Potential impacts to these environmental justice populations resulting from the construction and operation phases are evaluated below.

Construction Phase

The construction phase of Alternative 1 could have disproportionate impacts on minority populations in Ladonia, Honey Grove and Bonham. The types of impacts from the construction equipment, vehicles, and activities that were evaluated include:

1. Noise Disturbances: Disturbances could occur from an increased level of noise created by construction equipment and vehicles associated with the northeast portion of the pipeline that traverses Honey Grove.

2. Congestion: Congestion would increase in the immediate area due to additional vehicles and traffic delays near the pipeline, affecting environmental justice populations in Honey Grove and Ladonia.
3. Community Cohesion: An increase in travel time or miles traveled during the construction of the pipeline could reduce access to community centers, neighborhood parks, and recreation areas for Honey Grove and Ladonia residents traveling west or north and Bonham residents commuting east or south.
4. Human Health and Safety: Construction workers are inherently exposed to safety risks such as injury by unguarded machinery and dust inhalation by operating heavy machinery and working on construction sites.
5. Job opportunities: Beneficial impacts could include the availability of short-term construction jobs.

During at least a portion of the construction phase, Alternative 1 could result in disproportionate impacts on Honey Grove, Ladonia, and/or Bonham residents. As discussed in Section 4.6, Acoustic Environment (Noise), increased noise levels would occur from tree clearing activities, the use of cranes and concrete trucks, mud pumps, diesel generators, and heavy construction vehicles during the construction of the dam. However, the shortest distance between Ladonia, Honey Grove, and Bonham residents to the impoundment area or pipeline route is about five miles. Locations more than 800 feet from use of heavy equipment would seldom experience appreciable levels of construction noise. Noise from the construction of the 35-mile pipeline to the Leonard WTP would not be fixed in one location but would progress along the pipeline as construction progresses; and the pipeline would not traverse any of the minority populations. Some nearby Honey Grove residents may experience annoying levels of noise; however, given the distance to the pipeline, impacts would be indirect. Such indirect impacts would be temporary and intermittent, and last for the duration of pipeline-related construction activities but not for the full duration of the three- to four-year construction phase. To minimize the effects of noise impacts, construction would primarily occur during normal weekday business hours in areas adjacent to noise sensitive land uses such as residential and recreation areas; and construction equipment mufflers would be properly maintained and in good working order.

As discussed in Section 4.12 (Transportation), congestion would increase in the immediate project area due to additional vehicles and traffic delays. FM 1396 is an existing two-lane TXDOT asphalt road that runs from Ravenna; east across the county transecting the proposed reservoir; and south to Honey Grove and Ladonia. FM 1396 would not be available during construction of the dam and reservoir. Residents of Honey Grove and Ladonia routinely commuting west or north would be affected by increased traffic and time delays during the construction phase. Similarly, Bonham residents routinely commuting east or south would be affected by increased traffic and time delays. Community cohesion could be affected because travel time or miles traveled due to re-routing would increase during this time, potentially reducing access to community facilities such as parks, churches, or schools. That said, the existing transportation infrastructure in Fannin County would be sufficient to support the increase in vehicle traffic. Contractors would route and schedule construction vehicles to avoid conflicts with other traffic, and strategically locate staging areas to minimize traffic impacts.

Job opportunities would not create disproportionate beneficial impacts to minority populations within Fannin County. In other words, the potential benefit of job opportunities would not be a function of race, just as it would not be a function of location. Impacts would be felt most by those who might be in search of a short-term job. As discussed in Section 4.14 (Socioeconomics), construction of the proposed project would also create a number of indirect or induced jobs from project-related spending and the spending decisions of workers.

Operation Phase

The operation phase of Alternative 1 would not disproportionately impact minority populations adversely in the long-term. The proximity of Honey Grove, Ladonia, and/or Bonham to the reservoir might be advantageous for local recreationists and job-seekers. FM 1396 would be replaced with FM 897, located two to three miles to the west of FM 1396. The new FM 897 would be higher quality compared to the existing FM 1396, and as such could disproportionately benefit Honey Grove and Ladonia residents commuting into Bonham as it would be built to higher speed standards, and would be centrally located across the reservoir site. These effects would be beneficial when compared to existing conditions or the No Action Alternative. The proposed reservoir would introduce a recreational resource to the county, and represent a beneficial impact for all residents.

Low-Income Populations

As established in Section 3.13.1.2 (Low-Income Populations), Fannin County does not meet the regulatory definition of a low-income population. Census tract (CT) data show that between 21 and 25 percent of the population in Bonham is living below the poverty threshold, and therefore qualifies Bonham as an environmental justice population (See Figure 3.13-2: Distribution of Low-Income Populations in Fannin County).

Construction Phase

The construction phase of Alternative 1 could have disproportionate impacts on low-income populations in Bonham. Some of the same types of impacts from the construction equipment, vehicles, and activities evaluated above for minority populations in Bonham were evaluated for low-income populations in Bonham and include:

1. <u>Community Cohesion:</u> An increase in travel time or miles traveled during the construction of the pipeline could reduce access to community centers, neighborhood parks, and recreation areas for Bonham residents commuting east or south.
2. <u>Human Health and Safety:</u> Construction workers are inherently exposed to safety risks such as injury by unguarded machinery and dust inhalation by operating heavy machinery and working on construction sites.
3. <u>Job opportunities:</u> Beneficial impacts could include the availability of short-term construction jobs.

Potential impacts to low-income populations in Bonham would essentially be the same as those to minority populations in Bonham. As discussed above in Section 4.15.2.1 (Minority Populations), potential impacts from noise disturbances would not affect Bonham residents given the distance from Bonham to the reservoir or pipeline route. Also discussed above in Section 4.15.2.1 (Minority Populations), potential impacts from congestion could affect minority populations and community cohesion in Ladonia and Honey Grove, or those commuting into Bonham to access community centers, neighborhood parks, and recreation areas; however, neither minority nor low-income populations living in Bonham would be affected. Low-income populations in Bonham routinely commuting east or south into Windom, Honey Grove, or Ladonia would be affected by increased traffic and time delays during construction of the 35-mile pipeline to the Leonard WTP. Increased traffic and delays would be temporary and intermittent, lasting for the duration of pipeline-related construction activities affecting access to Windom, Honey Grove, or Ladonia (respectively), but not for the entire duration of the construction phase.

If local construction workers are hired, job opportunities could result in beneficial impacts to Bonham residents in search of a job. As discussed in Section 4.14 (Socioeconomics), the construction phase would also create a number of indirect or induced jobs from project-related spending and the spending decisions of workers. However, the potential benefit of job opportunities would not be a function of location or income. Impacts would be felt by anybody who might be in search of a short-term job. All construction workers – low-income or otherwise – could inherently be exposed to safety and health risks due to operating heavy machinery and working on-site. Any health and safety risks associated with construction activities would not disproportionately affect low-income construction workers.

Operation Phase

The operation phase of Alternative 1 would not create disproportionate and adverse impacts on low-income populations in the long-term. The long-term impacts of Alternative 1 would be primarily beneficial due to a major new recreational facility, but these benefits would not disproportionately benefit low-income populations in Bonham. The replacement of FM 1396 with the new FM 897 would disproportionately benefit low-income populations in Bonham routinely commuting east or south into Windom, Honey Grove, or Ladonia.

Protection of Children

In compliance with EO 13045, *Protection of Children From Environmental Health Risks and Safety Risks*, this analysis examines local, regional, and national demographic data; evaluates the number and distribution of children in the area; and discerns whether these children could be exposed to environmental health and safety risks from Alternative 1 or 2. The analysis considers that physiological and social development of children makes them more sensitive to health and safety risks than adults. It also recognizes that children in minority and low-income populations are more likely to be exposed to, and have increased health and safety risks from, environmental contamination than the general population. Activities that result in air emissions, water discharges, and noise emissions are considered to have severe environmental health and safety risks if they were to generate disproportionately high environmental effects on youth populations within the ROI. Potential effects include health and safety concerns such as respiratory issues, hearing loss, and interruption of communication or attention in nearby residences and schools with children present.

Fannin County overall does not meet the regulatory definition of a minority or low-income population, or an environmental justice population. However, because the safety risks are higher in the vicinity of the proposed project, BGs identified high concentration "pockets" of minority populations in Ladonia, Bonham, and Honey Grove. CTs identified high concentration "pockets" of low-income populations in Bonham. As such, places where children "learn, live, and play" in Ladonia, Bonham, and Honey Grove are the focus of this analysis for disproportionate impacts as it relates to their health and safety.

Construction Phase

The construction phase of Alternative 1 could have disproportionate impacts on children in the vicinities of Honey Grove, Ladonia, and Bonham. This analysis considers that the following types of adverse impacts on children from the construction equipment, vehicles, and activities could include:

4. <u>Noise Disturbances</u>: Increased level of noise created by construction equipment and vehicles could affect children's learning, especially near homes, schools, and recreational areas.
5. <u>School Funding</u>: Decreased tax revenue from a decrease in taxable land that would be impounded could affect funding for teachers, classroom materials, or maintenance and improvement projects in the Bonham Independent School District (ISD).
6. <u>Mobile Source Air Pollutant Emissions (including traffic)</u>: Children living, learning, or playing along the eastern perimeter of the construction area and northern portion of the pipeline in close proximity to the project area could be impacted by construction activities and vehicles. Children are believed to be especially vulnerable due to higher relative doses of air pollution, smaller diameter airways, and more active time spent outdoors and closer to ground-level sources of vehicle exhaust.

7. Congestion and Obesity Factors: Increased congestion in the immediate area due to additional vehicles and traffic delays near the site could reduce opportunities for children to exercise outdoors and the accessibility of neighborhood parks, green spaces, and recreation areas. Children living in the east and northeast portion of Fannin County could be particularly affected.
8. Safety: Children living, learning, and playing in close proximity to the project area are inherently at a higher risk of accident or incident that could result in bodily harm.

Possible impacts under Alternative 1 to youth community and recreational facilities such as childcare centers, places of worship, schools, recreation facilities, hospitals, public health facilities, and social welfare facilities located in Fannin County would determine the characterization of impacts as posing a concern to the protection of children. Potential impacts to children at relevant youth community and recreational facilities in Fannin County are discussed below, and are included based on their location and proximity relative to the project area. The types of potential adverse impacts listed above in combination with impact factors (size, duration, likelihood, severity) are used to qualify the magnitude of impacts.

Youth minority populations living in Honey Grove could experience slightly disproportionate adverse impacts as they relate to noise disturbances and mobile source air pollutant emissions during construction of the 35-mile pipeline to the Leonard WTP. As discussed above under 4.15.2.1 and Section 4.6 Acoustic Environment (Noise), increased noise levels and mobile source air pollutant emissions would occur from tree clearing activities, the use of cranes and concrete trucks, mud pumps, diesel generators, and heavy construction vehicles during the construction of the dam and reservoir. Locations more than 800 feet from use of heavy equipment would seldom experience appreciable levels of construction noise. Given that the shortest distance between Honey Grove and the pipeline is about five miles, impacts would be indirect.

The Head Start Program at Bailey Inglish Elementary School (BIES) in Bonham is part of the United States Department of Health and Human Services that provides comprehensive education, health, nutrition, and parent involvement services to low-income children aged three to four and their families. While BIES is part of the Bonham ISD and benefits from its facilities and eligibility for state funding, the program serves all of Fannin County. A total of 139 children aged three to four are currently enrolled in the Head Start Program at BIES (48 three-year olds and 91 four-year olds) (Hunt, 2012). Because students enrolled in the Head Start Program may reside and commute from anywhere in Fannin County (as opposed to within the Bonham ISD), traffic and time delays during the construction phase could adversely impact families commuting from the east and northeast. Given the distance of BIES to the project area, any increase in noise levels created by construction equipment and vehicles would not affect learning at BIES. Similarly, it is unlikely that increased congestion and mobile source air pollutant emissions from construction vehicles in the project area would reduce opportunities for children to exercise or play outdoors or increase the risk of dust inhalation or other pollutants at BIES.

As discussed in Section 4.14 (Socioeconomics) under Local Fiscal Impacts, tax revenues could initially decrease due to taxable land that would be impounded or allocated for mitigation. However, the NTMWD has committed to keeping tax agencies whole by making payments equal to any lost revenues (payments in lieu of taxes or PILT) until re-growth in the tax base compensates for initial lost tax revenues. As such, there would not be any impacts from lost tax revenues to the Bonham ISD in the short-term. Beneficial tax impacts from ancillary development (i.e., real estate and businesses) discussed in Section 4.14 (Socioeconomics) could occur during and extend the construction phase.

Bonham State Park is a 261-acre park located in South Bonham with prairies, woodlands, and a 65-acre man-made lake. Facilities including a playground, a launching ramp, a boat dock, picnic tables, and a lighted fishing pier are open and accessible to the public seven days a week, year-round (TPWD, 2012). Due to the distance to the project area (more than 10 miles), the likelihood that children recreating in

Bonham State Park would be at an increased risk of dust inhalation or other pollutants is low. Any increase in congestion would not likely reduce opportunities for children to exercise outdoors or access Bonham State Park. Construction would primarily occur during normal weekday business hours in areas adjacent recreation areas – as opposed to during weekends, which is presumably more popular.

Texoma Medical Clinic (TMC) Bonham Hospital, formerly known as the Red River Regional Hospital, is a Joint Commission accredited critical access hospital located in Bonham. This 25-bed hospital provides inpatient, outpatient and emergency services to Fannin County and surrounding communities, and is the only hospital in Fannin County (TMCBH, 2016). In the case of an accident, time delays due to traffic or congestion from the construction of Alternative 1 could hypothetically have serious consequences, although the likelihood of this occurrence is very low.

Operation Phase

The availability of water and recreational opportunities at the reservoir could potentially influence land uses in the greater vicinity to become more industrialized and/or developed, creating both adverse and beneficial impacts to children. Since children are at greater risk due to developing bodies and increased exposures, if herbicides are applied for the purpose of maintenance around the periphery of the reservoir and/or pipeline right-of-way, it could result in adverse health impacts to children. However, the likelihood of this occurring is considered low and would result in slight impacts.

As the population grows with economic development during the operation phase of the dam and reservoir, the tax base would also expand, eventually boosting property tax revenues in local taxing jurisdictions. This net increase in tax revenue would enable the cities and county to increase the number of schools and teachers and provide community services for the increased population. It should, however, be noted that it is unclear whether the increased revenue would be in fact used to address these needs. Those decisions are a function of the political process of local government and may also depend on other outstanding needs.

As discussed in Section 4.14 (Socioeconomics) under Local Fiscal Impacts, property taxes from new permanent and weekend residences at full development would generate $5.9 million in county and school district revenues, of which $3.9 million would be enjoyed by school districts in Fannin County (Clower, 2012). Much of this gain in school district revenues would not be accompanied by a proportionate increase in students because a large percentage of the potential property tax revenue would be from weekend or vacation properties.

Maintenance of the dam and reservoir would potentially create slight to moderate beneficial impacts due to the increased tax revenue without (necessarily) an increase in youth populations, because children of weekend residents are not expected to necessarily enroll in the Bonham, Trenton, or Leonard ISDs. The size or physical extent of impacts would be medium (localized), because long-term teaching jobs, materials, and facilities would be felt most by children attending schools in Fannin County. Based on the increased tax revenue from real estate and business development in other Texas counties that have constructed dams and reservoirs in the recent past, the likelihood of impacts would be high. Impacts would be long-term and last as long as the dam and reservoir's lifetime (50-100 years).

A major new recreational facility close to Bonham and Honey Grove offering boating, fishing, swimming, and other outdoor activities would represent a benefit for all area youth. The visual and aesthetic value of the reservoir and the green space around it would also be considered by many as beneficial in the long-term.

Conclusion

Alternative 1 would not result in environmental justice impacts in the overall ROI. Census BG data identified Honey Grove, Ladonia, and Bonham as "pockets" of minority populations and Bonham as a "pocket" low-income population. Alternative 1 could create indirect, slightly adverse impacts for at least a portion of the construction phase, though not during the operational phase. Low-income populations in Bonham commuting east or south and minority populations commuting to BIES could experience intermittent and temporary impacts from traffic or time delays. Youth minority populations living in Honey Grove could experience slightly disproportionate adverse impacts as they relate to noise disturbances and mobile source air pollutant emissions during the construction of the 35-mile pipeline to the Leonard WTP. However, impacts would be temporary and intermittent and depend on the location and timing of specific construction activities. The size or physical extent of such impacts would be small (localized) and could affect the aforementioned "pockets" of environmental justice populations. The likelihood of all noise and air-quality related adverse impacts on environmental justice populations would be low given their distance(s) to the project area. The likelihood of adverse impacts on minority populations commuting to BIES would be medium: the unavailability of FM 1369 during construction of the dam and reservoir would indicate that the impacts have some chance of occurring, but the likelihood is below 50 percent.

Beneficial impacts in the form of jobs would not impact low-income or minority populations disproportionately in the short- or long-term. Long-term impacts of Alternative 1 on environmental justice populations would be moderately beneficial due to the replacement of FM 1396 with FM 897 and a major new recreational facility. Long-term impacts would last as long as the dam and reservoir's lifetime (50-100 years); impacts would occur throughout Fannin County and therefore the size or physical extent of impacts would be medium and localized; and the likelihood of beneficial impacts would be high.

4.15.3 Alternative 2

The reservoir under Alternative 2 would be roughly half the size of the reservoir footprint under Alternative 1. The size and location of the raw water transmission, storage, and treatments facilities in Leonard as well as the 35-mile pipeline connecting it to the reservoir would essentially be the same as under Alternative 1. Alternative 2 would also include an eight-mile pipeline from the existing pipeline in Wylie to the Leonard WTP in the southwestern corner of Fannin County. As such, Fannin County still represents the focus and ROI for any direct and indirect impacts from these elements of Alternative 2. Many of the potential impacts on environmental justice populations would be similar to Alternative 1, and differences in impacts from the downsized reservoir or additional eight-mile pipeline are noted throughout the analysis. Impacts associated with the 35-mile pipeline are summarized throughout the section but the detailed analysis is not repeated.

Alternative 2 would also include a 25-mile pipeline from Texoma to the balancing reservoir near Howe in Grayson County. For this portion of the project, Grayson County is also considered the ROI for any direct and indirect impacts. Additional impacts on environmental justice populations in Grayson County are analyzed below.

Minority Populations

As discussed under Alternative 1, Fannin County does not constitute an environmental justice population because the percentage of the minority population neither exceeds 50 percent nor is substantially higher than the percentage of minorities in the five surrounding counties. Overall, there would be no disproportionate environmental justice impact to Fannin County. However, an analysis of BG data identified portions of Fannin County (Honey Grove, Ladonia, and Bonham) as minority populations.

Similar to Fannin County, Grayson County does not constitute an environmental justice population because the percentage of the minority population neither exceeds 50 percent nor is substantially higher than the percentage of minorities in Fannin, Collin, Hunt, Cooke, and Denton counties (the counties in the ROI that surround Grayson County).

Construction Phase

Potential impacts on minority populations in Honey Grove, Ladonia, and Bonham from the construction of the dam and reservoir would be the same as those discussed under Alternative 1 in Section 4.15.2.1 (Minority Populations). The comparatively smaller reservoir that would be constructed under Alternative 2 would not change the types, duration, likelihood, size or physical extent, or severity of impacts from traffic and time delays. FM 1396 transects the reservoir under both Alternatives 1 and 2, and would not be functional during the construction phase of either alternative. The magnitude of impacts from the construction of the dam and reservoir under Alternative 2 would therefore be the same as those under Alternative 1.

The same 35-mile pipeline to the Leonard WTP that would be constructed under Alternative 1 would also be constructed under this alternative. As such, the disproportionate, slight, indirect impacts on minority populations in Ladonia, Honey Grove and Bonham discussed under Alternative 1 would occur under this alternative as well. The severity, duration, likelihood, and size or physical extent of impacts under Alternative 1 discussed in Section 4.15.2.1 (Minority Populations) would be the same for Alternative 2.

Additional infrastructure would be constructed for the blending portion of this alternative, including a new eight-mile pipeline from the existing pipeline in Wylie to the Leonard WTP in the southwestern corner of Fannin County. This pipeline segment is not located in Honey Grove, Ladonia, or Bonham; therefore, no additional impacts would occur to these locations with environmental justice populations.

Alternative 2 would also include a 25-mile pipeline from Texoma to the balancing reservoir near Howe, Texas in Grayson County. Grayson County does not constitute an environmental justice population because the percentage of minority population neither exceeds 50 percent nor is it substantially higher than the percentage of minorities in the five surrounding counties. As such, no additional environmental justice impacts would occur due to this portion of Alternative 2.

Operation Phase

As under Alternative 1, operation of the dam and reservoir would not disproportionately impact minority populations adversely. Long-term benefits could disproportionately impact Honey Grove and Ladonia residents commuting to Bonham when FM 1396 is replaced with the new FM 897. Given that the additional eight-mile pipeline segment in southwestern Fannin County would be located at least 10 miles from minority populations in Honey Grove, Ladonia, or Bonham, operation of this pipeline segment would not affect the aforementioned environmental justice populations. Operation of the 25-mile pipeline would not result in additional beneficial or adverse impacts, as Grayson County does not constitute a minority or environmental justice population.

Low-Income Populations

As under Alternative 1, Fannin County does not meet the regulatory definition of a low-income population. The percentage of persons living below the poverty line does not exceed 50 percent, and the percentage is not meaningfully greater than the populations of Grayson, Collin, Hunt, Cooke, and Denton counties. However, CT data was used to identify Bonham as a low-income population.

Grayson County does not constitute an environmental justice population by either of the CEQ definitions provided in Section 3.13.1.2 (Low-Income Populations). The percentage of persons living below the poverty line does not exceed 50 percent, and the percentage is not meaningfully greater than the populations of Fannin, Collin, Hunt, Cooke, and Denton counties.

Construction Phase

As described for Alternative 1, given the distance of Bonham to the project area, potential impacts to community cohesion would not affect Bonham residents during the construction phase. Low-income populations in Bonham routinely commuting east or south into Windom, Honey Grove, or Ladonia would also be affected by increased traffic and time delays during construction of the 35-mile pipeline to the Leonard WTP.

Additionally, similar types of impacts from traffic and time delays would occur to low-income populations in Bonham traveling west or south due to construction of the 25-mile pipeline in Grayson County or the eight-mile pipeline segment in southwest Fannin County.

Operation Phase

As under Alternative 1, the operation phase would not create disproportionate and adverse impacts on low-income populations in Bonham. The replacement of FM 1396 with FM 897 would also disproportionately benefit low-income populations in Bonham routinely commuting east or south into Windom, Honey Grove, or Ladonia. The type, duration, likelihood, and size or physical extent of this benefit would not change with the comparatively smaller reservoir that would be constructed under Alternative 2. Primary benefits would also be related to a major new recreation facility, but impacts would not disproportionately benefit low-income populations in Bonham. No additional impacts would result from operation of the 25-mile pipeline segment from Texoma to the balancing reservoir near Howe.

Protection of Children

As under Alternative 1, places where children "learn, live, and play" in Ladonia, Bonham, and Honey Grove were analyzed for disproportionate impacts as it relates to health and safety. Grayson County overall does not meet the regulatory definition of a minority or low-income (environmental justice) population.

Construction Phase

As discussed under Alternative 1, youth minority populations living in Honey Grove could experience slightly disproportionate adverse impacts as they relate to noise disturbances and mobile source air pollutant emissions during construction of the 35-mile pipeline to the Leonard WTP. Given that the shortest distance between Honey Grove and the pipeline is about five miles, impacts would be indirect.

The comparatively smaller reservoir that would be constructed under Alternative 2 would not change the types, duration, likelihood, size or physical extent, or severity of impacts from traffic and time delays. The same adverse impacts that could impact children of environmental justice populations commuting into Bonham from the east and northeast discussed under Alternative 1 would also occur under this alternative. Construction of the new eight-mile pipeline from the existing pipeline in Wylie to the Leonard WTP in the southwestern corner of Fannin County would not create additional impacts to children because this pipeline segment is not located in Honey Grove, Ladonia, or Bonham.

During at least a portion of the construction phase, the addition of the pipeline segment from Texoma to the balancing reservoir near Howe in Grayson County could create additional adverse impacts to children living in Grayson County. Children at learning centers, schools, and parks east of Highway 289 and west of Highway 75 – like those concentrated in Pottsboro, Denison, Sherman, Southmayd, and Howe – could experience adverse impacts from increased noise and mobile source air pollutant emissions. Both increases would be temporary and intermittent, and would move along the pipeline as construction progresses.

Operation Phase

The same impacts discussed under Alternative 1 would occur under this alternative. Operation of the dam and reservoir would potentially create moderate beneficial impacts due to the increased tax revenue. The size or physical extent of impacts would be medium (localized) and felt most by children attending schools in Fannin County. Based on the known benefits of increased tax revenue from development of dams and reservoirs in other Texan counties, the likelihood of impacts would be high. Impacts would be long-term and last as long as the dam and reservoir's lifetime (50-100 years). Existence of a major new recreational facility offering boating, fishing, swimming, and other outdoor activities would represent a benefit for all area youth. In the long-term, the visual and aesthetic value of the reservoir and the green space around it would also be considered beneficial by many.

The additional infrastructure needed for the blending portion of this alternative would not conflict with any existing infrastructure (i.e. no need to relocate any gas pipelines, transmission lines, roads, and cemeteries). Because children are at greater risk due to developing bodies and increased exposures, herbicides applied for the purpose of maintenance around the pipeline right-of-way in Grayson County could result in additional adverse health impacts to children. However, this pipeline segment would be constructed parallel an existing pipeline, and therefore it is assumed the right-of-way would be sprayed regardless of the implementation of this alternative. The likelihood that additional herbicide applied to this right-of-way would result in health impacts to children is considered low, and any such adverse impacts would be slight.

Conclusion

Impacts from Alternative 2 would be similar to those described under Alternative 1, and would not create environmental justice impacts in the overall ROI because neither Fannin nor Grayson counties meet the regulatory definition of minority or low-income populations. BG data identified Honey Grove, Ladonia, and Bonham as "pockets" of environmental justice populations. As with construction of the dam and reservoir under Alternative 1, low-income populations in Bonham commuting east or south and minority populations commuting to BIES could experience intermittent and temporary impacts from traffic or time delays. The likelihood of such impacts would be medium: the unavailability of FM 1369 would indicate that the impacts have some chance of occurring, but the likelihood is below 50 percent.

As under Alternative 1, construction of the 35-mile pipeline would create slightly adverse impacts on youth minority populations residing in Honey Grove as they relate to noise disturbances and mobile source air pollutant emissions. Under Alternative 2, additional adverse impacts could occur at learning centers, schools, and parks in Grayson County during construction of the 25-mile pipeline segment from Lake Texoma to the balancing reservoir near Howe. All pipeline-related construction impacts would be temporary and intermittent and would depend on the location and timing of specific construction activities. The size or physical extent under Alternative 2 would also be small (localized), and could also occur at youth community and recreational facilities in Grayson County – as with Honey Grove residents in close proximity to the 35-mile pipeline; those commuting to BIES; and low-income residents of Bonham commuting east or south to work. The likelihood of health and safety impacts to children at youth community and recreational facilities in Fannin and Grayson counties would be low given the distance to the project area.

Impacts from the operational phase would be the same as those discussed under Alternative 1, and would be moderately beneficial due to the replacement of FM 1396 with the new, higher-quality FM 897 and a major new recreational facility. Long-term impacts would last as long as the dam and reservoir's lifetime (50-100 years); the size or physical extent of impacts would be medium and localized; and the likelihood of beneficial impacts would be high.

4.16 Cultural Resources

The Area of Potential Effects (APE) is defined in the PA as "the reservoir footprint itself to the planned top of flood pool (elevation 541 feet MSL at crest of spillway), the planned location of the dam and all associated construction and staging areas, the planned new water treatment facility in Leonard, Texas, the pipeline from the new water treatment facility to the discharge point into Pilot Grove Creek, all raw water pipelines between the reservoir and associated existing treatment facilities, lands manipulated for impact mitigation, plus the full horizontal and vertical extent of any identified cultural or historic resources intersected by or adjacent to any of the above listed project component boundaries and associated impact areas" (NTMWD et al., 2010).

Table 4.14-1. Summary of Impacts to Cultural Resources Under Each Alternative

Impact Factors	Magnitude of Impacts		
	Alternative 1	**Alternative 2**	**No Action Alternative**
Construction Phase			
Size	Combined area of dam site disturbance, pipeline, WTP & TSR	Combined area of dam site disturbance, pipelines, WTP & TSR	Some sites already subjected to extensive testing
Duration	Permanent/Long-Term	Permanent/Long-Term	
Likelihood	High	High	
Severity	Severe	Severe	
Operation Phase			
Size	Combined area of dam site disturbance, pipeline, WTP & TSR	Combined area of dam site disturbance, pipelines, WTP & TSR	Unknown, but potentially severe
Duration	Permanent/Long-Term	Permanent/Long-Term	
Likelihood	High	High	
Severity	Severe	Severe	

4.16.1 No Action Alternative

Although the reservoir, raw water pipeline, new water treatment plant, and terminal storage facility would not be built under this alternative, there could be significant adverse impacts on cultural resources under the No Action Alternative. Since testing at sites has been completed, the No Action Alternative has already impacted sites by submitting them to extensive testing and by potentially revealing their location to the public due to visibility of work in some locations. In addition, because the sites have been revealed through testing, but eligible sites (aka Historic Properties) would not be mitigated if there was not an action, this could cause additional significant adverse impacts. Furthermore, because many of the sites are no longer on private property as they have been purchased by NTMWD (and have been surveyed and tested as necessary), the likelihood of additional adverse impacts on cultural resources is increased cumulatively and over the long term. Impacts to cultural resources from the No Action Alternative as a result of their location on non-private property are unknown.

4.16.2 Alternative 1

Impacts of Alternative 1 are discussed according to the category of cultural resource that may be affected by the undertaking (i.e., actions associated with this alternative).

National Register Properties

Alternative 1 would have no effect on properties currently listed on the NRHP because none are present on-site.

Historical Markers

Alternative 1 would have no effect on State of Texas historical markers because none are present on-site.

Historic Cemeteries

Within the Reservoir

One cemetery, the Wilks Cemetery (41FN96) is located within the proposed reservoir footprint. Based on a 2011 survey by ARC, the Wilks Cemetery was originally recommended as eligible for the NRHP and this recommendation was reviewed by the THC. The THC indicated that further testing is needed to evaluate the site's status and eligibility for the NRHP. Subsequently, the site will be relocated during the construction phase and would be evaluated during the mitigation phase.

Alternative 1 would have long-term and severe adverse effects to the Wilks Cemetery, hence the decision to relocate it if the project is implemented. Therefore, the site would have an undetermined status for RHP listing until the cemetery can be fully evaluated during the relocation phase. Regardless of its NRHP status, the Texas Health and Safety Code (Section 711) requires mitigation and re-interment of human remains that would be inundated or otherwise negatively impacted. Additionally, because the land is owned by NTMWD, a political entity of the State of Texas, it is subject to state burial laws, the Texas Health and Safety Code, and the Antiquities Code of Texas (Title 9, Chapter 191 of The Texas Natural Resources Code). Therefore, measures to mitigate the adverse impact on the Wilks Cemetery in accordance with these codes and regulations would consist of de-dedication of the cemetery by court order; removal of all human remains, markers, and any grave goods from the current location; and re-interment of these remains at a new perpetual care cemetery.

Outside of the Reservoir

Two cemeteries, Stancel Cemetery and White Family Cemetery, are located within the flowage easement to be acquired by NTMWD between the 541-foot contour and the 545-foot contour. Alternative 1 could result in temporary inundation and erosion of these cemeteries. Measures to mitigate such adverse impacts pursuant to the Texas Health and Safety Code could consist of construction of protective berms around the cemeteries to prevent temporary flooding or, alternatively, de-dedication of the cemeteries by court order; removal of all human remains, markers, and any grave goods from the current location; and re-interment of these remains at a new perpetual care cemetery. Therefore, Alternative 1 would have no impact on these cemeteries because they would be protected in place or relocated.

Historic Buildings and Structures

Within the Reservoir APE

Thirty-eight architectural resources are within the APE, none of which are recommended as eligible for the NRHP. Thus, Alternative 1 would have no impact on significant historic buildings or structures.

Outside of the APE

Alternative 1 would have no effect on architectural buildings or structures outside the APE and above the 541 foot MSL elevation.

Archeological Sites

Currently Known Sites Within and Close to the Reservoir APE

Within the proposed Lower Bois d'Arc Creek Reservoir, a total of 58 sites (28 prehistoric, 26 historic, and four prehistoric/historic multi-component) were recorded (41FN95-142 and 41FN147-159), yielding an average of one site per 86 acres. Seventeen sites are recommended for further testing and research to determine their eligibility: 41FN108, 109, 110, 113, 114, 118, 119, 120, 122, 136, 137, 138, 148, 151, 154, 156, and 159. Wilks Cemetery (41FN96) would be assessed for National Register of Historic Places eligibility during the relocation phase of the project. Impacts from Alternative 1 on these 17 sites would include loss of scientific information resulting from damage to sites due to reservoir construction, logging and land clearing, inundation, erosion, vandalism, deterioration of organic remains, and impacts to sites that may be sacred and/or significant to the Caddo Nation. There would be no impacts to the remaining 41 prehistoric, historic, and multi-component sites identified during the reservoir APE survey because they were evaluated as not significant and were recommended as not eligible for listing on the NRHP.

Site 41FN96 is the Wilks Cemetery and would require mitigation of adverse impacts, as described above in Section 4.14.2.3. The other sites that have been recommended for further testing would require mitigation of adverse impacts if it is determined, after further testing and evaluation, that the site could be eligible for the NRHP. Individual mitigation plans and a Memorandum of Understanding would be developed between the project proponent (NTMWD) and the USACE, THC, and Caddo Nation for each eligible site. If bridges or other structures are determined eligible, different types of mitigation plans would need to be prepared. Mitigation measures for archeological sites could include additional testing and excavation conducted in accordance with the PA, along with archeological data recovery.

Raw Water Pipeline Route and Associated Facilities

The proposed Leonard WTP, the proposed TSR adjacent to the WTP, and a proposed rail spur that would transport materials to the new WTP both during construction and operation were found to contain seven historic archaeological sites and one prehistoric artifact (an interior chert flake). All of the sites have been heavily impacted by farming and can offer little or no information about the early history of Fannin County. None are eligible for listing on the NRHP. Thus, impacts on cultural resources from these connected actions are expected to be non-existent.

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

Alternative 1 would involve relocating FM 1396 and constructing a new bridge over the proposed reservoir. The results of the survey identified two historic period sites, one historic debris scatter, and two historic-age bridges. None of the sites described are eligible for listing in the NRHP or as a SAL. In addition, because the design of the two bridges is basic, and because the bridges were likely built in the mid-20th century, neither bridge was found to be eligible for listing on the NRHP or as a SAL. Because there are no NRHP-eligible resources in the survey area, impacts on significant cultural resources from this connected action are expected to be non-existent.

Riverby Ranch Mitigation Site

Protocols set forth in the PA will be implemented during the continuing investigations on the Riverby Ranch mitigation site in accordance with Section 106 and the PA. The PA guides the work and ensures compliance with Section 106 on a timeline separate from the EIS. A brief summary of the work plan and a description of the work that has been completed to date are outlined in the following section below.

Following the completion of the Phase I investigation which helped define the High Potential Areas (HPAs), the Phase 2 study was conducted between March and August of 2015 and consisted of an intensive pedestrian survey of 3,670 acres of HPAs for prehistoric and historic archaeological sites. The survey included collecting, washing, labeling, and analyzing artifacts, as well as preparing a written report. Overall, a total of 86 sites (20 prehistoric, 52 historic, and 14 multicomponent) are recorded on the property as a result of the Phase I and II surveys (Davis et. al., 2016). In addition, a total of 28 architectural resources were found to meet the historic-age guideline as established for this project and therefore were evaluated for their integrity and potential eligibility in the NRHP. Twenty five of these structures did not fulfill Criterion A, B, or C. In addition, none of these 25 structures maintained the level of integrity required to be considered for listing in the NRHP. Furthermore, none of the 28 structures were found to meet any of the special requirements under Criteria Considerations A-G. Three structures (structures 11, 21, and 25) met the historic age requirement and exhibited a potential for historical significance under Criteria A, B, and/or C. However, after careful evaluation and consideration, none of these structures were found to maintain the significant association and/or integrity required by the NRHP. As a result, Structures 11, 21, and 25 are recommended not eligible for listing in the NRHP. A summary of the 86 archaeological sites (both new and previously discovered) identified during the survey and the known interments for the Riverby Ranch mitigation area are provided in Appendix S.

Operation of the LBCR Dam and Reservoir

Impacts from construction of Alternative 1 to cultural resources or historic properties listed or eligible to be listed on the NRHP would be long-term/permanent and would continue through operations. Therefore, operation of the LBCR Dam and Reservoir under Alternative 1 would result in the same impacts to cultural resources and/or historic properties as construction.

4.16.3 Alternative 2

Under Alternative 2, there would be a small reduction in dam height and corresponding footprint, but the dam would still need to be able to pass the Probable Maximum Flood (PMF) without breaching. Based on engineering judgment, it is assumed that the dam footprint would be about 90 percent of Alternative 1. Alternative 2 would impact 9,305 acres (dam and reservoir) of waters, wetlands, and uplands, all within the footprint of Alternative 1 (Figures 4.14-1 and 4.14-2). Alternative 2 would also impact 3,800 acres of land around the perimeter of the proposed reservoir for the flood pool. The ROI for the cultural resources analysis under Alternative 2 is the same as the APE, which is defined in this alternative as the smaller reservoir footprint and including the dam and all associated construction and staging areas, planned new water treatment facility, raw water pipeline, terminal storage facility, and Riverby Ranch mitigation site. The smaller reservoir footprint would result in a surface area of approximately 8,600 acres, roughly half the acreage of Alternative 1. Impacts of the downsized alternative are discussed here by category of cultural resource that may be affected by the smaller version of the LBCR project.

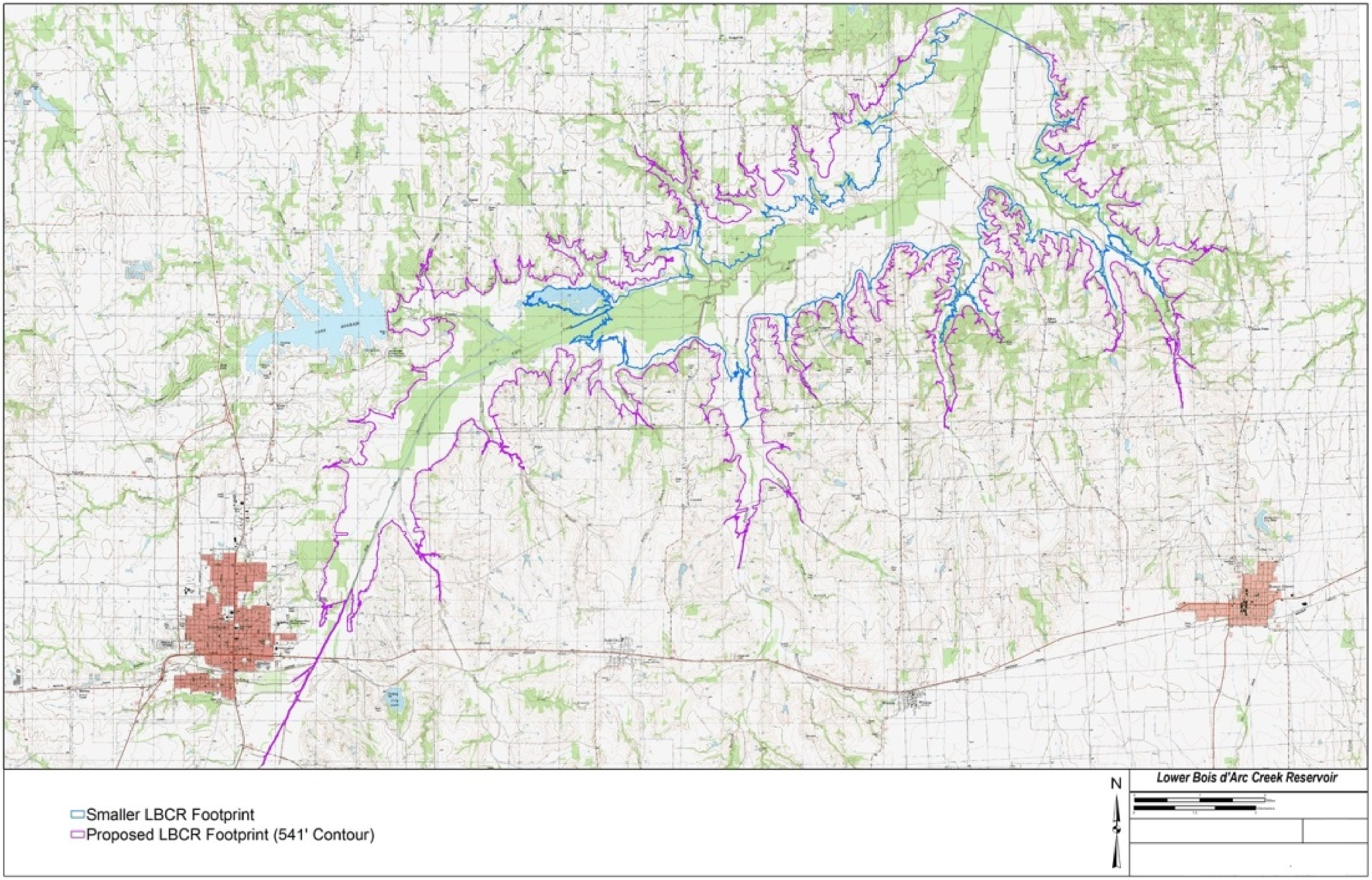

Figure 4.14-1. Downsized Alternative 2 APE with Associated Facilities

Source: Davis, 2016

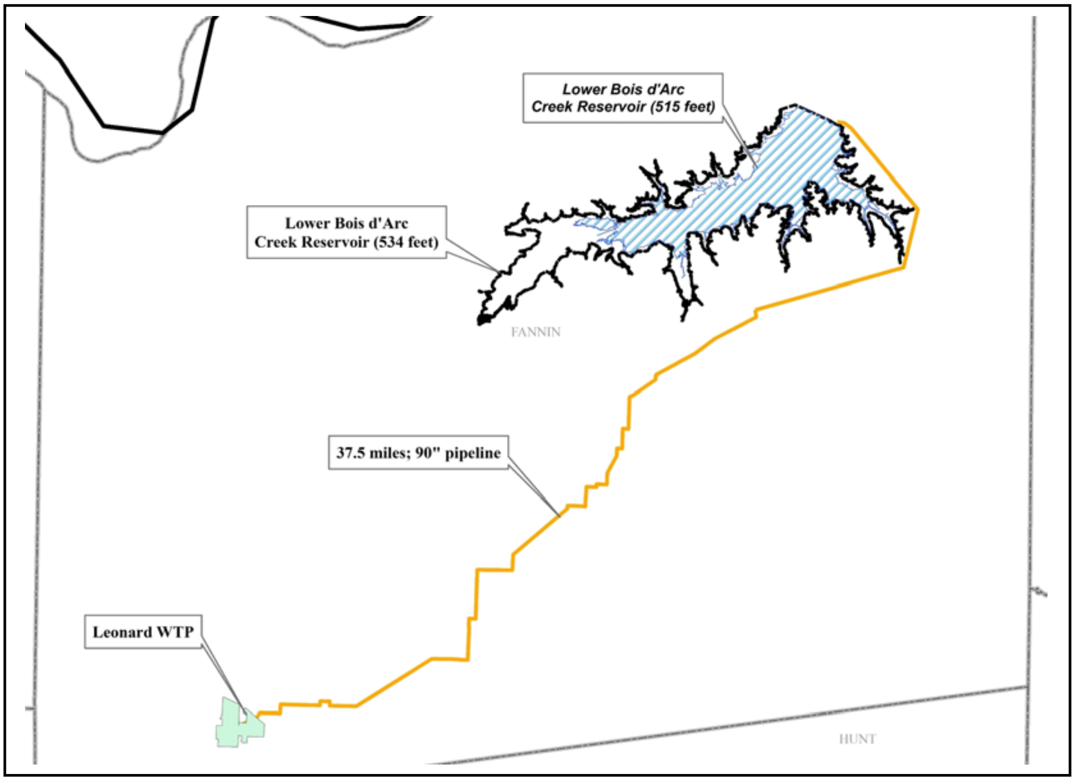

Figure 4.14-2. Sketch of Downsized LBCR and Raw Water Pipeline (Alternative 2)

National Register Properties

The downsized LBCR would have no impact on properties currently listed on the NRHP because none are present on-site.

Historical Markers

The downsized alternative would have no impact on State of Texas historical markers because none are present on-site.

Historic Cemeteries

Within the Reservoir

Alternative 2 would have an adverse impact on Wilks Cemetery (41FN96) because, while the site is located outside of the footprint under Alternative 2, temporary inundation and erosion are anticipated due to its location within the flowage easement to be acquired by NTMWD between the 541' contour and the 545' contour. Measures to mitigate this adverse impact (relocation and reinterment) would be the same as Alternative 1 pursuant to the Texas Health and Safety Code, thus impacts would be similar.

Outside of the Reservoir

The impacts to cemeteries outside of the downsized alternative footprint under Alternative 2 would be the same as described in Alternative 1.

Historic Buildings and Structures

Within the Reservoir APE

Thirty-eight architectural resources were identified during the archaeological field survey of the proposed action LBCR footprint under Alternative 1. Under the downsized footprint as part of Alternative 2, 11 buildings/structures would be located within the APE for the alternative reservoir footprint. As discussed in Chapter 3, none of the structures and/or buildings identified was found to meet any of the special requirements under NRHP Criteria Considerations A-G. Therefore, all historic-age resources evaluated are recommended ineligible for listing in the NRHP and subsequently, Alternative 2 would have no impact on significant historic buildings or structures.

Outside of the APE

The impacts to historic buildings and structures outside the APE would be the same under Alternative 2 as Alternative 1except that the 27 architectural resources (i.e. buildings and structures) would be located outside of the new APE. Because all of the buildings and structures are recommended ineligible for listing in the NRHP, there would be no impacts to significant historic buildings or structures under Alternative 2.

Archeological Sites

Currently Known Sites Within the Reservoir APE

Under Alternative 2, 31 archaeological sites (including 21 prehistoric, nine historic, and one prehistoric/historic multi-component site) would be located within the APE for the alternative reservoir footprint. Of these, eight were recommended for further testing and evaluation to determine NRHP eligibility and the remaining 23 were recommended as ineligible for listing in the NRHP. This alternative would be expected to have the same types of impacts to these 31 sites located within the reduced APE as Alternative 1 (e.g. the loss of scientific information resulting from damage to sites due to reservoir construction, logging and land clearing, inundation, erosion, vandalism, deterioration of organic remains, and damage to sites sacred and/or significant to the Caddo Nation).

Because eight sites are being tested in the downsized alternative APE, and nine are being testing outside of the downsized alternative, there is no meaningful difference in probability of eligible sites being affected. Subsequently, it is not known at the present how many sites are eligible within the reduced or full APE, and the impacts from the downsized alternative could be exactly the same as Alternative 1. It may be that all sites tested in the downsized alternative are eligible and none in the proposed project outside the downsized alternative are eligible. In addition, because the magnitude of impacts for any eligible site (all sites eligible for the NRHP) would be severe, and because the extent would be reduced if there are fewer eligible sites, both magnitude and extent of impacts cannot be evaluated at present. Subsequently, as with Alternative 1, there is no difference between short-term and long-term impacts because cultural resources are non-renewable resources that would be irreparably altered (destroyed) by the project even if mitigated.

Table 4.14-2 below outlines and summarizes the archaeological sites that would be impacted under the downsized LBCR, Alternative 2 APE compared to Alternative 1 (full-scale dam and reservoir).

Table 4.14-2. Known Archeological Sites within the Downsized Alternative 2 APE as Compared to Alternative 1

Site Trinomial	NRHP Eligible?	Site Located Within the Reduced APE of Alternative 2	Sites Located Outside of the Reduced APE of Alternative 2 but Included in Alternative 1
41FN95	No	X	
41FN96	Unknown – would be relocated during construction phase and would be evaluated during the mitigation phase.		X

Site Trinomial	NRHP Eligible?	Site Located Within the Reduced APE of Alternative 2	Sites Located Outside of the Reduced APE of Alternative 2 but Included in Alternative 1
41FN97	No		X
41FN98	No	X	
41FN99	No	X	
41FN100	No		X
41FN101	No		X
41FN102	No		X
41FN103	No	X	
41FN104	No	X	
41FN105	No		X
41FN106	No		X
41FN107	No		X
41FN108	Further testing is needed to determine NRHP eligibility		X
41FN109	Further testing is needed to determine NRHP eligibility		X
41FN110	Further testing is needed to determine NRHP eligibility	X	
41FN111	No	X	
41FN112	No		X
41FN113	Further testing is needed to determine NRHP eligibility		X
41FN114	Further testing is needed to determine NRHP eligibility		X
41FN115	No	X	
41FN116	No	X	
41FN117	No	X	
41FN118	Further testing is needed to determine NRHP eligibility	X	
41FN119	Further testing is needed to determine NRHP eligibility	X	
41FN120	Further testing is needed to determine NRHP eligibility	X	
41FN121	No	X	
41FN122	Further testing is needed to determine NRHP eligibility	X	
41FN123	No	X	
41FN124	No	X	
41FN125	No	X	
41FN126	No	X	
41FN127	No	X	
41FN128	No		X
41FN129	No		X
41FN130	No	X	
41FN131	No	X	
41FN132	No	X	
41FN133	No	X	

Site Trinomial	NRHP Eligible?	Site Located Within the Reduced APE of Alternative 2	Sites Located Outside of the Reduced APE of Alternative 2 but Included in Alternative 1
41FN134	No	X	
41FN135	No	X	
41FN136	Further testing is needed to determine NRHP eligibility	X	
41FN137	Further testing is needed to determine NRHP eligibility		X
41FN138	Further testing is needed to determine NRHP eligibility		X
41FN139	No longer considered a site		X
41FN14	No longer considered a site		X
41FN141	Further testing is needed to determine NRHP eligibility		X
41FN142	No longer considered a site		X
41FN147	No		X
41FN148	Further testing is needed to determine NRHP eligibility		X
41FN149	No	X	
41FN150	No		X
41FN151	Further testing is needed to determine NRHP eligibility	X	
41FN152	No		X
41FN153	No		X
41FN154	Further testing is needed to determine NRHP eligibility		X
41FN155	No	X	
41FN156	Further testing is needed to determine NRHP eligibility	X	
41FN157	No	X	
41FN158	No		X
41FN159	Further testing is needed to determine NRHP eligibility		X

Raw Water Pipeline Routes and Associated Facilities

Under the downsized alternative, impacts to cultural resources located within the APE for the proposed Leonard WTP, the TSR adjacent to the WTP and a proposed rail spur that would transport materials to the new WTP both during construction and operation would be the same in duration and extent as Alternative 1. Under the downsized alternative, a new raw water pipeline would also be built from Lake Texoma that would parallel and be directly adjacent to an existing raw water pipeline also from Lake Texoma. Although the new raw water pipeline would be located in very close proximity to the existing pipeline, the potential exists for previously unidentified cultural resources to be uncovered or impacted during the course of ground disturbance or construction activities. Subsequently, the new raw water pipeline would require a separate cultural resources survey, and appropriate Section 106 compliance under the PA would occur prior to any construction or ground disturbance. Based on the results of the cultural resources survey, measures to mitigate the adverse impacts to any eligible properties should be developed in a Memorandum of Understanding between the project proponent (NTMWD), the USACE, the Caddo

Nation, and the Texas Historical Commission in accordance with the PA. Mitigation measures could include archeological data recovery or other appropriate methods.

There are no currently known historic properties within the new raw water pipeline and associated facilities under the downsized alternative since a cultural resources survey has not been completed for the area. Therefore, potential adverse impacts to eligible historic properties remain unknown. Construction activities would be subject to the terms and stipulations of the PA, and protocols set forth in the PA would remain in place during the cultural resources investigations for the new pipeline. Although the investigations and identification of cultural resources remain unknown, because any ground disturbance resulting in modification to a historic property damages or destroys it permanently, impacts to cultural resources from construction of a new raw water pipeline (such as ground disturbance) would be comparable to those described for the treated water pipeline to be built from the new LBCR (whether full-scale or downsized).

FM 1396 Relocation (FM 897 Extension from U.S. 82 to FM 9779) and New Bridge Construction

As with Alternative 1, Alternative 2 would also involve potential ground disturbance or inundation from construction and relocation of FM 1396 and construction of a new bridge over the proposed reservoir. The results of the survey identified two historic period sites, one historic debris scatter, and two historic-age bridges. None of the sites are eligible for listing in the NRHP or as a SAL. In addition, because the design of the two bridges is basic, and because the bridges were likely built in the mid-20th century, neither bridge is eligible for listing on the NRHP or as a SAL. Since there are no NRHP eligible resources in the survey area, impacts on significant cultural resources from this connected action under Alternative 2 are expected to be non-existent.

Riverby Ranch Mitigation Site

Under the downsized alternative, impacts to cultural resources at the Riverby Ranch mitigation site would remain because the cultural resource investigations and archeological surveys at the site are ongoing and have not been complete. Protocols set forth in the PA would remain in place during the investigations on the Riverby Ranch mitigation site in accordance with Section 106 and the PA. Although the investigations and identification of cultural resources remain unknown, the impacts to identified cultural resources are anticipated to be less widespread and significant compared to Alternative 1 because the smaller reservoir footprint would require less area that would be mitigated. This would likely decrease both the potential to impact cultural resources and the extent of potential impacts, although it would not decrease the duration.

Operation of the LBCR Dam and Reservoir

Impacts from construction for Alternative 2 to cultural resources or historic properties listed or eligible to be listed on the NRHP would be long-term/permanent and would continue throughout operations. Therefore, operation of the LBCR Dam and Reservoir under Alternative 2 would result in the same impacts to cultural resources and/or historic properties as construction.

4.16.4 Conclusion

Because of the potential for disturbance of a site listed on or eligible for listing on the NRHP, the impacts from both Alternative 1 and Alternative 2 would be of severe magnitude. One site, the Wilks Cemetery located within the APE under Alternative 1, has been recommended as eligible for the NRHP, and this recommendation was reviewed by the THC. NRHP eligibility testing is ongoing at all sites for which an eligibility recommendation could not be made from survey data alone. Also, additional sites may be identified during the course of construction and ground disturbance activities, and these would be subject to the terms and stipulations of the PA, which requires that work cease in the vicinity and the signatories be contacted within 48 hours. A damage assessment would be performed and a defendable NRHP recommendation made at such sites. The PA guides this work.

The duration of impacts to each identified historic property (any site eligible for listing on or listed on the NRHP) would be long-term because cultural resources are non-renewable; any adverse effect is permanent/long-term. The likelihood of impact is high and the magnitude is severe. Given these ratings, the adverse impacts to historic properties under Alternatives 1 and the downsized Alternative 2 would be considered significant under NEPA. Should any of the sites recommended for further testing (eight of which are in the downsized APE) be determined to be historic properties, the impacts to each historic property would be adverse and significant under NEPA. Because it has not yet been determined if the eight sites recommended for further testing are determined to be historic properties, there is no known difference in the number of eligible sites between the two reservoir footprints under either Alternative 1 or 2. Once further testing has been completed and eligibility determinations have been made, then NTMWD would submit mitigation plans for each historic property to USACE, the Caddo Nation, and the THC for approval. Because impacts are significant and adverse to each historic property identified, mitigation measures must be applied to bring impacts below the level of significance.

As discussed above, impacts can be mitigated, including the use of archeological data recovery, exhumation of burials including repatriation and reburial of Native American burials discovered during excavation or construction, and/or site containment, stabilization, and/or capping of cultural deposits. Implementing these mitigation measures, as appropriate, would reduce the level of impact on cultural resources. The sites undergoing testing are being considered for NRHP eligibility under Criterion D, which states they have yielded or have the potential to yield information important in history or prehistory. The value of most historic properties is in the data they can provide regarding history or prehistory. Therefore, mitigation through data recovery would reduce the level of impacts below the threshold of significance. If prehistoric sites contain burials, the Caddo Nation would work with NTMWD, USACE, and THC to determine the most respectful manner for exhuming and relocating the individuals under the Texas Health and Safety Code. Historic burials would also be relocated using best practices. Sites that are not considered historic properties (those that are not eligible for the NRHP) are not evaluated for impacts due to their lack of significance.

4.17 UNAVOIDABLE ADVERSE IMPACTS

Sec. 102(C)(ii) of NEPA [42 USC § 4332] requires an EIS to list "any adverse environmental effects which cannot be avoided should the proposal be implemented." Table 4.17-1 lists, by resource topic, unavoidable adverse impacts that would result from Alternatives 1 and 2, i.e., construction and operation of the LBCR and related facilities. As noted throughout this chapter, many of these adverse effects could be mitigated to some extent, but in the instances below, some level of adverse impact remains even after mitigation.

Table 4.17-1. Unavoidable Adverse Impacts Associated with Alternative 1 and Alternative 2

Resource Topic	Unavoidable Adverse Effects	
	Alternative 1	**Alternative 2**
Land Use	• Long-term changes in land use toward higher-density development in the project vicinity induced by Alternative 1 itself and in Fannin County generally both from LBCR and growth of the DFW Metroplex. These changes may	• Long-term changes in land use toward higher-density development in the project vicinity induced by Alternative 1 itself and in Fannin County generally both from LBCR and growth of the DFW Metroplex. These changes may

Resource Topic	Unavoidable Adverse Effects	
	Alternative 1	Alternative 2
	be regarded by certain existing and future residents as adverse.	be regarded by certain existing and future residents as adverse.
Topography, Geology and Soils	• Topography would be permanently altered by dam construction and reservoir impoundment, though these impacts would be localized. • Surficial geology at the site of the 2-mile long dam itself would be permanently altered due to excavation of a slurry trench and placement of an impervious barrier along the length of dam foundation. • Soils on a total dam and reservoir "footprint" of 17,068 acres would be permanently altered through excavation, dam construction, and impoundment of water within the reservoir. • 13 soil types listed as "Prime Farmland Soils" would be permanently removed from potential agricultural production at the site of the dam and reservoir, WTP, and TSR.	• Topography would be permanently altered by dam construction and reservoir impoundment, though these impacts would be localized. • Surficial geology at the site of the nearly 2-mile long dam itself would be permanently altered due to excavation of a slurry trench and placement of an impervious barrier along the length of dam foundation. • Soils on a total dam and reservoir "footprint" of 9,305 acres would be permanently altered through excavation, dam construction, and impoundment of water within the reservoir. • Up to 13 soil types listed as "Prime Farmland Soils" would be permanently removed from potential agricultural production at the site of the dam and reservoir, WTP, and TSR.
Water Resources	• Dam and reservoir footprint of 17,068 acres would permanently inundate 123.3 miles of Bois d'Arc Creek (and tributaries) in Fannin County, converting the creek from a mostly channelized, free-flowing stream by impounding water behind a dam to form a reservoir. • 123.3 miles of intermittent/ephemeral streams would be permanently inundated. • Sedimentation rate of 0.94 AF/mi^2/year, loss of 11,167 AF of storage capacity at the normal pool elevation (534 feet) after 40 years; 7.5 percent loss of storage capacity after 100 years. • Minimum of 120,000 AFY (firm yield) of water would be diverted from Bois d'Arc Creek annual discharge into the Red River; cumulative but slight reduction of flows into Red River. • Downstream effects on geomorphology of Bois d'Arc Creek including reduction in volume of discharge during most storm events and corresponding reduction in erosion, scouring, and channel downcutting; in	• Dam and reservoir footprint of 9,305 acres would permanently inundate 66.1 miles of Bois d'Arc Creek (and tributaries) in Fannin County, converting the creek from a mostly channelized, free-flowing stream by impounding water behind a dam to form a reservoir. • 66.1 miles of intermittent/ephemeral streams would be permanently inundated. • Sedimentation rate of 0.94 AF/mi^2/year, loss of 11,167 AF of storage capacity at the normal pool elevation (534 feet) after 40 years; 21 percent loss of storage capacity after 100 years. • Minimum of 86,100 AFY (firm yield) of water would be diverted from Bois d'Arc Creek annual discharge into the Red River; cumulative but slight reduction of flows into Red River. • Downstream effects on geomorphology of Bois d'Arc Creek including reduction in volume of discharge during most storm events and corresponding reduction in erosion, scouring, and channel downcutting; in

<table>
<tr><th rowspan="2">Resource Topic</th><th colspan="2">Unavoidable Adverse Effects</th></tr>
<tr><th>Alternative 1</th><th>Alternative 2</th></tr>
<tr><td>Water Resources (cont'd)</td><td>late summer, environmental flows would maintain flows when there is often no flow at present.</td><td>late summer, environmental flows would maintain flows when there is often no flow at present.</td></tr>
<tr><td>Biological Resources</td><td>• Construction of the dam and impoundment of water would impact 4,602 acres (4,035 FCUs) of forested wetlands, 1,223 acres (514 HUs) of emergent wetlands, and 49 acres (23 HUs) of scrub shrub wetlands.
• Construction of the dam and impoundment of water would impact 78 acres of open waters (ponds, stock tanks, etc.), and 651,140 linear feet (LF) (123.3 miles) of streams comprised of 286,139 LF (54.2 miles) of intermittent and 365,001 LF (69.1 miles) of intermittent/ephemeral streams.
• Change in aquatic biota abundance and species composition as a result of conversion from lotic to lentic conditions.
• Approximately 11,440 acres loss of upland wildlife habitat (forests, woodlands, grasslands) from dam, reservoir, and WTP.
• Probably contribute to spread of invasive species.
• Adverse effects on state-listed species possible.</td><td>• Construction of the dam and impoundment of water would impact 2,909 acres (2,502 FCUs) of forested wetlands, 684 acres (237 HUs) of emergent wetlands, and 27 acres (12 HUs) of scrub shrub wetlands.
• Construction of the dam and impoundment of water would impact 78 acres of open waters (ponds, stock tanks, etc.) and 348,928 LF (66.1 miles) of streams comprised of: 166,286 LF (31.5 miles) of intermittent and 182,642 LF (34.6 miles) of intermittent/ ephemeral streams.
• Change in aquatic biota abundance and species composition as a result of conversion from lotic to lentic conditions.
• Approximately 6,390 acres loss of upland wildlife habitat (forests, woodlands, grasslands) from dam, reservoir, and WTP.
• Probably contribute to spread of invasive species.
• Adverse effects on state-listed species possible.</td></tr>
<tr><td>Air Quality</td><td>• 3-4years of construction emissions would be limited to fugitive dust and diesel emissions from construction equipment during dam, water treatment facility, and pipeline development.
• Would have a relatively slight carbon footprint, and would have an incremental, but overall negligible, contribution to global warming.</td><td>• 3-4 years of construction emissions would be limited to fugitive dust and diesel emissions from construction equipment during dam, water treatment facility, and pipeline development.
• Would have a relatively slight carbon footprint, and would have an incremental, but overall negligible, contribution to global warming.</td></tr>
<tr><td>Acoustic Environment (Noise)</td><td>• During 3-4 year construction period, would have slight adverse effect on the noise environment.
• Temporary minor increases in noise would result from the intermittent use of heavy equipment during land clearing and construction.
• Would contribute both directly and indirectly to a cumulative increase in noise levels within Fannin County.</td><td>• During 3-4 year construction period, would have slight adverse effect on the noise environment.
• Temporary minor increases in noise would result from the intermittent use of heavy equipment during land clearing and construction.
• Would contribute both directly and indirectly to a cumulative increase in noise levels within Fannin County.</td></tr>
</table>

Resource Topic	Unavoidable Adverse Effects	
	Alternative 1	**Alternative 2**
Recreation	• Construction of the reservoir would have slight adverse impacts on local, small-scale recreation. • Infrequent minor to moderate adverse impacts may occur to the Legacy Ridge Country Club golf course from flooding due to severe storm events.	• Construction of the reservoir would have slight adverse impacts on local, small-scale recreation.
Visual Resources	• Due to its size and salience, the proposed dam and reservoir would have a major, long-term effect on visual resources locally; some observers may regard this change as adverse.	• Due to its size and salience, the proposed dam and reservoir would have a major, long-term effect on visual resources locally; some observers may regard this change as adverse.
Utilities	• Overhead power lines that run through the proposed reservoir site would have to be raised or removed and relocated before the reservoir can be filled. • Existing utilities would be impacted during construction of the pipeline.	• Existing utilities would be impacted during construction of the pipeline.
Transportation	• Impacts of moderate severity on roadways and bridges in the immediate vicinity of the proposed reservoir and inside the reservoir footprint. • 5 roadways closed and 10 roadways rerouted and/or rebuilt due to proposed reservoir operation.	• Impacts of moderate severity on roadways and bridges in the immediate vicinity of the proposed reservoir and inside the reservoir footprint. • 4 roadways closed and 7 roadways rerouted and/or rebuilt due to proposed reservoir operation.
Socioeconomics	• Construction and operation would entail both short-term and long-term severe adverse impacts, including economic, fiscal, and social effects, such as removal of agricultural land from production and removal of several long-term residents or landowners. • Would contribute cumulatively to increasing urbanization of Fannin County, which some residents would regard as an adverse effect.	• Construction and operation would entail both short-term and long-term severe adverse impacts, including economic, fiscal, and social effects, such as removal of agricultural land from production and removal of several long-term residents or landowners. • Would contribute cumulatively to increasing urbanization of Fannin County, which some residents would regard as an adverse effect.
Environmental Justice and Protection of Children	• None to slight impacts could occur during the construction and operation phases.	• None to slight impacts could occur during the construction and operation phases.
Cultural Resources	• Would adversely affect the Wilks Cemetery within the reservoir footprint. Therefore, the site would be relocated during the construction phase and evaluated during the mitigation phase. • Unavoidable adverse effects would occur to any historic property or NRHP eligible site located within the reservoir footprint. The adverse	• Would adversely impact Wilks Cemetery because, while the site is located outside of the footprint under Alternative 2, temporary inundation and erosion are anticipated due to its location within the flowage easement (between the 541' contour and the 545' contour). Measures to mitigate this adverse impact would be the same as under Alternative 1.

Resource Topic	Unavoidable Adverse Effects	
	Alternative 1	**Alternative 2**
Cultural Resources (cont'd)	effects can be mitigated, but even with data recovery, would permanently and unavoidably destroy eligible sites. • Excavation and data recovery destroys sites, even though data are salvaged. The integrity and context of the site would be forever altered under both alternatives. However, mitigation can reduce adverse impacts below the level of significance.	• Unavoidable adverse effects would occur to any historic property or NRHP eligible site located within the reservoir footprint. The adverse effects can be mitigated, but even with data recovery, would permanently and unavoidably destroy eligible sites. • Excavation and data recovery destroys sites, even though data are salvaged. The integrity and context of the site would be forever altered under both alternatives. However, mitigation can reduce adverse impacts below the level of significance.

4.18 Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

Sec. 102(C)(iv) of NEPA [42 USC § 4332] and 40 CFR 1502.16 require an EIS to address "the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity." This involves the consideration of whether a Proposed Action is sacrificing a resource value that might benefit the environment in the long term, for some short-term value to the project proponent or the public.

The purpose of Alternatives 1 and 2 – the Lower Bois d'Arc Creek Reservoir – is to capture, conserve, manage, and use a vital natural resource, water, in a manner that would benefit society. As disclosed in Chapter 4, after approximately 100 years of operation, the proposed reservoir under Alternative 1 would maintain approximately 92.5 percent of its capacity or storage volume; under Alternative 2 it would maintain approximately 79 percent of its storage volume. Thus, hypothetically, the LBCR project could help meet water needs for North Texas municipalities for a period of time measuring a century or more, which would qualify as long-term. Therefore, with regard to water, neither Alternative 1 nor Alternative 2 would be sacrificing long-term productivity for short-term use or gain.

The USACE acknowledges that there are tradeoffs inherent in any allocation of natural resources. In the present instance, implementation of the LBCR would necessitate the permanent loss of existing wetlands on site, including a regionally scarce type of wetlands – bottomland hardwood forest. Prime Farmland Soils in certain upland areas, some of which are currently used as agricultural land (cropland and pasture) and all of which could be used as such would also be permanently lost. Effects on wetlands, in any case, as mandated by Section 404 of the Clean Water Act, would require compensatory mitigation.

4.19 Irreversible and Irretrievable Commitments of Resources

Sec. 102(C)(v) of NEPA [42 USC § 4332] requires an EIS to address "any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented." Irreversible and irretrievable commitments of resources mean losses to or impacts on natural resources that cannot be recovered or reversed.

More specifically, "irreversible" implies the loss of future options. Irreversible commitments of resources are those that cannot be regained, such as permanent conversion of wetlands and loss of cultural resources, soils, wildlife, agricultural, and socioeconomic conditions. The losses are permanent, incapable of being reversed. "Irreversible" applies mainly to the effects from use or depletion of nonrenewable resources, such as fossil fuels or cultural resources, or to those factors, such as soil productivity, that are renewable only over long periods of time.

"Irretrievable" commitments are those that are lost for a period of time, such as the temporary loss of timber productivity in forested areas that are kept clear for use as a right-of-way, road, or winter sports site. The lost forest production is irretrievable, but the action is not irreversible. If the use changes back again, it is possible to resume timber production.

4.19.1 Irreversible Commitments of Resources

Under both Alternative 1 and Alternative 2 – construction and operation of the full-sized or downsized LBCR and construction and operation of related facilities and connected actions, the following irreversible commitments of resources would occur:

- Consumption of the fossil fuels (primarily diesel) and lubricants by the heavy construction equipment (bulldozers and Caterpillars, graders, scrapers, excavators, loaders, trucks, etc.) used to excavate and construct the dam and clear the reservoir footprint.
- Consumption of the fossil fuels (primarily diesel) and lubricants by the heavy construction equipment used to construct all related facilities and carry out connected actions, such as construction of the raw water pipeline and pump station/substation, water treatment plant, terminal storage reservoir, FM 1396 relocation and bridge construction, other road relocations, and the grading required at the Riverby Ranch and Upper BDC mitigation sites.
- Materials used to construct the dam and all other facilities such as the WTP, including cement/concrete, soil cement, slurry material, clay, sand, gravel, steel, iron, and other metallic alloys, copper wiring, PVC pipe, plastic, and so forth.
- Energy, supplied by fossil fuels or some other source of electricity, used over the operational life of the dam/reservoir to pump water from the intake/pump station at LBCR and possibly Lake Texoma to the North WTP near Leonard.
- Wetlands and linear feet of flowing stream permanently eliminated at the site of the reservoir footprint.
- Prime Farmland Soils inundated behind the dam within the reservoir footprint and therefore forever permanently removed from potential agricultural production. Also, Prime Farmland Soils converted to developed land at the WTP and TSR near Leonard.
- Existing and potential agricultural production on those Prime Farmland Soils and other soils within the footprint that could also be used for agriculture.
- Existing wildlife habitat within the reservoir footprint.
- Possible undiscovered archeological resources within the reservoir footprint, which would be permanently inundated by the reservoir and eventually buried under layers of sediments over the coming century and beyond, likely moving them beyond the reach of future investigations.
- Heritage and socioeconomic resources such as the homes, other structures, and multi-generational farmsteads that have to be purchased, demolished, and removed prior to impoundment.

4.19.2 Irretrievable Commitments of Resources

As noted above, "irretrievable" commitments of resources are those that are lost for a period of time, but not permanently. The Proposed Action would entail certain irretrievable commitments. The following two items represent such irretrievable commitments:

- Short-term loss of agricultural production during construction along the raw water pipeline right-of-way from the reservoir to the WTP near Leonard.
- Long-term loss of agricultural output and associated jobs, income, and tax revenue on lands (primarily pasture and ranch lands) at the Riverby Ranch mitigation site, which would be converted into wetlands, woodlands, and wildlife habitats to compensate for losses of these at the reservoir site.

5.0 CUMULATIVE IMPACTS

5.1 INTRODUCTION

Cumulative impacts are defined by the CEQ regulations in 40 Code of Federal Regulations (CFR) 1508.7 as "the impact on the environment which results from the incremental impact of the [proposed] action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time." Cumulative impacts include the direct and indirect impacts of a project together with the past, present, and reasonably foreseeable future actions of other projects. According to CEQ's cumulative impacts guidance, the cumulative impact analysis should be narrowed to focus on important issues at a national, regional, or local level. The analysis should look at other actions that could have similar effects and whether a particular resource has been historically affected by cumulative actions.

Several steps were taken to determine potential present and future actions to consider in the cumulative impacts analysis for the LBCR project. The first step involved coordinating with agencies to help identify other projects or actions in the area that could result in cumulative impacts when combined with the LBCR project. Agencies consulted included the U.S. Forest Service, U.S. Fish and Wildlife Service, Natural Resources Conservation Service, Texas Commission on Environmental Quality, Texas Water Development Board, Texas Parks and Wildlife Department, Texas Historical Commission, Upper Trinity Regional Water District, Fannin County government, and the Bonham Chamber of Commerce. This step included reviewing environmental documents that were recently completed or are in progress.

The study area ("area of cumulative effect") for cumulative impacts varies resource by resource. The study area for each resource is explained in the introduction to each resource topic in Section 5.6.

5.2 OVERVIEW OF EXISTING REGION C RESERVOIRS

NTMWD and Alternatives 1 and 2 are located in Region C of the Texas Water Development Board's designated planning areas. The various projects listed below, the various wholesale water providers and water user groups, are all connected by their relative proximity, transfers and sales of water among existing water sources and providers, cooperation in developing new water supplies and competition for some of those same prospective supplies. What happens to one water supply or provider can and does affect others in the region. This big picture provides perspective in considering cumulative impacts.

Region C includes all or portions of 16 northern Texas counties and contains approximately one quarter of the entire population of Texas. Region C's population grew seven-fold from just under one million in 1930 to 6.7 million in 2012 and continues to grow and develop rapidly. The two most populous counties in Region C, Dallas and Tarrant, contain 65 percent of its population. Region C includes most of the Dallas-Fort Worth-Arlington Metropolitan Statistical Area (MSA), in which the three largest employment sectors are trade, the service industry, and government, all of which depend heavily on water resources (Region C Water Planning Group, 2015).

Most of Region C is located in the headwaters of the Trinity River Basin, with smaller portions in the Brazos, Red, Sulphur, and Sabine Basins. Except for the Red River Basin, the predominant direction of stream flow in the region is from northwest to southeast, as is the case for most of Texas. In contrast, the Red River flows west to east, forming the northern border of Region C, as well as the border between Texas and Oklahoma. Its main tributaries within Region C, such as Bois d'Arc Creek, flow from southwest to northeast. The main streams in Region C include the Brazos River, Red River, Trinity

River, Clear Fork Trinity River, West Fork Trinity River, Elm Fork Trinity River, East Fork Trinity River, and many other Trinity River tributaries (Region C Water Planning Group, 2015).

As shown in Figure 5.2-1, at present, approximately 55 percent of the water available to Region C is supplied by approximately 30 reservoirs located within the region. A little less than half of that amount (25 percent) is supplied by imports of surface water from other Texas regions. Most of Region C's in-region reservoirs are located within the Trinity River Basin, but the region also depends on water supplies originating in the Neches, Red, Sabine, Brazos, and Sulphur River Basins (Region C Water Planning Group, 2015).

The following water-supply reservoirs are located within Region C:

- Cedar Creek – Impounded in 1965, Cedar Creek Reservoir is located in Henderson County, 15 miles west of Athens, and has a surface area of 32,623 acres.
- Richland-Chambers – Impounded in 1987, Richland-Chambers Reservoir is located in Navarro County, near Corsicana, and has a surface area of 41,356 acres.
- Hubert M. Moss – Impounded in 1960, Moss Lake is located in Cooke County, 10 miles west of Gainesville, and has a surface area of 1,140 acres.
- Texoma – Impounded in 1944, Lake Texoma is located on the Texas-Oklahoma border in Grayson County, northwest of Sherman-Denison, and has a surface area of 74,686 acres.
- Randell – Impounded in 1909, Lake Randell is located one mile south of Lake Texoma and three miles northwest of Denison in Grayson County, and has a surface area of 172 acres.
- Valley – Impounded in 1960, Valley Lake is located in Fannin County, three miles north of Savoy, and has a surface area of 1,080 acres.
- Bonham – Impounded in 1969, Bonham City Lake is located in Fannin County, three miles northeast of Bonham, and has a surface area of 1,020 acres.
- Ray Roberts – Impounded in 1987, Ray Roberts Lake is located in Cooke and Grayson counties, and has a surface area of 25,600 acres.
- Lewisville – Impounded in 1954, Lake Lewisville is located in Denton County, near Lewisville, and has a surface area of 29,592 acres.
- Benbrook – Impounded in 1952, Benbrook Lake is located in Tarrant County, 10 miles southwest of Fort Worth, and has a surface area of 3,635 acres.
- Weatherford – Impounded in 1957, Lake Weatherford is located 19 miles southwest of Fort Worth, and has a surface area of 1,158 acres.
- Grapevine – Impounded in 1952, Grapevine Lake is located in Tarrant and Denton counties, north of Grapevine, and has a surface area of 6,684 acres.

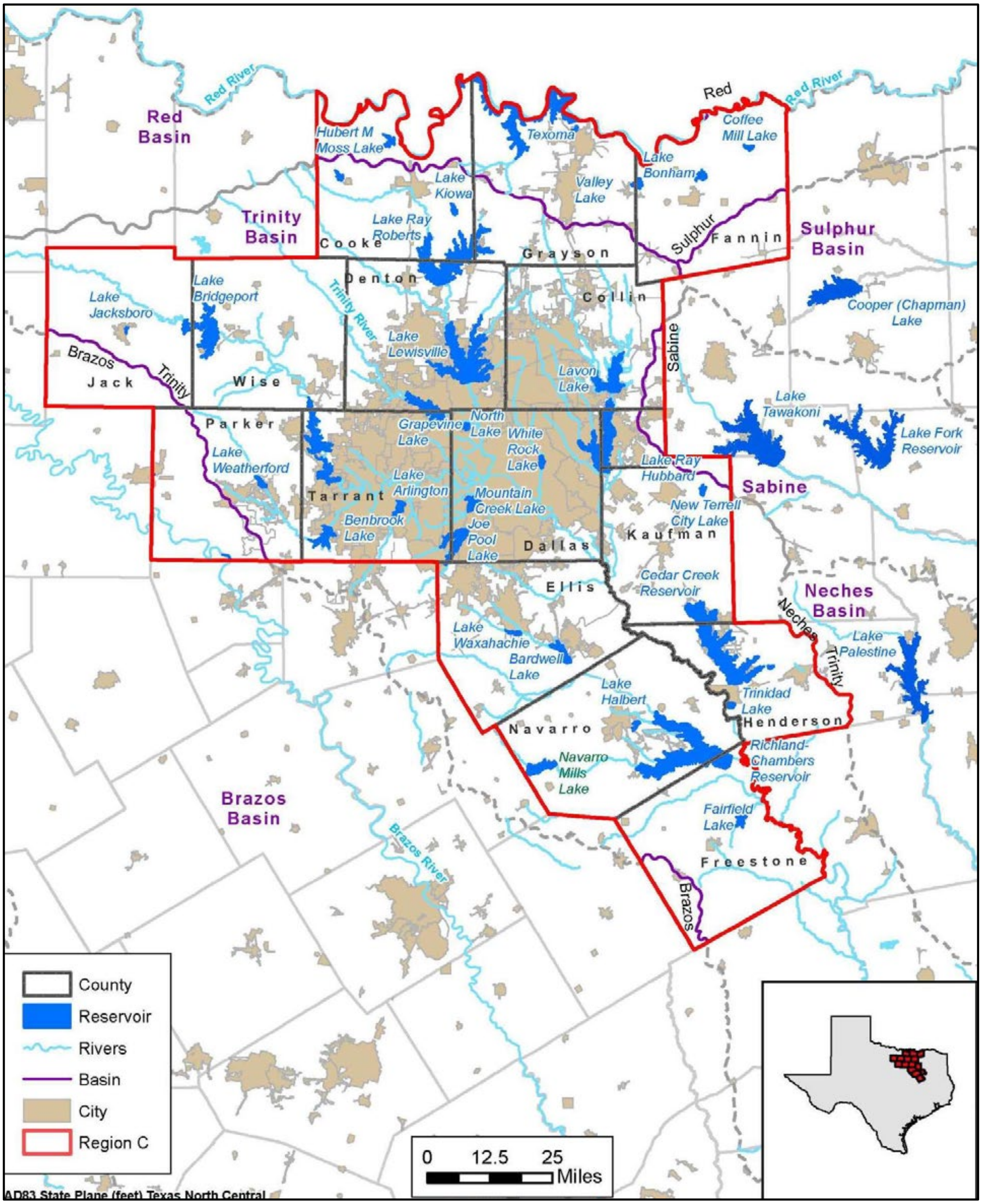

Figure 5.2-1. TWDB-Designated, 16-County Region C, Depicting Reservoirs Both Within and Outside of Regional Boundaries That Supply Water to Region C Users

- Arlington – Impounded in 1957, Lake Arlington is located in Arlington, Texas, and has a surface area of 1,939 acres.
- Joe Pool – Impounded in 1986, Joe Pool Lake is located in Tarrant, Ellis, and Dallas counties, four miles south of Grand Prairie, and has a surface area of 6,469 acres.
- Mountain Creek – Impounded in 1937, Mountain Creek Lake is located in Dallas County, four miles east of Grand Prairie, and has a surface area of 2,493 acres.
- Ray Hubbard – Impounded in 1968, Lake Ray Hubbard is located in Collin, Dallas, Rockwall, and Kaufman counties, one mile west of Rockwall, and has a surface area of 21,671 acres. A photo of Lake Ray Hubbard is shown in Figure 5.2-2.

Figure 5.2-2. 21,671-acre Lake Ray Hubbard in Collin, Dallas, Rockwall and Kaufman Counties

- White Rock – Impounded in 1910, White Rock Lake is located in the City of Dallas, and has a surface area of 1,088 acres.
- Terrell – Impounded in 1955, Terrell City Lake is located in Kaufman County, five miles east of Terrell, and has a surface area of 1,150 acres.
- Clark –Lake Clark is a small reservoir located in Ellis County, two miles from Ennis.
- Bardwell – Impounded in 1965, Lake Bardwell is located in Ellis County, four miles southwest of Ennis, and has a surface area of 3,138 acres.
- Waxahachie – Impounded in 1956, Lake Waxahachie is located in Ellis County, two miles south of Waxahachie, and has a surface area of 656 acres.
- Forest Grove – Impounded in 1976, Forest Grove Reservoir is located in Henderson County, seven miles northwest of Athens, and has a surface area of 1,502 acres.

- Trinidad City – Impounded in 1925, Trinidad City Lake is located in Henderson County, two miles south of Trinidad, and has a surface area of 690 acres.
- Navarro Mills – Impounded in 1963, Navarro Mills Lake is located in Navarro County and has a surface area of 5,070 acres.
- Halbert – Impounded in 1921, Lake Halbert is located in Navarro County near Corsicana and has a surface area of 603 acres.
- Fairfield – Impounded in 1969, Fairfield Lake is located in Navarro County, five miles northeast of Fairfield, and has a surface area of 2,159 acres.
- Mineral Wells – Impounded in 1920, Lake Mineral Wells is located in Parker County, east of Mineral Wells, and has a surface area of 440 acres.
- Teague City – Teague City Lake is a small reservoir located in Freestone County near Teague, Texas.
- Lavon – Impounded in 1953 and doubled in size in 1974, Lake Lavon is located in Collin County, four miles northeast of Wylie, and has a surface area of 21,400 acres.
- Muenster –Muenster Lake is located in Cooke County and has a surface area of 309 acres.

The combined surface area of these existing water supply reservoirs impounded in Region C over the last century is approximately 289,523 acres (452 square miles). By comparison, the surface area of the proposed LBCR (Alternative 1) is 16,641 acres, or approximately six percent of the existing regional total; the downsized LBCR alternative (Alternative 2) would have a surface area of approximately 8,600 acres, or three percent of the existing impounded surface area in Region C.

Figure 5.2-3 shows the acreage of new impounded surface area (reservoirs) added per decade from 1900 to the present in Region C. More surface area was added in the 1940s than any other single decade, and the peak period extended from the 1940s to through the 1980s. No new reservoir surface area has been added in Region C for almost three decades.

Figure 5.2-4 shows the number of reservoir projects per decade adding impounded surface area in Region C from 1900 to the present, using available information on completion dates (all major reservoirs are included). The 1950s and 1960s were the two peak decades, with eight reservoir projects completed in each of those two decades. There have been no new reservoir projects that expanded total surface area of impoundments in Region C from the 1990s to the present.

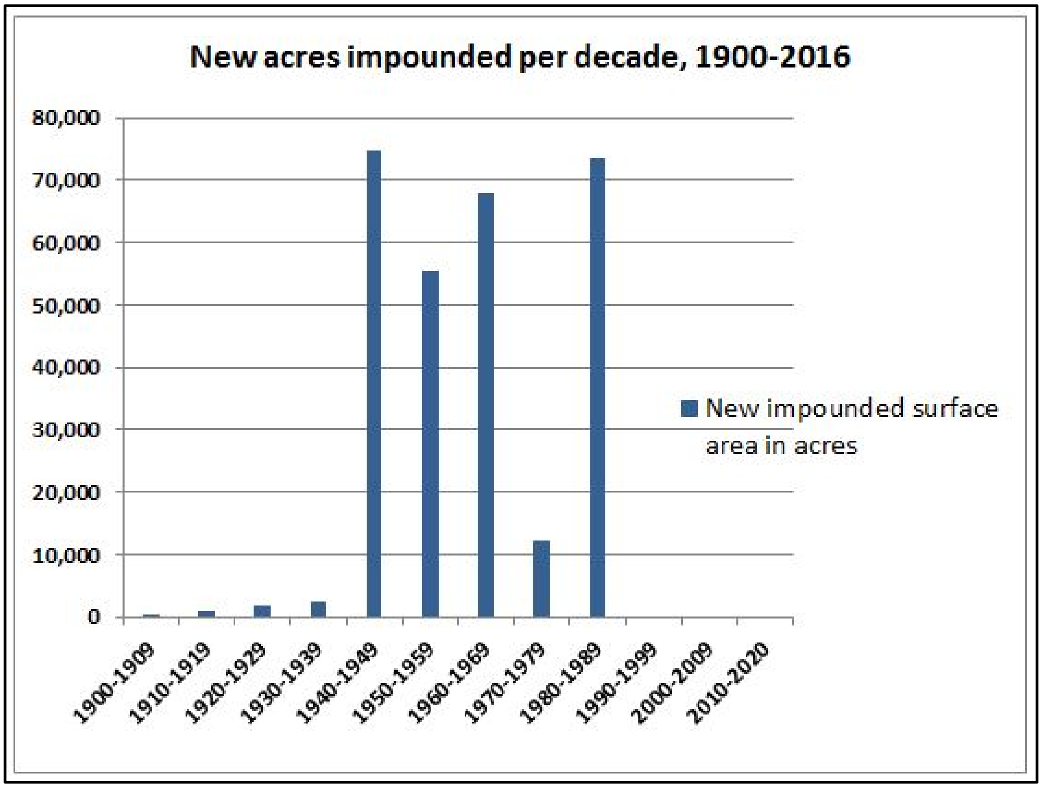

Figure 5.2-3. Increments of New Surface Area of Impoundments Added Per Decade in Region C from 1900 to Present

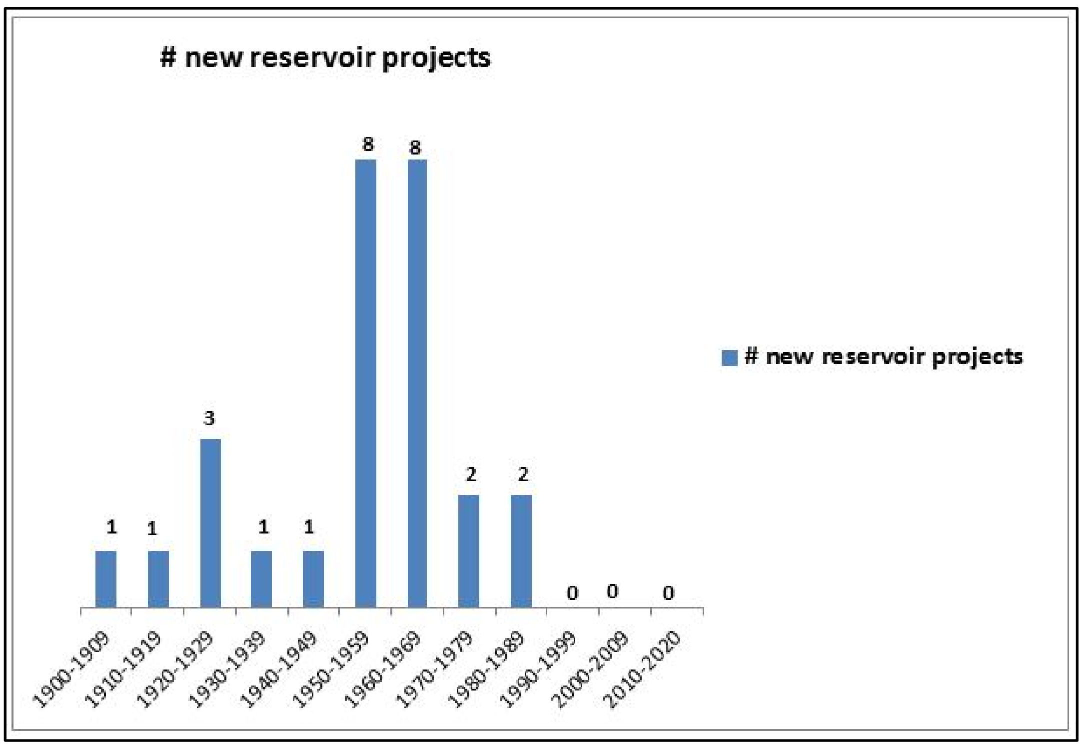

Figure 5.2-4. Number of New Reservoir Projects Completed Per Decade in Region C, from 1900 to the Present

There is no precise estimate of the length in linear feet of Region C water courses (streams and rivers) that have been impounded to date, i.e., converted from a lotic to a lentic condition. However, extrapolating from the ratio between the acreage of the proposed full-scale LBCR reservoir and the linear feet of stream length it would affect, an estimate of 11,149,407 linear feet (2,112 miles) of impounded streams and rivers is obtained.

While no hard data or studies are available, construction and operation of each of these reservoirs caused many of the same direct and indirect, short-term and long-term adverse environmental impacts that construction of the proposed LBCR (either Alternative 1 or Alternative 2) would cause, particularly on aquatic resources, including flowing waters of the United States, wetlands in general, and forested wetlands in particular. Cumulatively, the combined effects of constructing and operating these reservoirs within Region C have been important in a number of ways, from their hydrological and biological resource impacts to the population and economic growth and development they have induced, facilitated, or accommodated. In proceeding to the cumulative impact analysis for the present project, it is important to keep these pre-existing effects, the current baseline condition, in mind.

5.3 OVERVIEW OF PROPOSED NEW RESERVOIRS IN REGION AND STATE

A century ago, in 1913, just four major reservoirs with a total storage capacity of 277,600 AF had been constructed in all of Texas. In contrast, by January 2011, Texas had a total of 187 major reservoirs, defined as those with a normal capacity of 5,000 AF or larger. At present, there are approximately 6,740 reservoirs in the state with a normal storage capacity of at least 10 AF. Texas has about 5,607 square miles (3.6 million acres) of inland water, ranking it first among the 48 contiguous states in the U.S. (TSHA, no date-b). In Region C alone, as of 2016, there are approximately 30 existing major reservoirs with a total surface area of 289,523 acres (452 square miles).

In addition to the 187 existing major reservoirs in the state, both the *2012 State Water Plan* and the *2017 State Water Plan* recommend 26 new major reservoirs to meet water needs in several regions (see Figure 5.3-1), the majority located east of Interstate 35 where rainfall and runoff are more abundant. These new reservoirs would produce 1.1 million AFY of water in 2070 if all are built (TWDB, 2012; TWDB, 2016). As shown in Figure 5.3-1, many of these new reservoir sites are located off-channel, that is, they would not be constructed on the main stem of a river, although they may rely on flows from that main stem.

The five recommended new on-channel reservoirs in the Red River Basin (LBCR, Ralph Hall, Marvin Nichols, George Parkhouse North, and George Parkhouse South) would have a combined surface area of approximately 130,000 acres (more than 200 square miles), a 45 percent addition to the existing acreage of reservoirs in the region.

Overall, the construction of all existing reservoirs has had marked and significant cumulative effects – both beneficial and adverse – on the surface water hydrology of Texas and of Region C in particular. The LBCR would represent an incremental contribution to these already accumulated and reasonably foreseeable impacts on water resources in the region and state.

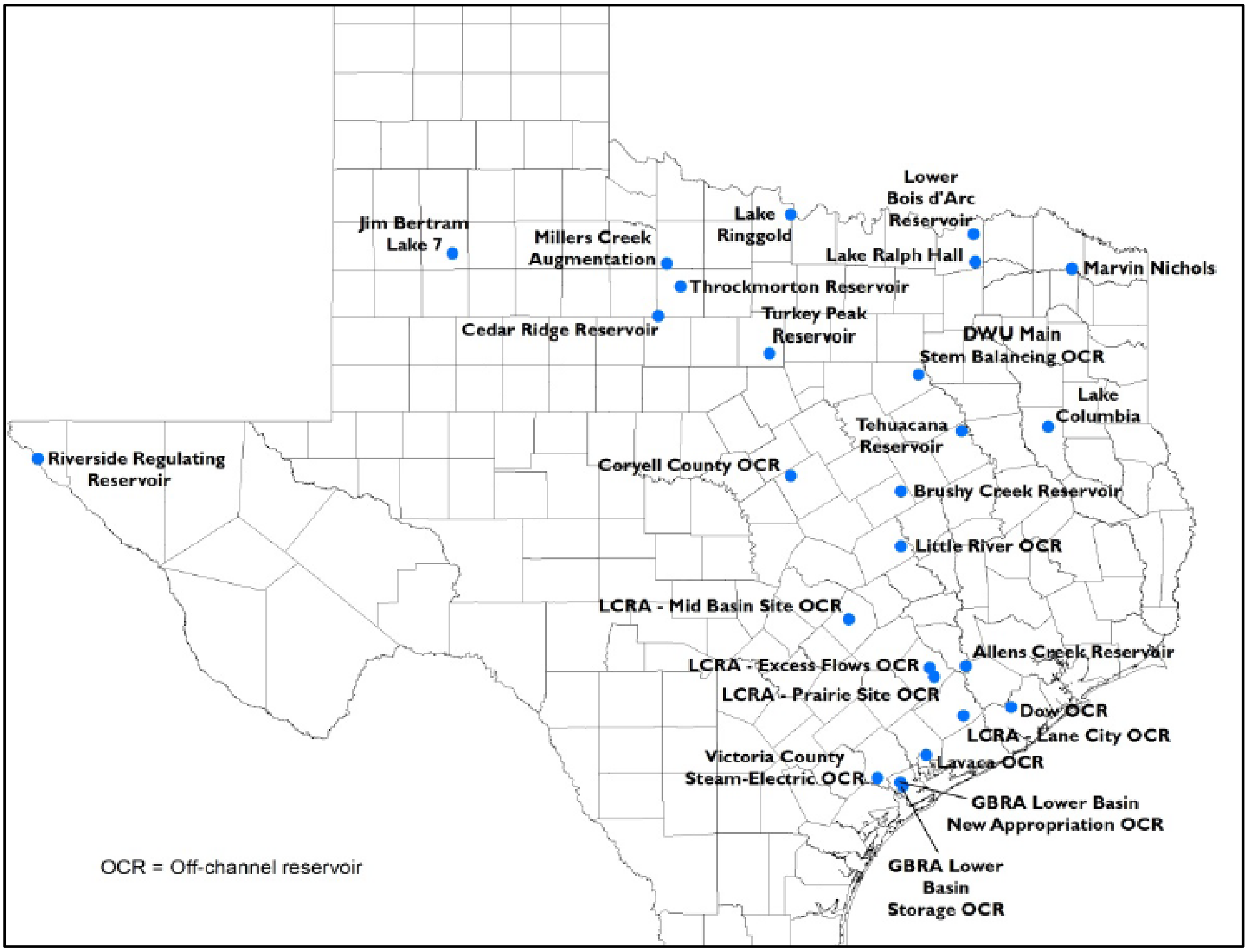

Figure 5.3-1. Recommended New Major Reservoirs in the *2017 Texas Water Plan*

5.4 ACTIONS CONSIDERED IN CUMULATIVE IMPACTS ANALYSIS

5.4.1 Past Actions

Fannin County's population peaked in 1900 at 51,793 and began a fluctuating decline that persisted through most of the 20th century (Pigott, 2012). By 1970, the county population had declined to below 23,000, less than half its size in 1900 and fewer than the number of residents in the 1880s. In the 2000 Census, the Fannin County population had increased to over 31,000, and this trend continued from 2000 to 2010, during which the number of residents grew by 9% to almost 34,000.

Throughout the 20th century, agriculture remained the principal source of economic activity and income, with cotton and corn as the main crops. More recently, beef cattle, wheat, milo, corn, pecans, and hay have become the chief agricultural and ranching products. Until the demographic and economic turnaround of the past few decades, Fannin County's economic activity was also at its highest early in the 20th century. Corn and hog production peaked in 1900 while cotton production peaked in 1920. The number of farms and businesses in the county also reached their zenith in 1900 (Pigott, 2012).

Channelization of Bois d'Arc Creek

As described in some detail in Chapter 3 (Section 3.3) of this EIS, modifications to the natural stream channel of Bois d'Arc Creek began prior to 1915. Over the past century, in order to control flooding, facilitate discharge, and expedite drainage in the area, substantial portions of the creek were channelized, including portions within the proposed reservoir footprint. These actions continued as recently as the 1970s. As documented in the 2010 Instream Flow Study (Appendix M), channelization and straightening have thoroughly modified the original hydrologic regime and geomorphology of Bois d'Arc Creek, resulting in channel downcutting and increased bank and bed erosion.

Bois d'Arc Creek flows are characterized as flashy, rising and falling rapidly in response to rainfall events, and with extended periods of little or no flow, especially in the late summer. The highly channelized and straightened nature of Bois d'Arc Creek plays an important role in determining the current behavior and geomorphological processes that prevail in this stream. It contributes to the flashy nature of the creek, considerable erosion of its bed and banks, limited habitat and biotic diversity in channelized sections, and minimal lateral migration (meandering).

The Bois d'Arc Creek channel has not yet re-established dynamic equilibrium since the time it was channelized and its riparian vegetation buffer changed. The creek's sediment supply and stream power are still out of balance and it continues to evolve through the same predictable sequence of channel stages that have been observed in many other modified stream systems.

Lake Bonham

Lake Bonham, shown in Figure 5.3-1, is located three miles northeast of the town of Bonham in Fannin County, immediately to the west of the upstream edge of the proposed LBCR. This reservoir was impounded in 1969 and has a surface area of 1,020 acres. It supports native emergent vegetation as well as a fishery, whose predominant fish species are largemouth bass, channel and blue catfish, sunfish, and crappie (TPWD, 2007b).

Figure 5.4-1. Lake Bonham

The Lake Bonham water right transferred to NTMWD in November 2010, and the lake is now used by NTMWD for water supply. Lake Bonham is used to meet the City of Bonham's demands, which were about 2,350 AFY in 2010. The reliable supply for NTMWD from Lake Bonham is about 5,340 AFY.

The impacts of Lake Bonham construction and operation that could contribute to cumulative impacts are shown in Table 5.6-1 at the end of the chapter.

Valley Lake (Brushy Creek Reservoir)

Valley Lake, also known as Brushy Creek Reservoir, is situated on Brushy Creek, a tributary of the Red River, about three miles north of the town of Savoy (about 10 miles west of Bonham) in Fannin County. The lake is owned and operated by Texas Power and Light Company for the purpose of condenser cooling and other power plant uses at its Valley Creek steam-electric generating station. Construction of Valley Dam began in April 1960 and finished in September 1961. Impoundment of water started in December 1960. The reservoir has a storage capacity of 16,400 acre-feet, encompassing a surface area of 1,080 acres, at the normal pool elevation of 611 feet MSL (TWDB, no date-b). The drainage area of Valley Lake is only eight square miles, but the water level in the reservoir is also maintained by the diversion of water from the Red River by two pumps installed in the power plant at the mouth of Sand Creek (TSHA, no date-a).

Coffee Mill Lake (Caddo National Grasslands)

Coffee Mill Lake is located approximately 15 miles northeast of Bonham in the Caddo National Grasslands. It is managed by the USFS. Coffee Mill Lake was impounded in 1939 on Coffee Mill Creek, a tributary of Bois d'Arc Creek with a confluence downstream of the proposed LBCR site. It has a drainage area of 39 square miles (TWDB, no date-c). It has a surface area of 650 acres and a maximum depth of 30 feet. Its normal pool elevation is 496 feet MSL. It is a popular, stocked fishing lake; largemouth bass, channel catfish, and crappie are the predominant species (TPWD, 2010e).

Lake Davey Crockett (Caddo National Grasslands)

Lake Davey Crockett is located in northeast Fannin County in the Caddo National Grasslands, approximately 20 miles east-northeast of Bonham. Like Coffee Mill Lake, it is managed by the USFS. Crockett Lake was impounded in 1938 on a tributary of Bois d'Arc Creek that has a confluence downstream of the proposed LBCR site. Its surface area is 355 acres and it has a maximum depth of 20 feet. Its normal (conservation) pool elevation is 487 feet MSL. Like Coffee Mill Lake, Lake Crockett is a popular, stocked fishing lake; largemouth bass, channel catfish, bluegill, and crappie are the predominant species (TPWD, 2007c).

Center for Workplace Learning – Grayson College

In 2003, the Center for Workplace Learning at Grayson College in Denison, TX was the recipient for a $1,700,000 public works investment. To date, this project has created 1,268 jobs and 1,175 existing jobs have been retained for a total of 2,443 jobs created and retained (TCOG, 2010). This action has improved the area's socioeconomic status and increased population. Increased population is associated with indirect and long-term, generally adverse cumulative effects on a number of environmental attributes. The impacts of Center for Workplace Learning construction and operation that likely contribute to cumulative impacts in the region are shown in Table 5.6-1.

North Texas Regional Airport

North Texas Regional Airport in Grayson County continues to enhance its facilities and site features with completion of the first phase of the $16.9 million Capital Improvement Program. In April 2009, the previously undersized water drainage system was updated and a $4.0 million taxiway rehabilitation project is still underway. This action affects regional transportation and general economic activity within the ROI.

<u>TransCanada Gulf Coast Pipeline Project</u>

Several pipelines cross the Riverby Ranch, including the Keystone Pipeline, an existing pipeline that transports oil from sand fields in Alberta, Canada into the U.S., terminating in Cushing, Oklahoma (KUT, 2015). The Keystone XL Pipeline is a proposed TransCanada Corporation project that would deliver crude oil from the Athabasca Oil Sands in northeastern Alberta, Canada to refineries in Illinois and Oklahoma before the pipeline heads south to the Gulf Coast at Port Arthur, Texas. The proposed pipeline would traverse Montana, South Dakota, Nebraska, Oklahoma, and Texas (NTEN, 2011).

The Keystone XL pipeline project includes 1,700 miles of pipeline in two sections. The southern section connects Cushing, OK, where there is a current bottleneck of oil, with the Gulf Coast of Texas, with its numerous oil refineries. That section, including the segment that passes through Fannin County and NTMWD's Riverby Ranch property, was constructed in 2013 and became operational in January 2014 (KUT, 2015). The other section of the Keystone XL pipeline project would include a new section from Alberta to Kansas. It would pass through the actively producing Bakken Shale region of eastern Montana and western North Dakota. This section is currently awaiting approval of a Presidential Permit from the U.S. State Department.

The southern leg of the pipeline, also known as the TransCanada Gulf Coast Pipeline Project, cuts through 16 counties in North and East Texas, including Fannin, Lamar, and Delta counties, on its way to the coast (Yeakley, 2012). While the length of the project in northeastern Fannin County is fairly short, it cuts through the Riverby Ranch property under an easement granted by the NTMWD.

According to the Final EIS conducted by the U.S. State Department on the Keystone XL Pipeline (U.S. Department of State, 2014), construction of the pipeline entails potential short-term impacts to surface water from sedimentation, changes in stream channel morphology and stability, temporary reduction in stream flow, and the potential for hazardous material spills. There would be other potential longer term effects during decades of operations, from potential releases of crude oil and other hazardous liquid spills. Other potential long-term impacts during operation include channel migration or streambed degradation that exposes the pipeline; channel incision that increases bank heights to the point where slopes are destabilized, eventually widening the stream; and sedimentation within a channel that could trigger lateral bank erosion. Mitigation measures would address these impacts (U.S. Department of State, 2014).

Other potential impacts of the pipeline identified in the EIS include those to floodplains, groundwater, wetlands, threatened and endangered species, geology and soils, wildlife, vegetation, fisheries, air quality and noise, land use, and cultural resources. Pipeline construction would also create temporary construction-related jobs.

TransCanada Corporation and the Gulf Coast pipeline are expected to contribute modestly to both the local economy and tax base for many years to come. The impacts of pipeline maintenance that potentially contribute to cumulative impacts in the region are shown in Table 5.6-1.

5.5 REASONABLY FORESEEABLE ACTIONS

The following reasonably foreseeable projects of all kinds in Fannin County and reservoir projects in Hydrologic Unit Code (HUC) 111401 that may take place in the future were identified as having potential cumulative effects when considered in conjunction with the proposed Lower Bois d'Arc Creek Reservoir.

Reasonably foreseeable Fannin County actions and trends include one large proposed reservoir project (Lake Ralph Hall), climate change, and general population growth and development in the county from expansion of the Dallas-Fort Worth (DFW) Metroplex. Each of these actions could contribute to a variety of cumulative environmental effects in the county.

5.5.1 Lake Ralph Hall

The Upper Trinity Regional Water District's (UTRWD) proposed Lake Ralph Hall (LRH) was initially identified as the main project affecting the assessment of cumulative impacts for the proposed LBCR. The proposed LRH would be located on the North Sulphur River approximately 4.8 miles northeast of the City of Ladonia and 22.5 miles southeast of the City of Bonham in Fannin County. Construction of the proposed 11,200-acre water supply reservoir would likely not take place during the same timeframe as the LBCR, but some years later. Figure 5.5-1 is a map displaying the two proposed reservoirs in relation to one another. This figure also depicts the location of the Riverby Ranch, the proposed mitigation site for the Lower Bois d'Arc Creek Reservoir. Figure 5.5-2 depicts a reach on the North Sulphur River in the vicinity of the proposed LRH dam site.

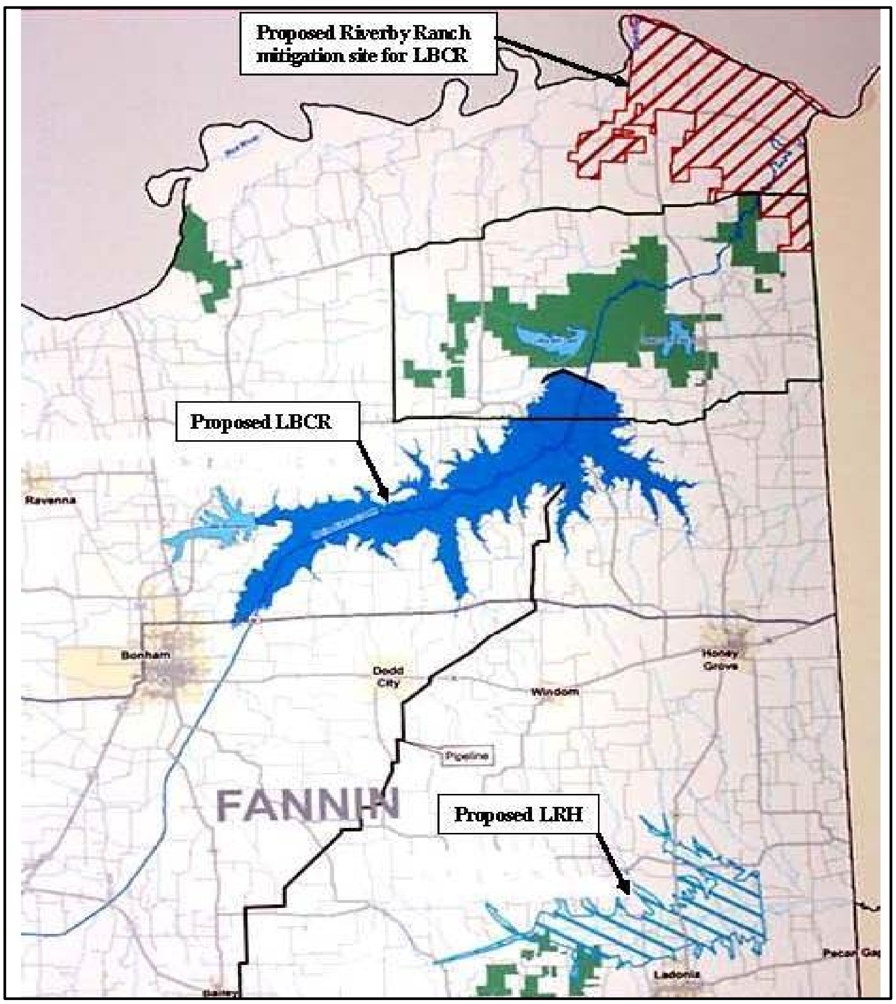

Figure 5.5-1. Relative Locations of LBCR, LRH and Riverby Ranch Mitigation Site in Fannin County

Figure 5.5-2. North Sulphur River Channel in the Vicinity of the Proposed Lake Ralph Hall

The purpose of the proposed Lake Ralph Hall is to provide water for approximately 33 towns, cities, and utility districts in portions of Collin, Cooke, Dallas, Denton, Fannin, Grayson, and Wise counties. Both the LBCR and Lake Ralph Hall Reservoir would serve portions of Collin, Fannin, and Denton counties. UTRWD could serve portions of NTMWD customer cities where it would be more feasible or cost efficient for them to provide water than it would be for NTMWD to extend lines to serve those areas. Generally, services from NTMWD and UTRWD would not overlap.

In March 2012, a meeting was held to consider possible cumulative interactions between the proposed LBCR project and the proposed LRH project. Attendees at this meeting included regulatory staff from the Tulsa and Fort Worth districts of the U.S. Army Corps of Engineers, representatives from the North Texas Municipal Water District and Upper Trinity Regional Water District, and EIS consultants and contractors. Both the LBCR and LRH EIS teams provided overviews of their projects (shown in Table 5.4-1) and summaries of preliminary key findings. To analyze socioeconomic impacts, both studies used the same IMPLAN model and data, and therefore the figures are comparable. A discussion of interacting direct and indirect consequences – both additive and subtractive – to tax revenue, jobs, recreational resources, residential and commercial development, real estate, agriculture, and ranching took place.

At the time the LBCR EIS began and even at the time of the March 2012 meeting to discuss cumulative impacts of LBCR and LRH, it appeared that their construction schedules could overlap, which would cause short-term cumulative impacts. However, this situation has changed and the current construction timeframe for LRH is estimated to occur between 2025 and 2030. This would be subsequent to the proposed construction of LBCR. It is thus likely that both projects would not be built concurrently. The impacts of Lake Ralph Hall that could contribute to cumulative impacts in the region are shown in Table 5.5-1.

Table 5.5-1. Comparison of Two Proposed Reservoirs in Fannin County

	Lower Bois d'Arc Creek	Lake Ralph Hall
Location	Fannin County	Fannin County
Service Area	Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rains, and Rockwall counties	Collin, Cooke, Dallas, Denton, Fannin, Grayson and Wise counties
Reservoir Surface Area	16,641 acres	11,200 acres
Impoundment	367,609 acre-feet of water	160,235 acre-feet of water
Construction Cost	$400,000,000	$187,164,295
Total Project Cost	$552,397,634	$198,478,359
Firm Yield/year	126,200 acre-feet	32,940 acre-feet

5.5.2 Climate Change

The climate of the Earth is warming as a result of the long-term buildup in the concentrations of greenhouse gases the atmosphere – primarily carbon dioxide (CO_2) and methane (CH_4) – as result of anthropogenic emissions of these gases (IPCC, 2013). According to the 2014 National Climate Assessment (Shafer et al., 2014), large areas of the Southern Plains, including Texas and Oklahoma, are expected to experience longer dry spells and periods of extreme heat (days above 100°F) over the coming decades. These changes in turn are likely to result in a number of effects on the project area, including upland and wetland vegetation communities, wildlife, hydrology, aquatic resources, water supplies, agriculture, and demand for electricity and water (See Table 5.6-1).

5.5.3 Growth of the Dallas – Fort Worth Metroplex

"Growth of the Metroplex" does not refer to one discrete project or action like the others listed above, but rather to the sum or aggregate of thousands of decisions and actions carried out over a period of decades by individual consumers and their families, companies (the private sector), and government (the public sector). Growth of the DFW Metroplex is more a trend than an action, but a trend with real physical implications for the landscape and the affected environment.

The demographic projections in Chapter 1 of this EIS indicate that Fannin County alone is expected to grow from a population of about 38,000 in 2010 to almost 87,000 in 2060, more than doubling in size. The population of Region C as a whole is projected to almost double over the same time period, increasing from approximately 6.7 million to more than 13 million. Accompanying this population growth will be development on a large scale to accommodate the needs and activities of 6.5 million new residents. Large areas of existing rural land or open space consisting of woodlands, cropland, pasture, or rangeland will be developed into residential, commercial, institutional, recreational, industrial, and transportation areas.

Based on extensive data collected and sampled for the National Resources Inventory (NRI) of USDA's Natural Resources Conservation Service (NRCS), the average Texas resident uses approximately 0.4 acre of land for all purposes (NRCS, 2013). Using these estimates and averages, approximately 2.6 million acres (4,063 square miles) of now-rural land would likely be developed to accommodate 6.5 million new residents in Region C by 2060. In Fannin County, at the state average of 0.4 acre per resident (population density of 1,600 per square mile), about 20,000 acres (31 square miles), would be developed to accommodate almost 50,000 new residents. This area is larger than the surface area of the proposed LBCR. Alternatively, assuming that new development in Fannin County over the coming decades took place at the more typical small town urban/suburban population density of 1,000 residents per square mile (Demographia, 2000), or 0.64 acre per resident, there would be approximately 31,000 acres (48 square miles) of additional development in the county, or about five percent of the total Fannin County area of 899 square miles. Depending on the density of development that actually does occur, the amount of new land developed in the county to accommodate projected population growth is likely to range between 31 and 48 square miles (about 20,000 to 31,000 acres), a substantial increase. While the county would still have more rural land than developed (urban or suburban) land, its character would change.

This process of development would have direct, indirect, and cumulative environmental impacts on virtually every topic covered in the Affected Environment and Environmental Consequences chapters of this EIS. For example, building a residential subdivision has direct, indirect, and cumulative, short-term and long-term impacts on soils, air quality, biological resources, surface water and groundwater (both in terms of effects on water quality and flows, that is, on hydrology, hydraulics, and flooding), vegetation, wildlife, noise, recreational opportunities, transportation, visual resources, socioeconomics, and cultural resources. The ongoing and projected future rapid population growth and attendant land development of the DFW Metroplex would affect the natural resources and environment not only in Fannin County, but most of the other counties in Region C. The population of the region as a whole is projected to increase from approximately 6.5 million in 2010 to 12.7 million by 2060 and 14.3 million by 2070 (Appendix N of this EIS and Table 2.1 in Region C Water Planning Group, 2015).

Potential cumulative impacts associated with growth of the DFW Metroplex are listed in Table 5.6-1.

5.5.4 Reasonably Foreseeable New, Nearby Reservoir Projects in Red River Basin

In their long-range water planning process, the Region C Water Planning Group and Texas Water Development Board foresee a number of potential reservoir projects in Region C. These projects are evaluated in Chapter 5 of the *2016 Region C Water Plan* as "Major Water Management Strategies" (Region C Water Planning Group, 2015). Some of these are already described in Chapter 2 of this EIS as a possible alternatives to LBCR – though none meet the specific purpose and need of this Proposed Action – or are mentioned as possible future options for NTMWD, in that implementation of even the full-scale LBCR would be insufficient to meet the long-term water demands of the NTMWD service area's projected population growth.

This section lists and briefly describes each of these reasonably foreseeable Region C reservoir projects, as well as their possible environmental consequences. Lake Ralph Hall is one of these reasonably foreseeable Region C reservoir projects; however, because it is located in Fannin County along with the proposed LBCR, it has already been described above. A number of other Major Water Management Strategies are also listed for Region C, which actually far exceed the number of potential new reservoir projects. These include: Gulf of Mexico desalination, new pipelines from existing reservoirs within Region C and outside of Region C, new reservoirs outside of Region C, water from Oklahoma, the Neches River Run-of-the-River Diversion, groundwater from several different counties, and a wetland and water reuse project involving return flows. None of these other alternative strategies would entail the magnitude of potential impacts on waters of the U.S. and wetlands that are associated with new reservoir projects, and therefore, only the potential new reservoir projects in Region C listed as Major Water Management Strategies in the 2016 plan are shown below.

Marvin Nichols Reservoir (elevation 328 feet MSL)

In the current *2016 Region C Water Plan*, developing the Marvin Nichols Reservoir site, located on the Sulphur River in Red River and Titus counties (Appendix O), has been downgraded from a recommended strategy to an alternative strategy for NTMWD, which means that it is considered a lower priority (Region C Water Planning Group, 2015). However, it is still listed in the 2016 plan as a Major Water Management Strategy for Region C as a whole, and it is considered a viable alternative strategy for TRWD, UTRWD, and Irving, in addition to NTMWD.

The Marvin Nichols Reservoir full configuration (328 feet MSL) would be a large new water source for the North Texas region. However, because of its size (more than 67,000 acres), the development of this reservoir site would likely entail extensive environmental impacts. The area that would be inundated is more than four times the footprint of the LBCR, with comparably greater impacts on natural habitats. The estimated acreage of impacted wetlands and bottomland hardwood forests (the two most high quality habitat types) for this alternative are considerably greater than the acreage determined for the Proposed Action (TWDB, 2008).

Estimates by TWDB (2008) are that total conversions of vegetated wetlands and associated habitats (bottomland hardwood forest, marsh, seasonally flooded shrubland, and swamp) due to this reservoir project would amount to 34,331 acres, in addition to 1,847 acres of open waters that would be affected (Appendix O).

Other possible direct and indirect adverse effects from the Marvin Nichols project would include impacts to threatened and endangered species, air and noise, agriculture, cultural resources, transportation, utilities, and infrastructure. Both adverse and beneficial impacts could occur to existing recreation resources and socioeconomics, with beneficial impacts in these two areas likely outweighing adverse effects. A project of this magnitude would also contribute to its own set of cumulative effects. Potential cumulative impacts associated with Marvin Nichols Reservoir and related to this project are listed in Table 5.6-1.

George Parkhouse Lake (North)

George Parkhouse Lake (North), also known as Parkhouse II, is a potential reservoir site located on the North Sulphur River in Lamar and Delta Counties, about 15 miles southeast of Paris, TX (see Appendix O in this EIS). It is listed as an alternative strategy in the *2016 Region C Water Plan* for NTMWD and UTRWD. It would inundate an estimated 15,359 acres, a large portion of which is cropland or pasture. No designated priority bottomland hardwoods are present within or adjacent to the reservoir site (Region C Water Planning Group, 2015).

George Parkhouse North would affect an estimated 3,195 acres of vegetated wetlands and associated habitats (riparian woodland/bottomland hardwood, forested wetland, emergent/herbaceous wetland, and shrub wetland) in addition to 182 acres of open water/lacustrine habitat (see Appendix O in this EIS).

Other possible direct and indirect adverse effects from this project would include impacts to threatened and endangered species, air and noise, agriculture, cultural resources, transportation, utilities, and infrastructure. Both adverse and beneficial impacts would likely occur to existing recreation resources and socioeconomics, with beneficial impacts in these two areas probably outweighing adverse effects. The George Parkhouse Lake (North) project would also contribute to its own set of cumulative effects. Potential cumulative impacts associated with George Parkhouse Lake (North) and related to this project are listed in Table 5.6-1.

George Parkhouse Lake (South)

George Parkhouse Lake South, also known as Parkhouse I, is a potential reservoir that would be located in Region D on the South Sulphur River in Hopkins and Delta counties, approximately 18 miles northeast of the city of Sulphur Springs. If constructed, it would be immediately downstream from Jim Chapman Lake. It is listed as an alternative strategy for NTMWD in the *2016 Region C Water Plan*, and would provide 108,480 AFY of water at a unit cost of $2.10 per thousand gallons (Region C Water Planning Group, 2015). With a conservation pool elevation of 401 feet MSL, Parkhouse I would inundate approximately 29,000 acres and store 652,000 acre-feet of water. The reservoir would have a total drainage area of 654 square miles (TWDB, 2008). It is estimated that it could not be built before 2035.

The yield of Parkhouse I would be reduced substantially by the development of Marvin Nichols Reservoir (Region C Water Planning Group, 2015). Yield studies conducted for TWDB as part of the Reservoir Site Protection Study indicate the yield of this lake would be reduced by 60 percent, to 48,400 acre-feet per year, if constructed after the Marvin Nichols Reservoir (TWDB, 2008).

George Parkhouse South would affect an estimated 10,379 acres of bottomland hardwood forest, 4,566 acres of marsh, 584 acres of seasonally flooded shrubland, 83 acres of swamp, 848 acres of open water, and various upland habitats (Appendix O).

Other possible direct and indirect adverse effects from this project would include impacts to threatened and endangered species, air and noise, agriculture, cultural resources, transportation, utilities, and infrastructure. Both adverse and beneficial impacts would likely occur to existing recreation resources and socioeconomics, with beneficial impacts in these two areas likely outweighing adverse effects. The George Parkhouse Lake (South) project would also contribute to its own set of cumulative effects. Potential cumulative impacts associated with George Parkhouse Lake (South) and related to this project are listed in Table 5.6-1.

5.6 CUMULATIVE EFFECTS OF ALTERNATIVE 1, ALTERNATIVE ACTION 2, NO ACTION ALTERNATIVE, AND OTHER ACTIONS

This section discusses the potential for cumulative impacts of the Proposed Action (Alternative 1), downsized version of the LBCR (Alternative 2), and No Action Alternative in the context of the past, present, and reasonably foreseeable future actions within the area of cumulative effect, which varies by resource topic.

This section also includes a brief discussion of the area of cumulative effect identified for each resource. The area of effect considers past and reasonably foreseeable actions. Table 5.6-1 provides a summary of the actions considered in the cumulative analysis of each resource topic.

5.6.1 Land Use

The study area for assessing cumulative effects on land use consists of Fannin County. The analysis considers the footprint of the project alternatives in combination with other projects located in Fannin County (see Table 5.6-1). Fannin County was selected as the area of effect for the cumulative impact analysis because land use classifications are made at the county-level and the direct land use impacts attributable to the project alternatives are located almost entirely within Fannin County.

The county is relatively sparsely populated at present, with the majority of residents being spread out among the various agricultural lands that surround Bonham, which is the county seat. The county's land use is predominantly agricultural, including crop, hay, and pasture land. Row crops are found more in the eastern half of the county. Other land uses include forest land, residential, light industrial, and commercial.

The LBCR project would cover up to 17,068 acres of bottomland and adjacent upland habitat along Bois d'Arc Creek in Fannin County. This land is predominantly undeveloped with scattered rural residences. The sites proposed for the WTP, TSR, and related facilities near Leonard are also located on rural agricultural land.

From Table 5.6-1, the past, present and reasonably foreseeable actions anticipated to cumulatively impact land use within the ROI include Bois d'Arc Creek channelization, past county reservoir projects, the two proposed reservoir projects (LBCR and LRH), and the growth of Fannin County and the DFW Metroplex.

In combination, the two reservoirs and their mitigation area(s) represent a substantial change in land use for Fannin County. Over time, as the population of the county grows, its rural, largely agrarian landscape would gradually decline as it becomes more developed and residential, commercial, and institutional land use increases. The two reservoirs and mitigation site(s) would permanently remain as open space and "parkland" as the county transitions away from agriculture and rural land uses.

Conclusion

If expected population growth and development occur, by 2060 there would be substantial cumulative changes in land use in Fannin County, with a smaller fraction of the county used for farmland and a growing percentage used for development of one type or another. In this context, the permanent nature of **Alternative 1** (full-scale LBCR) or **Alternative 2** (downsized LBCR) would generally maintain the open space character of the landscape. The **No Action Alternative** would not contribute to any cumulative changes in land use over the long term.

5.6.2 Topography, Geology, and Soils

The study area for cumulative effects on topography, geology and soils, including farmland classifications, consists of Fannin County. The analysis considers the footprint of the project alternatives in combination with other past and reasonably foreseeable actions in Fannin County (see Table 5.6-1). Fannin County was selected as the area of effect for the cumulative effects analysis because soils and geological characteristics are reported at the county-level (NRCS Fannin County soil survey) and the permanent impacts on soils and geology attributable to the project alternatives are located almost exclusively within the county.

Fannin County remains a largely rural, undeveloped county and most of its soils are used for agriculture, pasture, range, and woodland. The NRCS designates soil as "the most important natural resource in the county" (NRCS, 2001). Fannin County's soils produce forage for livestock, as well as food, fiber, and timber both for the market and for domestic consumption. These products are an important source of economic livelihood for many people in the county and agriculture is the main business on most lands in Fannin County. A number of soils, generally on milder slopes, are designated prime farmland soils. The major land uses supported by these soils are cropland and improved pasture. Nearly half of the agricultural income in the county is from the sale of livestock, primarily beef cattle; these livestock graze mainly on improved pastures (NRCS, 2001).

As shown in Table 5.6-1, the past, present and reasonably foreseeable actions anticipated to cumulatively impact Fannin County's soils include Bois d'Arc Creek channelization, all of the county's reservoir and pipeline projects (past and proposed), and the growth of Fannin County and the DFW Metroplex. In addition, as pointed in Section 4.3.1 (No Action Alternative for soils), past and future agricultural and grazing activities would be expected to continue to cause soil erosion in the county, especially on steeper slopes, gradually reducing soil depth.

Prime Farmland

Two large new reservoirs in Fannin County plus their mitigation site(s) would permanently inundate or change the vegetative cover on several thousand acres of prime farmland soils in the county. However, by 2060 another cause of conversion of prime farmland soils in the county is likely to be population growth and associated land development. TWDB's adopted demographic projections (Region C Water Planning Group, 2015) indicate that Fannin County's population is likely to grow by approximately 64,000 new residents, from an estimated 38,000 in 2020 to approximately 102,000 by 2060, an increase of about 170 percent. Road and parking lot pavement, subdivisions, building foundations, and other impervious surfaces which will cover up soils would be expected to increase more or less proportionately. Most of this projected growth and development would likely occur even in the absence of the Proposed Action, as the DFW Metroplex expands northward. However, the Proposed Action would contribute directly and indirectly to this adverse cumulative effect by stimulating new development.

Conclusion

Chapter 4 concluded that the effects on soils, including Prime Farmland soils, of constructing and operating the LBCR would be adverse. However, TWDB's adopted county population projections show Fannin County growing from approximately 38,000 residents in 2020 to almost 102,000 by 2060, an increase of about 64,000. Assuming a small town urban/suburban population density of 1,000 residents per square mile (Demographia, 2000), this would represent approximately 64 square miles of additional development (and associated conversion of agricultural soils to pavement, buildings, yards, and other built-up uses), compared to the combined 44 square miles that would be converted to reservoir by LBCR and LRH. Thus, if the Proposed Action were built, the sum total of all other development in Fannin County by 2060 would use an additional 145 percent of the amount of land that both proposed reservoirs would use. Given current land use in the county, much of it would likely be farmland, including prime farmland soils.

Under **Alternative 1**, the aggregate of all high-quality soil losses would constitute an adverse, long-term (permanent), moderate to severe impact covering a large area. Alternative 1 would contribute incrementally towards, and perhaps be partially responsible for some of this adverse cumulative effect, in the sense that without increased availability of municipal water, some share of the population growth and development might not materialize in this area.

Under **Alternative 2**, the aggregate of all high-quality soil losses would also constitute an adverse, long-term (permanent), moderate to severe impact covering a large area. Alternative 2 would contribute incrementally towards, and perhaps be partially responsible for some of this adverse cumulative effect, in the sense that without increased availability of municipal water, some share of the population growth and development might not materialize in this area.

Under the **No Action Alternative**, assuming that adequate water supplies were obtained from other sources – including enhanced conservation, water efficiency, recycling, reuse, and new water-saving technologies as well as the potential sources listed as "Major Water Management Strategies" in the *2016 Region C Water Plan* – to sustain population growth and continuing outward expansion of the DFW Metroplex toward the north, most of the same impacts on soils would occur as in the case of the Proposed Action. This would be due to the conversion of rural land soils to urbanized or developed lands. Impacts would thus be adverse, long-term, and moderate to severe.

5.6.3 Water Resources

This section consists of the assessment of cumulative effects on water resources including surface water hydrology, water quality, and groundwater.

The study area for cumulative effects on surface water hydrology and water quality includes the reach of Bois d'Arc Creek downstream of the project alternatives and the segment of the Red River at the confluence with Bois d'Arc Creek. The operation of the project alternatives in combination with the operation of the actions shown in Table 5.6-1 were selected for the cumulative effects assessment because the combined impact of these projects (changes in Red River flows and resulting impacts on surface water hydrology and water quality) may be measurable near the confluence of the Red River with Bois d'Arc Creek.

The Bois d' Arc Creek watershed, located over the Trinity Aquifer, was selected as the cumulative impact area of effect because the operation of the LBCR (either Alternative 1 or Alternative 2) in combination with the other actions occurring within the watershed (Table 5.6-1) could affect the aquifer.

Climate change is predicted to result in drier, hotter conditions in the region (Shafer et al., 2014) and drought conditions are likely to be more severe and longer-lasting. Paradoxically, there could be an increase in the intensity and frequency of storm events and corresponding high stream flows (discharges). In this context, expanding water storage capacity represents an important precautionary strategy for dealing with the likelihood of increasing water scarcity in the region.

Surface Water Hydrology

Streams

Bois d'Arc Creek, a tributary of the Red River, is the main watercourse traversing the heart of Fannin County from its headwaters in the southwest to its confluence with the Red River in the northeast. This creek has a number of tributary streams. To the north of the Bois d'Arc Creek watershed, other streams flow directly into the Red River, and to the south still others are tributary to the North Sulphur River, which discharges into the Red River downstream of its confluence with Bois d'Arc Creek.

The streams in Fannin County are impounded by four existing reservoirs: Lake Bonham, Lake Davy Crockett, Coffee Mill Lake, and Valley Lake. The first three are situated in the Bois d'Arc Creek watershed and the last is on Brushy Creek, a direct tributary of the Red River.

Most of the perennial and intermittent streams in Fannin County remain free-flowing, although it is expected that many would be in a somewhat degraded condition due to more than a century of erosion and sedimentation associated with agriculture and grazing. As mentioned earlier in this EIS, much of Bois d'Arc Creek itself has been channelized, which has affected the hydrology and geomorphology of this principal stream.

From Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact the study area's streams include Bois d'Arc Creek channelization, other reservoir and pipeline projects, climate change, and the growth of Fannin County and the DFW Metroplex.

In Region C as a whole, approximately 30 existing major reservoirs have already had a significant impact on streams. The construction and operation of five additional major reservoirs within the region in the coming decades would further the extent of these modifications to stream hydrology and geomorphology.

Conclusion

The LBCR Proposed Action would directly impact 651,140 linear feet of stream on Bois d'Arc Creek and its tributaries; however, at Riverby Ranch and elsewhere, 392,265 linear feet of streams are proposed for mitigation. Therefore, there would be a net loss of 258,875 linear feet (46.6 miles) of streams. While net losses of stream length have not been quantified and evaluated for other proposed reservoirs flowing into the Red River, conversion of flowing streams to lentic reservoir conditions would still likely be substantial.

In addition to impacts on streams associated with the two proposed reservoirs, the increase in impervious surfaces associated with projected development and urbanization of an estimated 48 square miles of Fannin County to accommodate a projected 64,000 new residents by 2060 would also likely have adverse effects on streams. Flooding, erosion, and sedimentation would all increase, as would down-cutting of stream channels from larger pulses of runoff during storm events (USGS, 2014a; USGS, 2014b; Konrad, 2003). These impacts could be mitigated and reduced, but not eliminated altogether, by a variety of measures such as retention and detention basins to reduce storm runoff and peak flows.

In sum, under **Alternative 1**, by 2060 the cumulative effect of all reasonably foreseeable changes on streams in the study area would be moderately adverse. Cumulative effects on streams of **Alternative 2** would be somewhat less than those of the Proposed Action, but would also be moderately adverse.

Under the **No Action Alternative**, while the direct impacts to streams of the Proposed Action would be avoided, most of the impacts on streams associated with growth of the DFW Metroplex would likely still occur. These effects would be moderately adverse and long-term.

Water Supply Availability Downstream

The contribution of Bois d'Arc Creek to flows and discharges in the Red River downstream is relatively modest. In recent years, on average, approximately three to four percent of the total flow at the Red River's Arthur City gage originated from the Bois d'Arc Creek watershed above the proposed dam site.

The Red River flows through two Texas water planning regions between the Red River-Bois d'Arc Creek confluence and the Louisiana state line: Region C, which includes Cooke, Grayson, and Fannin Counties bordering the Red River and 13 other counties to the south and southwest; and Region D, which includes Lamar, Red River, and Bowie Counties bordering the Red River, and 16 other counties to the south.

Conclusion

By impounding and diverting water from the LBCR, **Alternative 1** and **Alternative 2** would reduce downstream flows in Bois d'Arc Creek, although no existing water rights would be affected. Minor reductions of flows and water supply in the Red River downstream of the Bois d'Arc Creek confluence would also occur, though this might amount to several percent at most and would not represent a major adverse impact. Cumulative impacts from all actions, including mining and hydraulic fracturing for shale-gas production, are not likely to cause water supply shortages.

Overall, construction of three additional Region C water supply reservoirs over the coming decades in the Red River Basin – LRH, Marvin Nichols and George Parkhouse North, all in the Sulphur River system (a watershed within the Red River Basin) – would divert more than seven times the proposed water diversions from the full-scale LBCR, removing this water from other potential future uses downstream in the Red River. The **No Action Alternative** would not contribute to cumulative downstream water supply impacts.

Water Quality

As related in Chapter 4 of this EIS (Section 4.4.2.4), high salinity, measured as TDS and specific conductance, is a major water quality issue in the headwaters of the Red River upstream of Lake Texoma, to the extent that it limits use of this water for municipal purposes. Because water in Lake Texoma is relatively salty, hydroelectric and other releases from Denison Dam largely determine salinity levels below Lake Texoma. As the Red River flows downstream from Lake Texoma, less salty water enters the river from various tributaries and dilutes Denison Dam hydropower releases, gradually reducing salinity in the river (Albright and Coffman, 2014).

From Table 5.6-1, the past, present, and reasonably foreseeable actions in Fannin County anticipated to cumulatively affect water quality downstream in Bois d'Arc Creek and the Red River include stream channelization, the growth of Fannin County and the DFW Metroplex, and the past and proposed reservoir and pipeline projects.

Conclusion

Bois d'Arc Creek is one of the Red River tributaries whose flows dilute the salinity of the Red River; thus, by diverting most of the Bois d'Arc Creek flow from the proposed LBCR, the Proposed Action would inadvertently lead to higher salinity in the Red River than in the case of the No Action Alternative. However, as discussed in Chapter 4, analysis of specific conductance data show that with the reservoir present, TDS concentrations in the Red River downstream of the Bois d'Arc Creek confluence would likely increase by less than 2 percent. This is a slight cumulative, long-term impact.

Growth and development in Fannin County would increase stress on general water quality from non-point sources, including erosion, nutrients from fertilizer use, and runoff carrying contaminants from impervious surfaces. This is not expected to present serious problems for water quality in the LBCR. Natural gas development (hydrofracking for shale gas) in the Red River Basin is increasing in the Haynesville Shale, and can impact surface and groundwater water quality from soil erosion, turbidity, and sedimentation, as well as improper disposal of generated wastewater and methane contamination (McBroom et al., 2012; Nicot and Scanlon, 2012).

Alternative 1 and **Alternative 2** would result in at most minor adverse, long-term, cumulative impacts on water quality (salinity) in the Red River. The **No Action Alternative** would avoid cumulative impacts on salinity in the Red River altogether. Overall, growth and development of Fannin County, some of which would be induced by the Proposed Action but most of which would occur regardless from the northward expansion of the DFW Metroplex, would lead to increased stress on water quality in all watercourses of the watersheds within which development occurs, in some instances potentially leading to impairment.

Groundwater

The proposed LBCR is underlain by several aquifers, some of which – like the Northern Trinity Aquifer and Woodbine Aquifer – are significant regional aquifers recognized by the State of Texas as major or minor aquifers. Other aquifers in the area are less important regionally, although they may be drawn from locally to meet a variety of needs. In addition to the Northern Trinity and Woodbine aquifers, groundwater in Fannin County is also drawn from the Austin Chalk formation, the Blossom Aquifer, and the Red River alluvial aquifer, as well as an unnamed, shallow aquifer present beneath the proposed reservoir site.

As shown in Table 5.6-1, the past, present and reasonably foreseeable actions anticipated to cumulatively impact Fannin County's aquifers and groundwater resources include Bois d'Arc Creek channelization, reservoir and pipeline projects, and the growth of Fannin County and the DFW Metroplex.

Conclusion

The proposed LBCR project is not located directly above the recharge zone for any major or minor groundwater aquifer in Texas. The hydraulic head created by the impounded water in the reservoir could potentially serve as a source of recharge water for the subsurface aquifers due to water seepage, though this scenario is judged unlikely because the uppermost zone of the Woodbine aquifer is located between 500 and 1,000 feet below ground surface in the area of the proposed Lower Bois d'Arc Creek Reservoir.

Other minor aquifers located above the Woodbine aquifer in the study area are all considered to be insignificant aquifers in Fannin County. Groundwater wells in the undefined alluvium aquifer are presumably drawing water from the Red River alluvium, which is located in the northern portion of the county adjacent to the Red River.

The increase in surface water supply to the county and wider region as a result of both proposed reservoirs (LBCR and LRH) could potentially reduce the amount of groundwater pumping in the area and reduce declining groundwater levels, thereby allowing for increased aquifer recharge, storage and production. All of the other actions listed in Table 5.6-1 would have at most localized effects on groundwater.

Therefore, neither **Alternative 1** nor **Alternative 2** are expected to result in adverse cumulative impacts on local groundwater resources and may even have a beneficial impact. The **No Action Alternative**, by not meeting projected water needs, could possibly lead to an increase in well drilling, groundwater withdrawal, and pressure on already stressed groundwater resources within the study area.

5.6.4 Biological Resources

This section consists of the assessment of cumulative effects on wetlands, vegetation and terrestrial wildlife (upland habitats), aquatic resources, and state-threatened species.

Overview of Cumulative Effects

The study area for the cumulative effects on wetlands and waters is the USGS-designated Red-Little Watershed, Hydrologic Unit Code (HUC) 111401 (see Figure 5.6-1). This HUC, which straddles the border of Texas and Oklahoma, was selected as the cumulative area of effects because the HUC represents wetlands and other related resources that share common attributes at a watershed level and is a reasonable scale for being able to disclose cumulative effects. Table 5.6-1 shows the past and reasonable foreseeable actions that when combined with the project alternatives may result in cumulative effects on water-related resources occurring within the HUC. Construction or operation of these projects could result in either direct or indirect effects on the water-related resources located in HUC 111401.

The study area for the cumulative effects on vegetation and terrestrial wildlife consists of the upland areas within the Bois d' Arc Creek watershed. The watershed was selected as the cumulative study area because the vegetation and terrestrial wildlife habitats within the study area share common attributes. The past and reasonably foreseeable actions considered along with the project alternatives are identified in Table 5.6-1.

The study area for the cumulative effects on aquatic resources consists of Bois d' Arc Creek and tributaries. These watercourses were selected as the study area because the aquatic resources share common attributes and changes in the environmental conditions within the watershed attributable to the project alternatives and past and reasonably foreseeable actions can be more accurately determined. As indicated in the discussion of water resources above, impacts on water flow or quality below the confluence of the Bois d'Arc Creek with the Red River are not expected. The past and reasonably foreseeable actions considered along with the project alternatives are identified in Table 5.6-1.

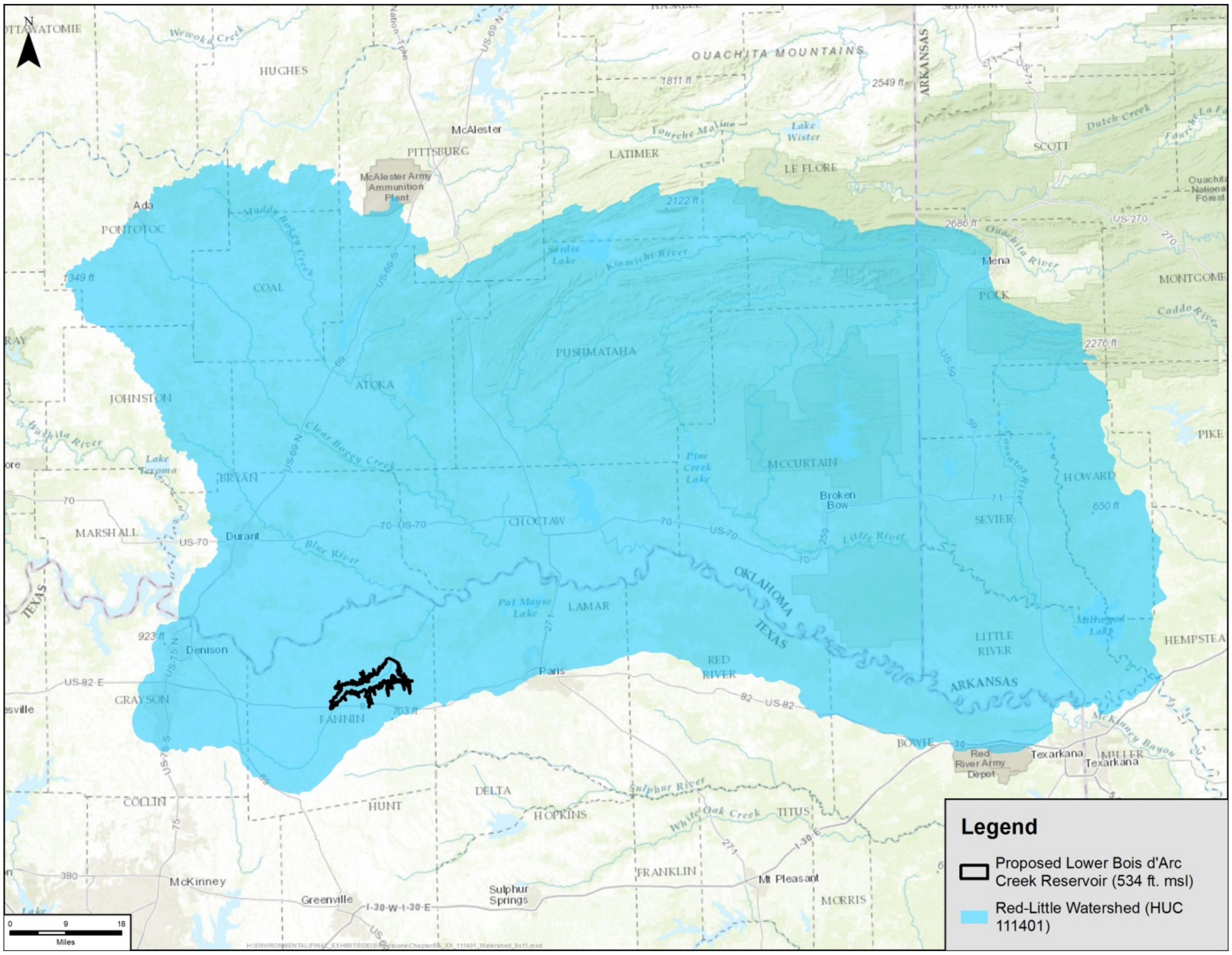

Figure 5.6-1. HUC 111401, Study Area for Cumulative Effects on Wetlands and Waters

The study area for the cumulative effects on state-listed species consists of the Bois d' Arc Creek watershed. This area was selected as the study area because the type, status, and suitable habitat of these species within the watershed can be readily identified and the changes in the environmental conditions within the watershed attributable to the project alternatives and past and reasonably foreseeable actions can be more accurately determined. The past and reasonably foreseeable actions considered along with the project alternatives are identified in Table 5.6-1.

If either Alternative 1 or Alternative 2 is implemented, there would be a short-term net loss in species abundance and biodiversity within the Bois d'Arc Creek watershed and Fannin County as a result of conversion of bottomland hardwood forest, streams, and riparian habitats and wildlife dependent on these habitats relocating.

In several decades however, after mitigation, no net long-term, adverse cumulative impacts on biological resources are anticipated under Alternative 1 or Alternative 2. The landscape in Fannin County has been heavily altered over more than a century of agricultural and residential development, so natural plant and animal communities that are left tend to be fragmented and heavily modified from those of the pre-settlement era. Flora and fauna that persist even in the face of growing residential and other development from projected population growth are those species and associations that are the most adaptable. Overall, in several decades, the presence of a large corridor of protected, largely connected open space and wildlife habitat would be highly beneficial for Fannin County's enduring biological resources. This corridor would start from the Red River/Bois d'Arc Creek confluence and proceed upstream for many miles; it would include Riverby Ranch, Caddo Grasslands, protected zones around LBCR, and habitats that have been protected and restored upstream for mitigation purposes (Figure 5.6-2).

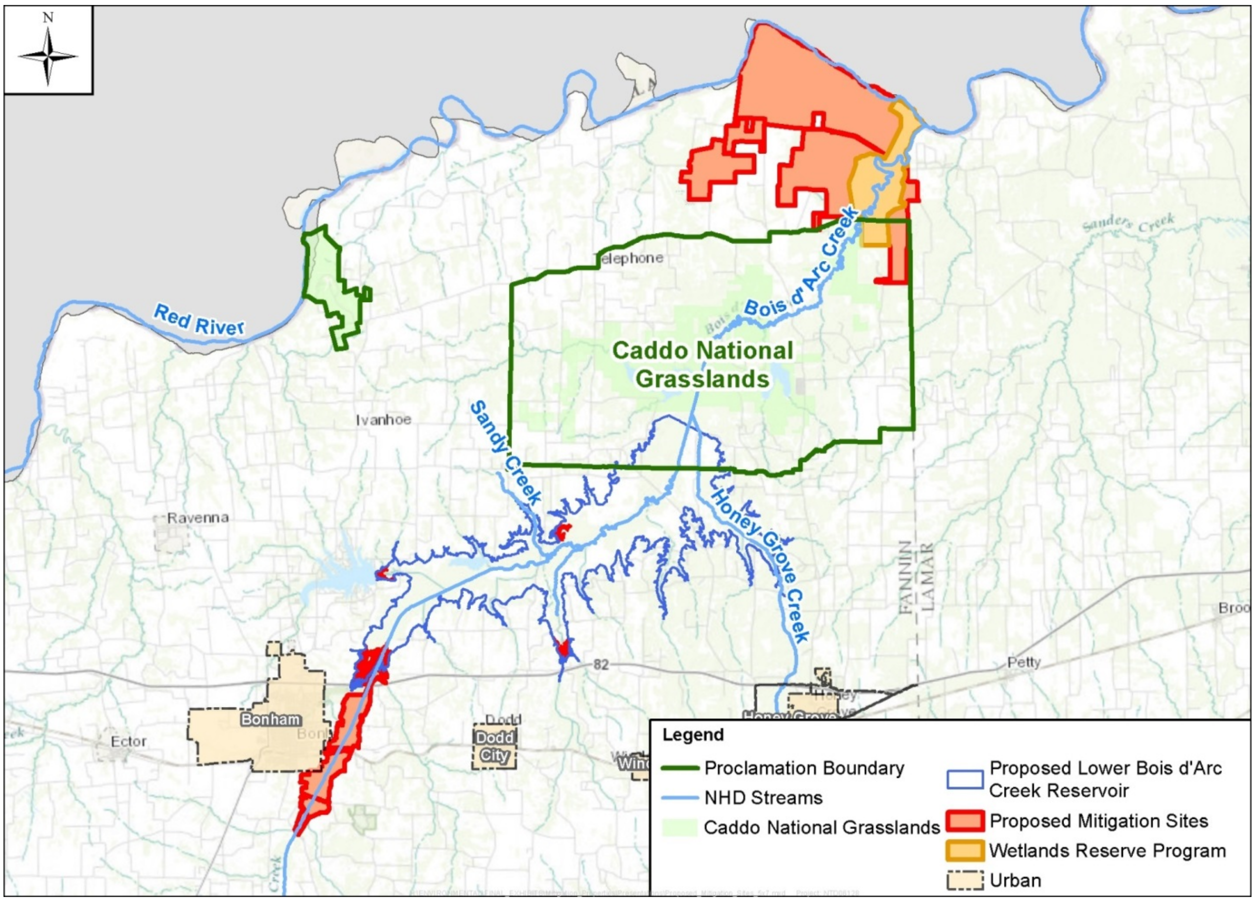

Figure 5.6-2. Potential Future Corridor of Protected and Connected Wildlife and Aquatic Habitats Along Bois d'Arc Creek

Statewide, the area of forested river and creek floodplain vegetation (i.e., bottomland hardwood forests and riparian vegetation) is estimated to have decreased from an original 16 million acres to 6 million acres at present (Texas Water Matters, 2012) as a result of dams/reservoirs and all other causes (e.g., clearing for agricultural purposes, channelization, urbanization, etc.). However, following the successful implementation of mitigation at the Riverby Ranch and other compensatory mitigation sites, neither Alternative 1 nor Alternative 2 would contribute to further net loss in the region or the state.

Impacts of Alternatives 1 and 2 on aquatic wildlife within the reservoir footprint would be adverse and beneficial, short-term and long-term, and of moderate severity. Within Bois d'Arc Creek downstream of the reservoir, long-term effects of the LBCR on aquatic wildlife are expected to be largely beneficial, due to the ability of water managers to control flows throughout the year and provide for continuous flow in the late summer months when (presently) there is often none.

Conclusion

Chapter 4 concluded that, overall, the impacts of Alternatives 1 and 2 on upland or terrestrial vegetation would be slightly adverse over the long term. However, with mitigation measures implemented, these impacts would be reduced. Once the reservoir habitats are established and stabilized, and Riverby Ranch and other mitigation site habitats have been fully developed, benefits for terrestrial and aquatic wildlife overall would likely have increased sufficiently as to offset and likely surpass the initial adverse effects, provided the mitigation goals and objectives set forth in the Revised Mitigation Plan (Appendix C) are achieved. Once proposed mitigation is taken into account, overall impacts to wildlife from Alternatives 1 and 2 would be both adverse and beneficial, and slight. No adverse effects to federally listed species are anticipated.

The cumulative impacts of all other reasonably foreseeable actions, including expected growth and development in the watershed and in Fannin County over the coming half century, would generally be negative for native vegetation and wildlife, as roughly 20,000 acres of rural lands and habitats are converted into developed areas. Certain species of vertebrates that are well-adapted to urban and suburban habitat settings – such as crows, robins, mockingbirds, cardinals, Canada geese, raccoons, squirrels, red foxes, and certain rodent and bat species – will not only survive but probably increase in number as human population density increases in the county. However, most species that are now common in the mix of farmland and woodlands that prevail across most of the county will probably experience population decreases or extirpation in the future. Thus, a net decrease in biodiversity is anticipated. An overall increase in the cumulative number of **invasive species** of both plants and animals is expected, as well as an increase in challenges and costs they impose.

Overall net cumulative effects on all biological resources from all reasonably foreseeable actions, including the Proposed Action, are expected to be adverse.

Wetlands and Waters

For analysis of cumulative impacts on waters of the United States, including wetlands, the study area is HUC 111401. However, it is worth starting with the State of Texas because data on wetlands are often compiled and aggregated state by state, but also because the values and functions of wetlands, especially as habitat for wildlife and migratory birds, are best considered on more extensive and ecosystem scales than the smaller scales of single watersheds or counties.

The USGS estimates that from the time of settlement through the 1980s, Texas lost approximately 52 percent of its original wetlands acreage. Wetlands comprise about 7.6 million acres of the state, or 4.4 percent of its area. The most widespread wetlands in the state are the bottomland hardwood forests and swamps of East Texas; the marshes, swamps, and tidal flats of the coast; and the playa lakes of the High Plains. The main causes of wetland losses are agricultural conversions, overgrazing, urbanization, channelization, water-table declines, and construction of navigation canals (Yuhas, 2013).

Statewide, as a result of dams/reservoirs and all other causes such as clearing for agricultural purposes, channelization, and urbanization, the area of forested river and creek floodplain vegetation (i.e., bottomland hardwood forests, forested wetlands, and riparian vegetation) in Texas is estimated to have decreased from an original 16 million acres to six million acres at present (Texas Water Matters, 2012). There are no comparable estimates for HUC 111401 in particular; however, the reduction in wetland area from pre-settlement times is likely to be considerable. This is due to the widespread presence within the HUC of hundreds of farms and ranches, many towns and roads, as well as several other large USACE reservoirs in Texas and Oklahoma, including the 5,940-acre Pat Mayse Lake (12 miles north of Paris, TX in Lamar County); 13,250-acre Hugo Lake (Choctaw County, OK); 3,750-acre Pine Creek Lake (McCurtain and Pushmataha counties, OK); 14,000-acre Broken Bow Lake (McCurtain County, OK) (Figure 5.6-3); and 14,360-acre Sardis Lake (Pushmataha and Latimer counties, OK).

Figure 5.6-3. Broken Bow Dam on the Broken Bow Reservoir on the Mountain Fork River in McCurtain County, Oklahoma, Built by the USACE in the 1960s

From Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact the study area's waters and wetlands include Bois d'Arc Creek channelization, other reservoir and pipeline projects, climate change, and the growth of Fannin and other counties and the DFW Metroplex. Specific projects and actions in the Oklahoma portion of the HUC (the majority of it) would be far too many to enumerate; however, population growth and associated development, agriculture, forestry, and other urban and rural activities could potentially affect wetlands generally and bottomland hardwoods in particular over the coming decades.

Conclusion

Total direct impacts to wetlands (forested, emergent, and scrub-shrub) and waters of the U.S. (streams and open waters) from the dam and reservoir would be 5,952 acres and 3,755 acres for **Alternatives 1 and 2**, respectively. The compensatory mitigation plan (see Appendix C) for Alternative 1 or Alternative 2 should result in no net loss of wetlands and should compensate for the loss of other waters of the United States. There are no other foreseeable reservoir projects within the HUC at this time.

Under both **Alternatives 1 and 2** – with mitigation – and the **No Action Alternative**, little or no contribution to cumulative adverse impacts on waters and wetlands in the HUC as a whole is anticipated. There would be no net loss, in keeping with national policy.

Aquatic Biota

The study area for the analysis of cumulative impacts on aquatic life in this EIS is Bois d'Arc Creek and its tributaries, from the upper end of the proposed reservoir site to its confluence with the Red River. The Index of Biological Integrity (IBI) is a measure of fish communities that includes components of species and trophic composition, abundance and condition. In surveys (Appendix M), IBI scores for fish community structure in Bois d'Arc Creek were Intermediate to High, with scores that increased longitudinally within the mainstem from upstream to downstream. Most fish species were generalists rather than fluvial specialists. The overall biological integrity of Bois d'Arc Creek's macroinvertebrate community was at the higher end of the intermediate range.

The effects of dam and reservoir construction on aquatic life in the reservoir itself and downstream would be both adverse and beneficial. Within the reservoir footprint, stream habitat would be inundated by the proposed reservoir and converted to lacustrine (lake-like) habitat. Diversity and relative abundance of aquatic fauna (both vertebrates and invertebrates) within the reaches that would be permanently flooded are expected to change as a result of the reservoir, which would provide a permanent water source of variable depth in place of what is now a permanent, relatively shallow stream with little or no flow during later summer months and with intermittent tributaries. The reservoir would create both shallow and deep water lentic (still water) habitat for a variety of aquatic species. Aquatic species more adapted to lacustrine or lentic environments would benefit while those with a preference for stream (lotic or flowing water) habitats would be disadvantaged. The abundance of other species that are more generalist or versatile may be little changed.

The fish species composition after inundation is expected to shift towards more pool-associated species, largely composed of sunfish (Centrarchids), temperate bass (Moronidae), catfish (Ictalurids), and suckers (Catostomids). Fish species that are found only in rivers and streams would disappear from the reaches of Bois d'Arc Creek and its tributaries that were impounded. Adverse effects to the existing benthic macroinvertebrate community would also occur due to construction and inundation of the proposed dam and reservoir.

Both adverse and beneficial effects would be anticipated for aquatic life downstream of the proposed dam. The flow regime downstream of a reservoir can be substantially different than before the reservoir was built. The flow regime in the draft water right permit would maintain flowing water in the creek channel, provide for connectivity between pools, maintain existing aquatic habitat and communities, and protect water quality downstream.

Over the long term, the change in flow regime downstream from the proposed dam could negatively affect those fish species with narrower habitat requirements. These species use temperature or flow for reproductive cues, are substrate-specific spawners, and depend on higher flows for egg dispersal. However, because most fish species collected from Bois d'Arc Creek during the Instream Flow Study are habitat generalists, no adverse effects are expected on downstream fish communities and biodiversity as long as there is water flowing in the creek. The proposed flow regime for Bois d'Arc Creek downstream of the proposed dam would provide a sound ecological environment that would support the existing and future aquatic ecosystem environment. The macroinvertebrate communities downstream of the impoundment should not change greatly, as long as adequate flows are maintained.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact aquatic life in Bois d'Arc Creek and tributaries include channelization, reservoir and pipeline projects within the Bois d'Arc Creek watershed, climate change, and the growth of Fannin County and the DFW Metroplex.

Conclusion

Alternative 1 and **Alternative 2** would contribute both adverse and beneficial cumulative impacts to the aquatic life of Bois d'Arc Creek, both within the segment that would be impounded (reservoir footprint) and within the segment downstream of the proposed dam. Overall, these net, long-term changes downstream would probably be more beneficial than adverse due to the ecological conditions that would likely result from the flow regime and releases outlined in the water right permit (included as Appendix F). Other actions within the Bois d'Arc Creek watershed in Fannin County, primarily the increase in non-point sources of pollutants and impervious surfaces associated with the development necessary to accommodate 64,000 new residents by 2060, would tend to have negative or adverse implications cumulatively for the diversity and abundance of aquatic life, both fish and benthic macroinvertebrates in Bois d'Arc Creek. While the **No Action Alternative** would avoid direct adverse and beneficial cumulative impacts resulting from the Proposed Action, it would not avoid adverse impacts from the anticipated increase in development within the watershed.

Upland Vegetation

The primary study area for the analysis of cumulative impacts on vegetation is Fannin County and all of Region C. The county is located in the Northern Post Oak Savannah Ecoregion, characterized by native bunch grasses and forbs with scattered clumps of trees, primarily post oak. At present, improved pastures, rangelands, and croplands make up the majority of this Ecoregion. Historically, fires and burns in the northern part of the East Central Texas Plains maintained grassy openings, but with the absence of fires, woody plants have taken over many of these grassy openings. Mixed native and introduced grasses and forbs on grassland sites or mixed herbaceous communities have resulted from the recent clearing of woody vegetation.

The proposed LBCR site is located on 17,068 acres of bottomland and adjacent upland habitat along Bois d'Arc Creek. The vegetation and habitats on this site are described in detail in Section 3.4. The two most abundant vegetation communities occurring on the project site are bottomland hardwoods/forested wetlands and grasslands/old fields. If construction of the LBCR were to proceed, the entire acreage within the project site would be converted to open water, fringe wetlands, mudflats, and the dam and appurtenant facilities, as described in Section 4.6. Additional minor effects on vegetation would be associated with connected actions.

Unavoidable impacts to both bottomlands/wetland and upland vegetation from the LBCR would be mitigated at the Riverby Ranch mitigation site as well as around the perimeter of the completed reservoir. Impacts and mitigation are quantified in a series of studies, the results of which are shown in Section 4-6. Once compensatory mitigation has been carried out, most but not all net impacts would be eliminated. There would still be a net deficit of Habitat Units for upland deciduous forest, grassland/old field, and shrubland; however, these are not considered sensitive or rare habitats in Texas. There would be a surplus of riparian woodland /bottomland hardwood, emergent wetland, and shrub wetland (as measured by net change in Habitat Units).

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact Fannin County and Region C vegetation include Bois d'Arc Creek channelization, all of the reservoir and pipeline projects, and the growth of Fannin County and the DFW Metroplex.

Conclusion

Alternative 1 and **Alternative 2** would have a long-term beneficial effect on some types of vegetation, particularly those associated with wetlands and waters of the U.S., and a minor, long-term, adverse effect on upland vegetation types. Cumulatively, as Fannin County's developed surface area expands to accommodate a population expected to more than double by the year 2060, all vegetation communities, particularly upland sites more amenable to building and not protected by regulations to conserve wetlands, are likely to decline. Similar trends would be expected in Region C as a whole. The proposed LBCR would not contribute to the growing cumulative pressure on wetlands-associated vegetation; however, it would contribute to a minor extent to the cumulative decline in upland vegetation associated with woodlands, ranching, and agriculture. The **No Action Alternative** would not contribute to any cumulative change in either wetland or upland vegetation; however, under this scenario there would still be a net decrease in natural vegetation in Fannin County and Region C, especially upland vegetation, associated with anticipated population growth and development.

Upland Wildlife

The primary study area for the analysis of cumulative impacts on terrestrial wildlife is upland areas within Bois d'Arc Creek watershed. Fannin County is located within the Texan Biotic Province. While several larger vertebrate species that once would have occurred here were extirpated long ago, upland and wetland habitats in this province, Fannin County, and the wider region as a whole, still support a wide variety of terrestrial vertebrates (mammals, birds, amphibians, reptiles) and invertebrates. Included are herbivores, omnivores, carnivores, insectivores. The reservoir site and surrounding habitats are characterized by wildlife typical to this part of Texas, including white-tailed deer, squirrels, raccoons, wild turkey, raptors, colonial waterbirds, songbirds, and other migratory birds. Common reptiles and amphibians are especially abundant in wetland habitats.

Adverse effects from the proposed LBCR on wildlife would be expected to be moderate in severity and long-term. During construction, terrestrial habitats at the dam site and within the cleared areas would be removed. Eventually the areas within the footprint of the reservoir would be converted to open water aquatic habitats.

Taking into account the proposed mitigation plan, overall impacts to wildlife from the Proposed Action would be adverse and beneficial as well as short-term and long-term. Over the long run, once the reservoir habitats are established and stabilized, and once Riverby Ranch mitigation site habitats have been fully developed, the benefits for wildlife overall would likely have developed sufficiently as to offset and perhaps surpass the initial adverse effects, provided that planned mitigation goals and objectives come to fruition.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact terrestrial wildlife include Bois d'Arc Creek channelization, all of the reservoir and pipeline projects, climate change, and the growth of Fannin County and the DFW Metroplex.

Conclusion

Alternative 1 and **Alternative 2** would have medium-term adverse effects on existing wildlife and wildlife habitat by converting those existing habitats into another habitat type altogether (mostly open water). However, over the long term, the immediate adverse effects of the LBCR on wildlife in upland areas of the watershed would be offset by wildlife habitat restoration and improvement at the Riverby Ranch and other mitigation sites. Thus, the long-term net cumulative effect of the LBCR may be beneficial. In spite of these positive gains however, by 2060 there would likely be less terrestrial wildlife overall (both less abundance and less species diversity) within upland areas of the watershed than at present due to the need to develop existing wildlife-supporting habitats to support the expected addition of 64,000 more residents within Fannin County. The **No Action Alternative** would not contribute to adverse cumulative impacts on wildlife associated with growth and development; however, it would not prevent this growth and development from occurring.

State Threatened Species

The study area for the analysis of cumulative impacts on threatened and endangered species in this EIS is the Bois d'Arc Creek watershed (no federally-listed species are present). In terms of state-listed species, the Texas state-threatened blackside darter, blue sucker, creek chubsucker, and timber/canebrake rattlesnake may occur in the vicinity of the project and its connected actions. Several state-listed species of mussels may also be present. Long-term adverse impacts to the Texas state threatened blackside darter, blue sucker, creek chubsucker, timber/canebrake rattlesnake and one or more listed mussel species are possible due to the construction and inundation of the proposed dam and reservoir. Overall, potential adverse effects to all these species would be moderate in severity.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact threatened and endangered species include Bois d'Arc Creek channelization, the reservoir and pipeline projects, climate change, and the growth of Fannin County and the DFW Metroplex.

Conclusion

Alternative 1 and **Alternative 2** would not contribute to cumulative adverse impacts on federally threatened and endangered species in Fannin County. However, the dam, reservoir, and connected actions might adversely affect four state-listed species that could be present in the project vicinity. Other projects and general development expected within the county to accommodate the needs of 64,000 projected new residents by 2060 would also directly or indirectly cause adverse effects on these state-threatened species. Thus, overall expected cumulative impacts on state-listed species documented within Fannin County would be adverse and long-term. The **No Action Alternative** would not contribute to cumulative adverse impacts on state threatened and endangered species in Fannin County. However, cumulative adverse impacts could occur on these species due to expected growth and development of Fannin County.

Invasive Species

Ground disturbance and vegetation removal associated with the construction work of both **Alternative 1** and **Alternative 2** would increase opportunities for the spread of invasive species in the Bois d'Arc Creek watershed. Lake-based recreation in a new reservoir on Bois d'Arc Creek would facilitate and be adversely affected by the spread of aquatic invasive species. As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively affect invasive species include Bois d'Arc Creek channelization, reservoir and pipeline projects, climate change, and the growth of Fannin County and the DFW Metroplex. The **No Action Alternative** would neither contribute to nor impede the spread of invasive species within the study area.

5.6.5 Air Quality

The study area for cumulative effects on air quality and climate change is the 19-county Air Quality Control Region (AQRC) 215. The cumulative assessment considers the construction and operation-related emission generated by the project alternatives in combination with the other actions identified in Table 5.6-1. AQCR 215 was selected as the area of effect for the cumulative impact analysis as the project alternatives are located within the AQCR and because air quality constituents and emissions sources are monitored, reported, and managed at the AQCR level.

According to EPA, Fannin County air quality is in attainment for all criteria pollutants. However, portions of the region are not in attainment for ozone (O_3).

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions in Fannin County anticipated to cumulatively affect air quality within the ROI include reservoir and pipeline projects, the

Center for Workplace Learning, North Texas Regional Airport, climate change, and the growth of Fannin County and the DFW Metroplex.

Dam/reservoir projects and pipeline construction and maintenance work would entail short-term, localized impacts to air quality during construction from tailpipe emissions of construction equipment, workers' vehicles, and fugitive dust. There would be short-term increases in criteria pollutants such as particulate matter, VOCs, NOx, and perhaps ozone. Other reasonably foreseeable projects would also result in similar types of emissions during construction. None of these projects, individually or in conjunction with each other, are likely to shift Fannin County or the ROI from attainment to non-attainment status even if occurring simultaneously.

Over the long term, both **Alternative 1** and **Alternative 2** would contribute small incremental amounts of air pollution if they become popular recreation destinations, both from tailpipe emissions of vehicles used by visitors to access these attractions, as well as from the use of outboard motors on boats. However, these would likely be negligible in a regional context. As the DFW Metroplex grows towards the north, this will have a much stronger influence on air quality trends. It will tend to degrade air quality, especially by increasing ozone concentrations, within Fannin County and the ROI as a whole. This would occur as a result of increasing vehicular traffic associated with a projected 64,000 new residents by 2060, and other emissions sources, such as fossil fuel fired power plants and industrial and manufacturing facilities. There would also be a large increase in the sources of VOCs, NOx, particulates emissions, and perhaps HAPs. However, at the same time, ongoing improvements in air pollution control technology both with regard to vehicular and power plant emissions could offset or even slightly reverse this trend, in spite of the increasing number of pollutant sources.

Conclusion

Chapter 4 concluded that overall, the impacts on air quality from **Alternative 1** and **Alternative 2** would be adverse and generally of slight severity, and of both short-term (construction) and long-term (operation) duration.

As the DFW Metroplex expands into Fannin County over the next 50 years, the increase in the number of vehicles and vehicle-miles-traveled (VMT) will increase emissions of criteria air pollutants, in particular VOCs and NOx, which would tend to degrade air quality within the county. However, continuing improvements in fuel efficiency (CAFE) standards and ever more stringent tailpipe emissions requirements would likely offset or even slightly reverse this trend. Overall, while there would likely be adverse effects on air quality, that is, lower average air quality in the future, the effects would likely not be significant, and the area is likely to stay in attainment for all criteria air pollutants.

Alternative 1 and **Alternative 2** would both contribute directly to these cumulative impacts only to a negligible or minor degree. The recreational features of the LBCR and the water supply it would provide could be an indirect cause of some of these cumulative impacts on air quality. The **No Action Alternative** would not directly contribute to any cumulative impacts on air quality in the ROI, but many of these same impacts would probably still occur due to regional growth.

5.6.6 Acoustic Environment (Noise)

The study area for cumulative effects on the acoustic environment was determined to be the area at and within the vicinity of noise generated by the alternatives in combination with noise generated by the other actions shown in Table 5.6-1. Because of the rural nature of the site under Alternatives 1 and 2, the assessment of cumulative effects included growth in Fannin County and the DFW Metroplex Area.

Neither Fannin County nor the State of Texas have noise ordinances. The City of Bonham has a nuisance noise ordinance that addresses common noises such as car radios, but not construction noise. According to Section 3.6.3, existing sources of noise near the proposed sites include typical noise sources associated with ranching and activities associated with Caddo National Grasslands and surrounding recreation areas including: rural roadway traffic, high-altitude aircraft overflights, farm equipment, and natural noises such as the rustling of leaves and bird vocalizations. In general, noise levels are typical of a rural setting, and existing noise is predominantly due to secondary roadways. In small towns such as Bonham and Honey Grove, as would be expected, higher existing ambient noise levels prevail.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions in Fannin County anticipated to cumulatively affect noise levels within Fannin County include the growth of Fannin County and the DFW Metroplex. Fannin County and the study area will become a noisier place in the future primarily as a result of projected growth and development and the associated increased presence and use of noise-generating machinery, from autos and light trucks to air conditioners, lawn mowers, and generators.

Conclusion

Chapter 4 concluded that Alternative 1 and Alternative 2 would have short-term and long-term slight effects on the acoustic environment. While most existing sources of noise within the reservoir footprint such as agricultural activities, automobile traffic, and lawn maintenance equipment would be eliminated, there is likely to be noise associated with long-term recreational and real estate development at and in the vicinity of the reservoir. However, these predicted increases in noise would not create areas of incompatible land use or violate any Federal, state, or local noise ordinance.

Overall, because of a substantial increase in the number of noise sources associated with projected population growth and development, Fannin County will likely be a noisier place in 50 years. **Alternative 1** and **Alternative 2** would contribute both directly and indirectly to this cumulative increase in noise levels; however, these impacts and noise levels would not be significantly adverse. The **No Action Alternative** would not contribute to the expected cumulative increase in future ambient noise levels in Fannin County.

5.6.7 Recreation

The study area for cumulative effects on recreation includes other recreation sites within Fannin, Collin, Hunt, Lamar, Grayson, and Delta Counties. This study area was based on the willingness of recreationists to travel to similar reservoirs as well as actions within the region that could result in loss of recreation opportunities similar to those that currently occur within the footprint of the reservoir site. The actions considered in cumulative assessment of effects on recreation resources are shown in Table 5.6-1.

The area of cumulative effect for recreation is Fannin County and the surrounding counties (Collin, Hunt, Lamar, Grayson, and Delta). This is considered the distance over which daily users of any recreation facilities developed at a future lake under Alternatives 1 and 2 would be willing to travel.

Recreation land within the reservoir footprint and pipeline route(s) provides non-commercial opportunities for recreation on individual private lands. Private landowners and their guests access the Bois d'Arc Creek for recreation activities such as boating, wildlife observation including bird watching, fishing, hunting (for deer, feral hogs, waterfowl, and dove), trapping, and enjoyment of scenic natural beauty. Another private recreation area in the immediate vicinity of the proposed reservoir is the Legacy Ridge Country Club which includes a clubhouse, residences and developments under construction and a 72-par golf course which winds into the wetlands of the Bois d'Arc Creek.

The six-county ROI contains a number of lakes and parks that provide outdoor recreation experiences including the Caddo National Grasslands, managed by the U.S. Forest Service.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact recreation within the ROI include Bois d'Arc Creek channelization, existing reservoirs, the two proposed Fannin County reservoir projects (LBCR and LRH), and the growth of Fannin County and the DFW Metroplex.

Long-term cumulative impacts would likely occur because of the LBCR and LRH reservoirs operating in relatively close proximity, with both providing recreational opportunities such as fishing and boating. At this juncture it is impossible to predict whether they are likely to compete with or complement one another. In general, even if the two lakes compete with each other for recreational users at first, subsequent increases in demand for lake-based outdoor recreation that occurs as population in the region grows over time could eventually reduce or eliminate any competition. At some point, the proximity of the two facilities could become advantageous as a draw to visitors.

Conclusion

Chapter 4 concluded that recreational opportunities from **Alternative 1** and **Alternative 2** are likely to be moderately beneficial and long term. As the population and level of development in Fannin County increase, demand for recreational opportunities would be expected to increase. While the county's fishing and boating and other water recreation-related opportunities would be increased by the presence of two new lakes (LBCR and LRH), it is likely that hunting opportunities in Fannin County would decrease, because hunting is not generally compatible with higher human population densities due to safety concerns, and possibly, less game. Overall cumulative impacts on recreation from all actions would be generally beneficial, and the LBCR would contribute to these. A potential downside is that with 64,000 projected additional residents in Fannin County, and similar demographic trends in some of the other surrounding counties within the ROI (population increases from one million to 1.9 million in Collin County [2020 to 2060]; from 135,000 to 251,000 in Grayson County, etc.), some outdoor recreation sites and facilities could potentially face overcrowding, which would diminish the visitor experience. The **No Action Alternative** would contribute neither the adverse nor the beneficial, long-term and cumulative effects described above.

5.6.8 Visual Resources

The area of cumulative effect for visual resources is the viewshed at and in the vicinity of the project alternatives. The focus of this assessment is to identify the combined effects on the viewshed as a result of constructing the project alternatives in combination with projects constructed or planned in the vicinity. The other projects considered in this analysis are shown in Table 5.6-1.

Visual resource ratings for the entire proposed reservoir location range from moderate to least visual quality. The higher values are due to the presence of water at the creek site, as the scenic quality inventory ranks areas with water as visually more appealing.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact visual resources within the ROI include Bois d'Arc Creek channelization, the proposed LBCR, and the growth of Fannin County and the DFW Metroplex.

LBCR would cause a large change to the existing visual appearance of a part of Fannin County, which is now largely rural and agricultural. Over time, as the population of the county increases, its rural appearance would gradually fade as it becomes more developed and populous. In this scenario, the open space and "natural areas" represented by both lakes and their adjacent areas could become a valued asset of the county.

Conclusion

Chapter 4 concluded that, due to their size and salience, **Alternative 1** and **Alternative 2** (in particular, dam and reservoir construction and operation) would have a major, long-term impact on visual resources; however, whether this impact would be regarded as positive or negative, that is, whether it is a beneficial or adverse impact, would depend on the observer. Some individuals would regard the permanent elimination of gently rolling pastoral scenery along Bois d'Arc Creek as a loss outweighing any gain provided by a lake setting. Other individuals would regard the permanent addition of a lake to the landscape as an aesthetic asset to the community. Many members of the public are expected to appreciate both the aesthetic loss and the aesthetic gain.

As Fannin County's population grows and its developed land increases at the expense of rural countryside, cumulative effects on visual resources would be expected to be generally negative for most observers. However, in the more developed setting in the future, the LBCR and the open space surrounding it would represent a positive visual element, counteracting the overall degradation of visual resources that is typically associated with urbanization and loss of open space.

The **No Action Alternative** would not change the appearance of Bois d'Arc Creek or the surrounding area. Cumulatively, over the long run, by not developing a lake with a protected green perimeter, this alternative may deny future residents a positive visual element in a county that would be both more populous and more developed.

5.6.9 Utilities

The study area for the cumulative effects of utilities consists of Fannin County. The county was selected as the study area because the utility services affected by the project alternatives are local in nature and not part of a broader regional utility infrastructure. Utility services could be further adversely affected by the actions shown in Table 5.6-1.

Overhead power lines run within the vicinity of the proposed Lower Bois d'Arc Creek reservoir footprint. Utility corridors crisscross Fannin County in a number of locations in a manner reminiscent of most other counties in the United States.

As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively affect utilities within the ROI include the two proposed reservoir projects (LBCR and LRH), the Center for Workplace Learning, pipeline projects, climate change, and the growth of Fannin County and the DFW Metroplex. As Fannin County grows considerably more populous in the coming decades, the requisite utilities needed to accommodate this grow will proceed apace. A warmer climate may increase consumer demand for water and electricity (for air conditioning) over and above anticipated population growth.

Conclusion

No cumulative adverse impacts are expected from **Alternative 1, Alternative 2,** or the **No Action Alternative** because, as the county population grows, there will be more utilities and utility corridors of all types.

5.6.10 Transportation

The study area for the cumulative transportation effects assessment consists of Fannin County. The county was selected as the study area because the roadways affected by the project are local transportation routes and not part of a broader region or statewide transportation network. The capacity and condition of the local roadways could be further adversely affected by the actions shown in Table 5.6-1.

The proposed reservoir footprint is traversed by a number of roads and bridges and many of these would be impacted by the LBCR, especially FM 1396. As shown in Table 5.6-1, the past, present, and reasonably foreseeable actions anticipated to cumulatively impact transportation within the study area include Bois d'Arc Creek channelization, past reservoir projects in the county, the two proposed reservoir projects (LBCR and LRH), and the growth of Fannin County and the DFW Metroplex.

If the LBCR and LRH dam/reservoir construction projects were to occur simultaneously, which appears increasingly unlikely, there would be an additive, short-term adverse effect on transportation facilities and traffic. These are unlikely to be considered significant. With population growth and correspondingly increased vehicle miles traveled in the future, Fannin County will need to add capacity to its ground transportation network as do all areas in the process of growth and development.

Conclusion

Chapter 4 concluded that **Alternative 1** and **Alternative 2** would have short-term, moderate adverse effects on transportation and traffic, due to the number and length of roads requiring temporary or permanent closure and relocation. Short-term and long-term effects to Fannin County's road network would be mixed. After completing the proposed dam, the reservoir would close some secondary roadways, and motorists would be rerouted in some fashion. If construction of LBCR and LRH overlapped, short-term effects on traffic and transportation corridors could be exacerbated.

Although these effects would be adverse, there would be an overall net benefit to roadway infrastructure for roads not closed by the LBCR, such as a new highway and bridge (rerouting of FM 1396 and extension of FM 897) over the new reservoir. Effects would be of slight severity and last for many decades. Given the mitigation measures proposed to ameliorate these impacts, the long-term effects of the LBCR on transportation would be moderate.

Anticipated growth and development in Fannin County in the coming decades would bring about substantial cumulative effects in the county's road transportation network and traffic situation. Whether traffic congestion will be a significant problem in the future is impossible to predict due to the number of variables. What is certain is that there will be much more traffic than at present. The contribution of the proposed reservoirs to these cumulative effects related to transportation would be minimal.

The **No Action Alternative** would have no direct or indirect effects on transportation in Fannin County; however, many of the predicted cumulative effects related to increase traffic and a need for greater transportation infrastructure able to accommodate much larger traffic volumes will occur regardless.

5.6.11 Socioeconomics

The study area or region of influence for the cumulative socioeconomic effects assessment consists of Fannin, Collin, Hunt, Lamar, Grayson, and Delta counties. This six-county study area was selected because the social and economic effects of constructing and operating the project alternatives are expected to occur outside of the immediate vicinity of the project as well as outside of Fannin County alone. In addition, the county-level assessment method was selected as socioeconomic data is typically reported at that level. The other actions occurring within the study area that may contribute to social and economic effects are shown in Table 5.6-1.

Construction Phase

If both the LBCR and LRH reservoirs are permitted, the construction timeframe of both reservoirs could overlap, although this appears less and less likely. In the case of simultaneous construction, the cost of materials, especially fuel and cement, could increase. However, this is considered unlikely because the amount of fuel and cement expected for both projects would not be considered very large relative to overall consumption in the region (LBCR would be an earthen dam with cement used primarily for the spillway). Future purchase agreements with construction contractors would lock the price of materials into place. A single contractor bidding on both projects, or two contractors bidding together on both projects, could drive down costs and increase efficiency. In this latter scenario, cost synergy – the opportunity of a combined corporate entity to reduce or eliminate expenses associated with running a business – would likely occur. Cost synergies are generally realized through economies of scale, whereby duplicate costs are eliminated.

The simultaneous construction projects would likely have subtractive effects to the overall economic activity figures of each project; and could simultaneously indicate a bigger indirect and induced impact. Water from LRH is estimated to generate more than $18 billion in economic benefits to Denton, Collin, and Dallas counties. The lake would also generate $148 million in economic benefits for the Fannin County area (UTRWD, 2005b). These figures (as well as the LBCR figures) likely double-count job creation and/or overstate potential economic impacts.

Property Taxes

Both NTMWD and UTRWD would make payments to Fannin County by agreement and in lieu of taxes. These payments would begin during the pre-construction period to offset the reduced tax rolls (and therefore tax revenue) that would be associated with the two proposed reservoirs. Payments would not cease until tax rolls returned to their pre-project level(s). The large amount of land that would be acquired for the two impoundment areas would otherwise create a significant loss in property tax revenue. With payments extending beyond both construction periods, no such losses would occur (McCarthy, 2017).

Operation Phase

Recreational Users and Revenue

Both proposed reservoirs are planned to provide recreational opportunities such as boating and fishing.

The Texoma Council of Government (TCOG) 2012 *Texoma Comprehensive Economic Development Strateg*y affirmed the goal of promoting Lake Texoma as a tourism destination as well as supporting the region's associated tourist destinations such as historic and heritage sites, state parks, and refuges. According to the USACE, Lake Texoma attracts more than six million visitors per year and generates millions of dollars in tax revenue through associated spending in recreation activities, retail purchases, accommodations, and food service (TCOG, 2012). In light of the TCOG's goal, it can be assumed that the lakes created by the LBCR and LRH projects would be marketed in such a way as to capitalize on recreational revenues. However, it is unclear if an equal amount of marketing for the two proposed lakes would take place; and consequently if one would create disproportionately more revenue than the other (possibly at the expense of the other).

Because LRH is roughly 30 miles closer to Dallas than LBCR, visitors from the DFW Metroplex might be more attracted to LRH. However, the LBCR would be roughly three times the size of LRH so it might attract more recreationalists from further away. Both are adjacent to the Caddo National Grasslands; in fact, LRH would inundate approximately 250 acres within the 2,780-acre Ladonia Unit. The majority of the nearly 18,000-acre Caddo National Grasslands recreational area occurs within the Bois d'Arc Unit which is adjacent to – but would not overlap with – the proposed LBCR. One designated campground exists in the Ladonia Unit, compared to several in the Bois d'Arc Unit. The Bois d'Arc unit also includes campgrounds, multi-purpose trails, and boating on Coffee Mill Lake and Lake Crockett (see Figure 5.6-4). Therefore, the area near the Lower Bois d'Arc Creek Reservoir would offer more activities than the area near LRH, and thus could be more appealing to prospective anglers and boaters.

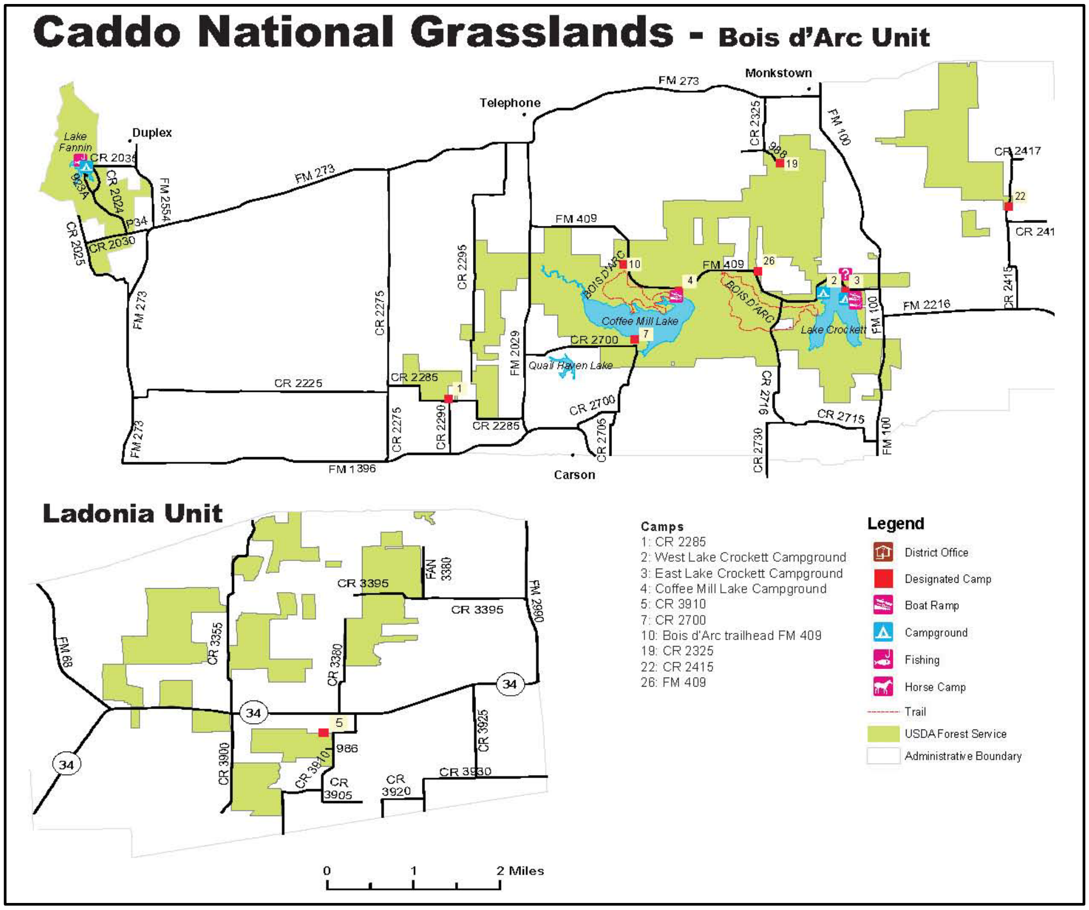

Figure 5.6-4. Caddo National Grasslands – Ladonia and Bois d'Arc Units

Source: USFS, no date

Regardless, the potential impacts from both reservoirs would likely be additive. That is, the increase in demand for certain goods and services would justify even more development in the form of commercial and residential real estate, sporting/boat/bait shops, restaurants, etc. There exists the risk of saturating the market to the point it no longer generates new demand for a set of products. This could occur due to competition, decreased need, or obsolescence; however, the aforementioned factors are unlikely to occur in the foreseeable future.

Tax Revenue

Real estate taxes from commercial and residential development around both reservoirs would increase the county's tax roll. Future tax receipts from oil and gas pipeline projects would also contribute to the increased tax revenues in Fannin, Lamar, and Grayson counties.

Social Impacts

Potential impacts from both reservoir projects to community cohesion and the quality of life in Fannin County could be adverse. Some of the opposition and controversy surrounding the two projects, as manifested in their planning and EIS scoping stages, is rooted in the belief that socially cohesive areas of small towns and rural lifestyles, which have experienced little change over the decades, would be subjected to social and cultural changes that would erode this cohesion over time. However, the population of Fannin County and surrounding counties in the study area are projected to grow enormously regardless of whether or not LRH or LBCR are built, due to the large-scale, long-term growth of the DFW Metroplex.

Lake Ralph Hall has drawn opposition from environmentalists, landowners, businesses, and some of the UTRWD's own members, including Flower Mound. In 2004, Flower Mound filed a lawsuit against the UTRWD over plans for a new treatment plant the town claimed was unnecessary. That suit was dismissed; however, the town kept fighting the project. It claimed that the UTRWD overbuilt infrastructure based on inflated population estimates. It has also raised questions about the district's financial condition (Hundley, 2012).

Conclusion

If the LBCR (either **Alternative 1** or **Alternative 2**) and LRH dam and reservoir construction projects were to occur simultaneously, a scenario that seems increasingly unlikely, there could be additive, short-term effects, both beneficial (from job and income creation) and adverse (from an influx of outside workers). Whether or not these effects would be synergistic is uncertain. If cost synergy occurs, the cost of materials, number of jobs, and overall potential economic activity would be reduced. However, lower costs for both projects could reduce the cost of water to customers as the annual amortization rate could diminish marginally. If other construction projects occurred simultaneously with either of the proposed dam and reservoir projects, these could further drive up the costs of labor and materials and reduce economic activity overall.

However, as noted in at the beginning of this chapter, it appears more and more likely that the two reservoir projects would occur sequentially rather than simultaneously, which would dampen and draw out socioeconomic effects, both beneficial and adverse.

Financing costs would potentially create cumulative impacts of moderate magnitude if job creation is double-counted and economic activity is overstated for each project. This cost-synergy scenario would also create beneficial impacts to NTMWD and UTRWD customers, as project costs would have been overstated and therefore projected water price increases as well. Decreased tax rolls in the short-term from property acquisition would be offset by both water districts making payments until the tax base has reached its pre-project level(s); in the long-term, both reservoirs would create additive, cumulative impacts. Additionally, tax receipts from various pipeline projects would add tens of thousands of dollars of annual revenue to Fannin, Lamar, and Grayson counties.

In the long-term, beneficial impacts from recreational revenue, and commercial and real estate development property tax revenue for both dam projects would be additive and significant. The two reservoirs would contribute to the stable economic development of Fannin and surrounding counties. Population growth and economic activity would be expected to be greater in the presence of the two projects than in their absence. Under the **No Action Alternative**, much population growth, change and development would still occur in Fannin County and the rest of the cumulative effects study area.

5.6.12 Environmental Justice

The study area for the cumulative effects on low-income or minority communities or populations is the same six-county region as for socioeconomic effects (Fannin, Collin, Hunt, Lamar, Grayson, and Delta counties). Environmental justice populations on the basis of ethnicity are present in Honey Grove, Ladonia, and Bonham. In addition, Bonham constitutes an environmental justice population on the basis of low-income status. Chapter 4 (Section 4.15) showed that disproportionate EJ impacts would be negligible to minor for both minority and low-income populations. The other actions occurring within the study area that may also contribute to cumulative effects are shown in Table 5.6-1.

Conclusion

Any long-term cumulative effects from **Alternative 1**, **Alternative 2**, and LRH on environmental justice would be slight but likely beneficial (from increased economic and recreational opportunities). No cumulative effects on environmental justice are expected from the other reasonably foreseeable actions. The **No Action Alternative** would not result in any cumulative impacts on environmental justice.

5.6.13 Cultural Resources

The study area for the cumulative cultural resource effects assessment consists of Fannin County. The county was selected as the study area because the location and type of cultural resources similar to those within the project's Area of Potential Effect (APE) can be more accurately determined. The other actions occurring within the study area that may contribute to social and economic effects area shown in Table 5.6-1.

A 2010 Programmatic Agreement (PA) signed by four parties (NTMWD, USACE, SHPO, and the Caddo Nation of Oklahoma) governs all cultural resources investigations and analysis related to this project. The PA serves as a guidance document that will be relied upon by all parties to ensure that Section 106 requirements are met throughout the life of the project. It will ensure Section 106 compliance on a timeline independent of the EIS. The PA will be in place for a period of ten years from signing, and is renewable. An additional agreement document will be drafted and signed by the PA signatories that will outline mitigation or avoidance measures for all identified adverse effects.

In 2011 and 2013 surveys, a total of 61 archaeological sites (31 prehistoric, 26 historic, and four prehistoric/historic multi-component) and 26 isolated objects (IOs) were recorded in the APE of the Alternative 1 reservoir footprint. Most of the prehistoric and historic sites were not eligible for listing on the National Register of Historic Places (NRHP) or as State Antiquities Landmarks (SALs). However, 17 archaeological sites (both historic and prehistoric) were recommended for further testing and research to determine their eligibility. The Wilks Cemetery has an undetermined eligibility for listing on the NRHP, but would be relocated prior to the construction of the reservoir and would be evaluated for eligibility during that phase of the project. A total of 38 architectural resources were identified within the proposed LBCR boundaries. In addition, seven historic archaeological sites and one prehistoric artifact were documented during a pedestrian survey and intensive investigation of the LBCR pipeline (Davis et al., 2014).

Regardless of its NRHP status, measures to mitigate the adverse effect on Wilks Cemetery would consist of de-dedication of the cemetery by court order, removal of all human remains, markers, and any grave goods from the current location, and re-interment of these remains at a new perpetual care cemetery.

Two other cemeteries outside the reservoir footprint, but within the flowage easement, could also be affected. Measures to protect them could consist of construction of protective berms around the cemeteries to prevent temporary flooding or, alternatively, de-dedication of the cemetery by court order;

removal of all human remains, markers, and any grave goods from the current location; and re-interment of these remains at a new perpetual care cemetery.

Impacts to archeological sites of undetermined eligibility possibly requiring additional archeological testing to clarify their eligibility would include loss of scientific information resulting from damage to sites due to reservoir construction, logging and land clearing, inundation, erosion, vandalism, and deterioration of organic remains.

In sum, without mitigation, both **Alternative 1** and **Alternative 2's** impacts on cultural resources, primarily archeological sites, would be considered significant under NEPA. Impacts could be mitigated by such measures as archeological data recovery, exhumation of burials including possible repatriation of Native American burials, and/or site containment, stabilization, and/or capping of cultural deposits. Implementing mitigation measures, as appropriate, would reduce the level of impact on cultural resources in general to below the threshold of significance.

Both large reservoir projects (LBCR and LRH) and other construction projects in Fannin County would impact cultural resources, although both would need to reduce those impacts to below the threshold of significance in order to comply with federal and state laws. There is a continuing, cumulative loss of heritage resources in the area and elsewhere as a result of development, destruction, neglect, and natural processes such as weathering, erosion, and decay.

On the other hand, both Alternative 1 and Alternative 2 would also cause beneficial effects related to cultural resources. The LBCR project has triggered intensive research leading to the discovery of previously unknown cultural information that otherwise might have remained unknown and ultimately lost due to the natural processes associated with weathering and decay. Cultural resources investigations are continuing at the Riverby Ranch mitigation site. A vast amount of data, information, and artifacts will be collected, studied, and preserved. Future generations could possibly benefit from the information garnered from the cultural resource studies associated with the LBCR and its analysis.

Conclusion

Chapter 4 concluded that the impacts from **Alternative 1** and **Alternative 2** on cultural resources would be severe. There would be no direct or indirect impacts to cultural resources from the **No Action Alternative**. However, over the long term, any cultural resources within the reservoir footprint and mitigation sites would be largely unprotected by federal law because they are on private properties. Thus, cumulatively and over the long term, impacts to cultural resources from the No Action Alternative are unknown.

There is an ongoing, cumulative loss of heritage resources in the county and elsewhere as a result of development, destruction, neglect, and natural processes such as weathering, erosion, and decay. With expected growth and development over the coming 50 years, these processes would be accelerated and the losses to cultural resources would be exacerbated. Thus, cumulative adverse impacts to cultural resources would be considered major, and the proposed LBCR would contribute to these major adverse impacts. However, the proposed LBCR has already, and will continue to, trigger the collection of a large amount of information and knowledge about Fannin County's cultural resource legacy. Cumulatively, in the coming decades, the opposite and contradictory trends of ongoing or accelerating cultural resource degradation and destruction, on the one hand, and increasing discovery, mitigation, protection, and knowledge, on the other, are both expected to continue.

Table 5.6-1. Cumulative Impacts Associated with Lower Bois d'Arc Creek Reservoir

		Past Actions								Reasonably Foreseeable Future Actions						
Resource	Area of Cumulative Effect	Bois d'Arc Creek Channelization	Lake Bonham	Valley Lake	Coffee Mill Lake	Lake Davy Crockett	Center for Workplace Learning	North Texas Regional Airport	Pipeline Maintenance	Lake Ralph Hall	Climate Change	Growth of Fannin County	Growth of DFW Metroplex	Marvin Nichols Reservoir	George Parkhouse Lake (North)	George Parkhouse Lake (South)
SOILS																
Soils and Geology	Fannin County	X							X							
Prime Farmland	Fannin County	X										X	X			
WATER RESOURCES																
Surface Water Hydrology	Bois d'Arc Creek and portions of Red River Basin[a]	X	X	X	X	X			X	X	X	X	X			
Water Quality	Bois d'Arc Creek and portions of Red River[a]	X			X	X			X	X	X					
Groundwater	Bois d'Arc watershed	X			X	X			X		X	X	X			
BIOLOGICAL RESOURCES																
Wetlands and Waters	HUC 111401	X	X	X	X	X			X		X	X	X			
Aquatic Biota	Bois d'Arc Creek and tributaries	X	X		X	X			X		X	X	X			
Upland Biota (Vegetation and Wildlife)	Upland areas within Bois d'Arc Creek watershed		X		X	X			X		X	X	X			
State-threatened Species	Bois d'Arc Creek watershed	X	X		X	X			X		X	X	X			
Invasive Species	Bois d'Arc Creek watershed	X	X		X	X			X		X	X	X			
AIR QUALITY AND CLIMATE																
Air Quality	AQCR 215[b]							X	X	X	X	X	X			
Climate			X	X	X	X				X		X	X	X	X	X

		Past Actions								Reasonably Foreseeable Future Actions						
Resource	**Area of Cumulative Effect**	**Bois d'Arc Creek Channelization**	**Lake Bonham**	**Valley Lake**	**Coffee Mill Lake**	**Lake Davy Crockett**	**Center for Workplace Learning**	**North Texas Regional Airport**	**Pipeline Maintenance**	**Lake Ralph Hall**	**Climate Change**	**Growth of Fannin County**	**Growth of DFW Metroplex**	**Marvin Nichols Reservoir**	**George Parkhouse Lake (North)**	**George Parkhouse Lake (South)**
ACOUSTIC ENVIRONMENT (NOISE)	Areas of elevated noise during construction and operation											X	X			
RECREATION	6-county ROI[c]	X	X		X	X				X		X	X		X	X
VISUAL RESOURCES	Viewshed of Alternatives 1 and 2		X		X	X						X	X			
LAND USE	Fannin County	X	X	X	X	X			X	X		X	X			
UTILITIES	Fannin County						X	X		X	X	X	X			
TRANSPORTATION	Fannin County						X	X		X		X	X			
SOCIOECONOMIC IMPACTS	6-county region[c]	X	X	X	X	X	X	X		X		X	X		X	X
ENVIRONMENTAL JUSTICE	6-county region[c]						X			X		X	X		X	X
CULTURAL RESOURCES	Fannin County	X	X	X	X	X			X	X		X	X			

[a] Bois d'Arc Creek and portion of Red River downstream of confluence.

[b] 19-countyAir Quality Control Region.

[c] Fannin, Collin, Hunt, Lamar, Grayson, and Delta counties.

BDC = Bois d'Arc Creek

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