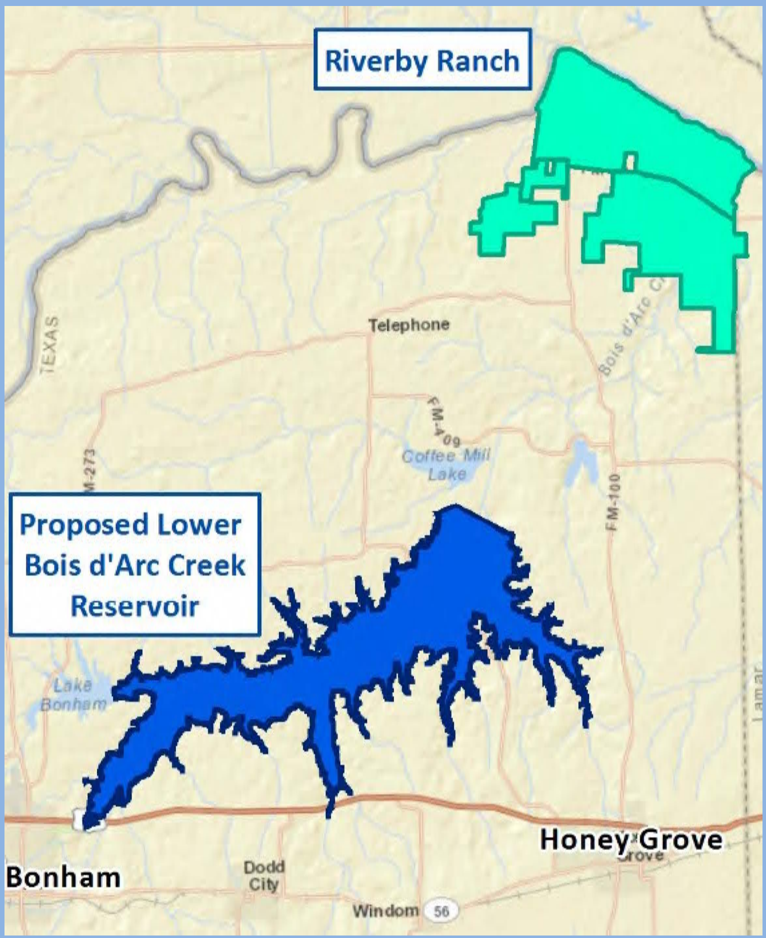
LOWER BOIS D'ARC CREEK RESERVOIR
Fannin County, Texas
SECTION 404 PERMIT APPLICATION

Draft Environmental Impact Statement
Volume I – DEIS

U.S. Army Corps of Engineers
Tulsa District



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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 of new water, with an estimated firm yield of 126,200 acre-feet/year, 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 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 a Section 404 permit may have a significant impact on the quality of the human environment and, therefore, requires the preparation of an Environmental Impact Statement (EIS). This Draft EIS analyzes the direct, indirect, and cumulative effects of the Proposed Action. The purpose of the Draft EIS is to provide decision-makers and the public with information pertaining to the Proposed Action and alternatives, and to disclose environmental impacts and identify mitigation measures to reduce impacts.

The project site is located in an area of largely rural countryside with scattered residences. Approximately 38 percent of the reservoir footprint is cropland and 37 percent consists of bottomland hardwoods and riparian woodlands, with the remaining 25 percent mostly upland deciduous forest. Construction of the reservoir and related facilities would result in permanent impacts to approximately 6,180 acres of wetlands and 651,024 linear feet of streams. Other adverse and beneficial impacts of substance would occur to soils and farmland, biological resources, recreation, land use, roads, socioeconomics, and cultural resources.

The applicant (NTMWD) has prepared an aquatic resources mitigation plan 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 U.S. that would be caused by construction of the proposed reservoir. NTMWD has purchased a 14,960-acre parcel of land known as 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 within the proposed 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 Texas Commission on Environmental Quality (TCEQ), and stipulated in the Draft Water Right Permit issued by TCEQ to NTMWD.

The 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 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 DEIS may be sent to:

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or via e-mail: ceswt-ro@usace.army.mil

Comments must be received within 60 days of publication of the Notice of Availability in the *Federal Register*, or until April 21, 2015.

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 has determined that issuance of such a permit may have a significant impact on the quality of the human environment and, therefore, requires the preparation of an Environmental Impact Statement (EIS). This EIS examines the Proposed Action and the No Action Alternative in detail.

A number of federal, state, and tribal agencies have cooperated or participated in studies, surveys, investigations and meetings related to the preparation of this Draft EIS. 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
- 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 Archeological Resources with USACE, NTMWD, and the THC)

Proposed Action

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 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. State population projections show the population of the NTMWD service area increasing from 1.6 million to 3.3 million by 2060. The LBCR would provide a new source of supply to help meet the increasing water demands of this growing population.

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 (east) 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 90-96 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 (49.8 linear miles) of existing perennial streams, 99 acres (73.5 miles) of intermittent streams, 87 acres of open water, 4,602 acres of forested wetlands, 1,223 acres of herbaceous wetlands, and 49 acres of shrub wetlands would all be impacted. Additionally, construction of the raw water pipeline, new terminal storage reservoir, and water treatment plant, in combination, would impact 0.44 acre (4,335 linear feet) of streams and 0.1 acre of open waters.

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 1.6 million to 3.3 million by 2060. 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 areas in the state of Texas. This growing population and the location of this 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.

Alternatives to the Proposed Action

Potential alternatives to the Lower Bois d'Arc Creek Reservoir project can be divided into those that will be implemented prior to LBCR – and regardless of whether LBCR is approved and built – and those that are true alternatives to the proposed project. The former category includes interim water purchases, water conservation, and water reuse. The latter category includes development of new reservoirs, transporting water from existing reservoirs, development of new groundwater supplies and desalination of brackish water. NTMWD's water conservation and water reuse strategies complement the Proposed Action rather than substitute for it; without these strategies, the need for additional water supply in the coming decades due to projected population growth in NTMWD's service area would be even greater. Chapters 1 and 2 of the DEIS describe NTMWD's water conservation and reuse programs in some detail.

Chapter 2 of the DEIS considers a number of alternatives to the Proposed Action which are eliminated from detailed consideration because they are not practicable or feasible, do not meet the stated Purpose and Need, or do not involve substantially lower environmental impacts than the LBCR. Each of these alternatives is evaluated according to the following set of criteria:

- <u>Environmental impacts</u> – relative general impacts to water and biological resources as well as to the human environment
- <u>Carbon footprint</u> – Long-term energy consumption and related carbon dioxide emissions from transporting (pumping) water from the new supply source to NTMWD's service area or treatment plant
- <u>Water quality</u> – Key water quality parameters; lower quality raw water would entail greater treatment costs
- <u>Purpose and Need/Adequacy of supply</u> – relative comparison of the water supply that would be added with that which would be supplied by LBCR; does the alternative meet the fundamental purpose and need?
- <u>Economic cost</u> – relative cost to NTMWD and water users of developing the alternative
- <u>Reliability and availability</u> – whether or not the alternative is fully available or is encumbered or compromised in some manner
- <u>Time to implementation</u> – could the alternative be developed within the time frame in which NTMWD needs the water
- <u>Need for partners</u> – could NTMWD develop the water source by itself or would it need to team up with partners

There are several categories of alternatives sources of water supply:

<u>Supply from New (Undeveloped) Reservoirs</u>

All of these potential alternatives to the Proposed Action reviewed would also entail discharges of dredged or fill material into waters of the United States. Thus, to one extent or another, 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, surface water is granted under a priority system, "first in time, first in right." This priority system is a factor in determining the magnitude of prospective yields available from any given project.

New (undeveloped) reservoirs considered in Chapter 2 include the following:

- Downsized (Smaller) Version of LBCR Project – This smaller, downsized version of LBCR is not a reasonable or practicable alternative to address the underlying long-term need for the project. It does not provide sufficient supplies to meet NTMWD's needs and it underutilizes a potential water resource as well.

- Upper Bois d'Arc Creek Reservoir – Due to the smaller drainage area and smaller storage in the reservoir, this alternative cannot provide the amount of water supply needed for the project; it other words, it would not meet the purpose and need for the project.

- Marvin Nichols Reservoir – This alternative is not a practicable or preferred alternative to the Proposed Action because: 1) in all probability it would generate greater environmental impacts, and 2) it cannot be implemented within the time frame required to satisfy the stated purpose and need of this project.

- George Parkhouse South Lake – This is not a practicable alternative to the LBCR due to the uncertain reliability of supply with the development of other reservoirs in the river basin and the environmental impacts. Its estimated firm yield of 122,000 AFY, of which only 80% (or 98,000 AFY) would be available for NTMWD, is less than LBCR's firm yield of 126,200 AFY. This alternative would impact more land area, and larger areas of bottomland hardwood forest, marsh, and wetlands than would LBCR. It also has a higher cost per thousand gallons of water yielded.

- George Parkhouse North Lake – While this alternative would likely impact less bottomland hardwood forest and wetlands than the LBCR, and its cost per acre-foot of water delivered compares favorably, it is not a practicable alternative to LBCR due to the uncertainty of the reliable supply, given the highly probable development of other reservoirs in the river basin which would constrain its yield. For instance, Lake Ralph Hall is currently under permit evaluation so it is somewhat more likely it could be constructed in the near future.

- Other New Reservoirs – Several other proposed reservoirs in the region were recommended or considered in the 2012 Texas State Water Plan, but are not considered feasible for NTMWD because of commitments to other users. These other proposed reservoirs included Lake Fastrill, Lake Columbia, Lake Tehuacana, and Lake Ralph Hall.

Transporting Water from Existing Reservoirs

- Lake Lavon – Reallocating flood storage to water supply in Lake Lavon is not a viable alternative to the LCBCR because it would only provide about five percent of LBCR's yield and it cannot be implemented within the timeframe needed for the water. Moreover, there are risks associated with the reliability of this supply during drought as well as risks to residents from a potential reduction in flood control capacity during storm events.

- Lake Jim Chapman – Reallocating flood storage to water supply in Lake Jim Chapman is not a viable alternative to the LCBCR because it would only provide about 20 percent of LBCR's expected yield and it cannot be implemented within the timeframe needed for the water. Furthermore, as with Lake Lavon, there are risks associated with the reliability of this supply during drought as well as risks to residents from a potential reduction in flood control capacity during storm events.

- 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. Lakes Ray Roberts and Lewisville are owned and operated by the USACE. Reallocation of these reservoirs individually or as a group does not constitute a practical alternative to LBCR because they can neither provide the amount of water supply needed, nor within the time period required.

- Lake Texoma Development with New Fresh Water Supplies **–** Water from Lake Texoma is relatively high in naturally-occurring dissolved salts and must be blended with water from other lower-salinity sources to make it potable. At present, there are no readily available fresh water supplies in the amount needed to blend with the new water supply from Lake Texoma, and existing supplies are insufficient to provide a blended water of acceptable quality for municipal use. Therefore, the blended alternative cannot be implemented without also implementing another water supply to provide new fresh water to the NTMWD.

- Toledo Bend Reservoir **--** Toledo Bend Reservoir is located on the Sabine River on the Texas-Louisiana state line to the southeast of Dallas. This is not a practicable alternative to the Proposed Action because it has significantly higher capital costs, greater energy usage and associated carbon dioxide (greenhouse gas) emissions, and higher long-term operating costs than the costs for the LBCR.

- Water from Oklahoma **–** 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. Due to the uncertainty regarding the Oklahoma moratorium on export of water to Texas and the uncertain status of the Oklahoma water rights permit, this strategy would likely not be able deliver water in a timely manner to meet the NTMWD's near-term (10-20 year) water needs.

- Lake O' the Pines **–** This reservoir is located about 120 miles from the North Texas region, and this distance, the limited supply it would provide, and uncertainty concerning the need to reach agreements with existing water rights holders, all make this supply uncertain and impractical as an alternative to LBCR.

- Wright Patman Lake – This existing reservoir in the Sulphur River Basin is about 150 miles from the NTMWD. Due to the uncertainty of reaching contractual agreements with existing water rights holders, the environmental impacts to the White Oak Mitigation Area and surrounding area of raising the flood pool, potential conflicts with other water suppliers, and higher operational costs, it is not considered a practicable alternative to LBCR within the specified near-to mid-term time frame.

- Lake Livingston – This is an existing reservoir on the Trinity River located about 180 miles from the North Texas service area. It is impractical because of the much greater distance, unit cost, greenhouse gas emissions, and uncertain future availability.

- Sam Rayburn Reservoir/Lake B.A. Steinhagen – Sam Rayburn Reservoir is an existing USACE reservoir on the Angelina River in the Neches River Basin. Because of the long distance, this is a relatively expensive source of supply for NTMWD. This particular strategy was considered in the 2007 Texas State Water Plan but was not even listed in the 2011 Region C Water Plan due to excessive cost and unavailability for water suppliers in Region C.

- Other Existing Lakes – Other existing lakes in the vicinity of NTMWD service area include Lake Ray Hubbard, Ray Roberts Lake, Lewisville Lake, Lake Grapevine, Lake Fork, Cedar Creek Reservoir, Richland-Chambers Reservoir and Lake Palestine. However, each of these sources is fully committed to its existing customers. Thus, none is able to meet the purpose and need of the Proposed Action.

New Groundwater Supplies

- Ogallala Aquifer – Mesa Water controlled rights to groundwater in Roberts County with options for additional supply and has permits from the local groundwater conservation district to export groundwater. Mesa Water sold these rights in 2011 to the Canadian River Municipal Water Authority. With the completion of the sale, this water supply alternative is no longer available to the NTMWD.

- Carrizo-Wilcox Aquifer – The Carrizo-Wilcox Aquifer covers a large area of east, central, and south Texas. Due to high cost considerations, uncertain availability, and competition for this water source, the Carrizo-Wilcox groundwater alternative is not considered a practicable alternative to the Proposed Action.

- Other Groundwater Supplies in Region C – Two major aquifers and four minor aquifers supply groundwater in Region C. However, many providers and users compete for this water already, and little additional water supply is actually available from Region C aquifers. Thus, this is not a feasible alternative for NTMWD.

Desalination of Brackish Water

- Desalination of Lake Texoma Water – Desalinating Lake Texoma water would use 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 require disposal of substantial amounts 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. Thus, large-scale desalination of Lake Texoma water is not a practicable alternative to the Proposed Action due to the cost uncertainty, smaller water supply and the potential environmental impacts associated with large-scale brine disposal.

- Gulf of Mexico Seawater Desalination – The State of Texas has sponsored initial studies of potential seawater desalination projects. These may be a potential future supply source for the state in general. However, as noted above, desalination continues to be both costly and energy-intensive. 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 supply for NTMWD.

Environmental Consequences of Proposed Action and No Action Alternative

Table ES-1 summarizes and compares the environmental effects of the two alternatives evaluated in detail in the Draft EIS, the Proposed Action and the No Action Alternative.

Table ES-1. Summary and comparison of environmental impacts of alternatives evaluated

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Topography, Geology and Soils	**Section 4.3.1 (p. 4-12)** • Over short term, topographic features, geological formations, and soils on the reservoir site, along the proposed pipeline, and at the water treatment plant site would all remain essentially in their present condition. • Over long term, if these lands continued to be used for agriculture or grazing, rather than being restored to a more natural and thicker vegetative cover, soil erosion would be expected to occur on the steeper sites, gradually reducing soil depth. • Ongoing erosion and downcutting associated with channelization of Bois d'Arc Creek would continue for the foreseeable future. • Due to continuing 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 due to the conversion of rural land soils to urbanized or developed lands. Impacts would thus be adverse, long-term, and moderate to major.	**Section 4.3.2 (p. 4-13 to p. 4-17)** • Overall effects on topography, geology, and soils of constructing the LBCR would be adverse but less than significant. • Operating the LBCR would have a long-term adverse, but less than significant, impact on Prime Farmland Soils by eliminating these soils from potential use in agriculture. • Effects on soils from FM 1396 relocation and new bridge construction would be adverse, long-term, minor, localized and of slight precedence. • Cumulative impacts on soils in Fannin County from all past, present, and reasonably foreseeable future actions are expected to constitute an adverse, long-term (permanent), moderate to major impact covering a large area. These impacts would mostly occur due to growth and development of Fannin County and the DFW Metroplex.
Water Resources	**Section 4.4.1 (p. 4-17 to p. 4-18)** • Continuing evolution of channelized segment of Bois d'Arc Creek and tributaries towards a state of dynamic equilibrium. • Increased runoff from development and urbanization, particularly in	**Section 4.4.2 (p. 4-18 to p. 4-37)** • Proposed Action would permanently impact up to 5,876.76 acres of wetlands, 225 acres of streams, and 113 acres of open waters. • No adverse water supply impacts are predicted to occur downstream on the Red

Water Resources (cont.)	the nearby City of Bonham. • Potential for flooding caused by the development of new roads and bridges. • Increases in turbidity could result from development and/or increased erosion and downcutting of channel. • Overall, direct, indirect, and cumulative impacts on surface water resources would be of minor magnitude, long term duration, medium or localized extent, probable likelihood, and slight precedence – adverse but insignificant. • Moderate impact on local aquifers because of potential for increased pumping of groundwater. • While direct impacts to streams of the Proposed Action would be avoided, most of the cumulative impacts on streams associated with growth of the DFW Metroplex would likely still occur under the No Action Alternative. These effects would be adverse, moderate, long-term, of large extent, probable likelihood, and slight precedence. • Would not contribute to cumulative downstream water supply impacts.	River, even under low flow conditions. • Building the LBCR would not increase flooding upstream of Highway 82, including at Highway 56. • Net impacts on waters of the United States would be adverse in the short and medium term and beneficial over the long term. • Significant impacts of the project on waters of the U.S. would be substantially mitigated following implementation of the proposed mitigation plan at Riverby Ranch. • Due to proposed water release regime from LBCR, impacts on the existing downstream aquatic environment would likely be beneficial, of moderate magnitude, long-term duration, medium extent, probable likelihood, and moderate precedence. • Little or no contribution to cumulative adverse impacts on waters and wetlands in Fannin County or Texas as a whole is anticipated. • Would reduce cumulative downstream flows in Bois d'Arc Creek, although no existing water rights would be affected. • Would result in minor reductions of flows and water supply in the Red River downstream of the Bois d'Arc Creek confluence, though this would not represent a significant cumulative adverse impact. • Cumulative impacts from all actions in the Red River Basin, including hydraulic fracturing for shale-gas production, are not likely to cause water supply shortages.
Air Quality and Climate	**Section 4.5.1 (p. 4-52)** • Air quality would remain unchanged when compared to existing conditions. • Would have no direct impact on the climate, and would not contribute to global warming. • Nonetheless, long-term moderate adverse effects would be expected under No Action Alternative due to anticipated climate change in region. • Would not contribute at all to	**Section 4.5.2 (p. 4-52 to p. 4-55)** • Short-term emissions would be limited to fugitive dust and diesel emissions from construction equipment during dam, water treatment facility, and pipeline development. • Emissions would not be expected to exceed applicability thresholds or contribute to a violation of any federal, state, or local air regulation. • Would have a relatively small carbon footprint, and would have an incremental, but overall negligible, contribution to

Air Quality and Climate (cont.)	cumulative air quality impacts in the ROI.	global warming. • 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 less available precipitation. • Would contribute directly to cumulative air quality impacts in the ROI only to a negligible to minor degree.
Acoustic Environment (Noise)	**Section 4.6.1 (p. 4-58)** • Noise levels would remain unchanged when compared to existing conditions. • Would not contribute at all to the expected cumulative increase in future ambient noise levels in Fannin County as it becomes more populous and developed.	**Section 4.6.2 (p. 4-58 to p. 4-60)** • Short-term minor increases in noise would result from the temporary use of heavy equipment during land clearing and construction. • There is likely to be noise associated with long-term recreational and real estate development at and in the vicinity of the reservoir. • Increases in noise would not create areas of incompatible land use or violate any Federal, state, or local noise ordinance. • Would contribute both directly and indirectly to a cumulative increase in noise levels within Fannin County, however, these impacts and noise levels would not be significantly adverse.
Biological Resources	**Section 4.7.1 (p. 4-61 to p. 4-62)** • Any substantive change to wildlife abundance or diversity in the area would come from projects such as additional rural houses, an increase or intensification of agriculture practices, and reversion of agricultural fields to old fields, grass fields, or eventually, woody habitat. • Overall effects to aquatic wildlife would be minor to moderate, adverse, and long term because the degraded condition and modified hydrology of this creek would continue for the indefinite future. • Would not contribute to any cumulative change in either wetland or upland vegetation, but under this scenario, there would still be a net decrease in natural vegetation in Fannin County,	**Section 4.7.2 (p. 4-62 to p. 4-80)** • Effects of reservoir construction to vegetation would be adverse, moderate in magnitude, short-term and long-term in duration, medium in extent, probable, and moderate in precedence and uniqueness. • Approximately 6,330 acres of bottomland vegetation would be removed. • Net impacts of the Proposed Action on upland or terrestrial vegetation would be moderately adverse in the short and medium term and minor adverse over the long term. With mitigation measures implemented, these impacts would be less than significant. • Taking into account the proposed mitigation plan, overall impacts to terrestrial wildlife from the Proposed Action would be both adverse and beneficial as well as short-term and long-term.

Biological Resources (cont.)	especially upland vegetation, associated with anticipated population growth and development in the coming decades. • Would not contribute to adverse cumulative impacts on wildlife associated with growth and development, but nor would it prevent this growth and development from occurring. • Would avoid direct adverse and beneficial cumulative impacts resulting from the Proposed Action, but it would not avoid adverse impacts on aquatic life in Bois d'Arc Creek from the anticipated increase in development within the watershed. • Would not contribute to cumulative adverse impacts on either federal or state threatened and endangered species in Fannin County. However, cumulative adverse impacts might still occur on these species due to expected growth and development.	• Once reservoir habitats become established, 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 of Proposed Action. • Impacts of Proposed Action on aquatic wildlife within the reservoir footprint would be both adverse and beneficial, short-term and long-term, of medium extent, probable likelihood, and moderate precedence. • Downstream of reservoir, likely effects of the Proposed Action on aquatic wildlife would be largely beneficial, due to the ability of water managers to control flows throughout the year. • Effects on federally-listed T&E species are unlikely due to their probable absence from the site. • Adverse impacts are possible, though considered unlikely, to five state-threatened fish species and one reptile, because their preferred habitat is found at the LBCR site, though none of these species were documented during surveys. • Would not contribute to the growing cumulative pressure on wetlands-associated vegetation, but would contribute to a minor extent to the cumulative decline in upland vegetation associated with woodlands, ranching, and agriculture as a result of expected population growth and development in Fannin County in coming decades. • Over the long term, the immediate adverse effects of the Proposed Action on wildlife in Fannin County would be offset by wildlife habitat restoration and improvement at the Riverby Ranch mitigation site. Thus, the long-term net cumulative effect of the Proposed Action 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 diversity) in Fannin County than at present due to the need to

Biological Resources (cont.)		develop existing wildlife-supporting habitats to support another 48,000 human residents within the county. • 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 the segment that would be downstream of the proposed dam; on balance, 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 of the draft water right permit. • 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 48,000 new residents by 2060, would tend to have adverse implications cumulatively for the diversity and abundance of aquatic life, both fish and benthic macroinvertebrates in Bois d'Arc Creek.
Recreation	**Section 4.8.1 (page 4-80)** • Little to no direct impacts on existing recreation facilities, opportunities, types and levels. • No changes would occur to existing public or private recreation areas in this region. Increased pressure on recreation areas due to a larger population may impact the quality of or access to existing recreation areas in the future. • Would experience neither the adverse nor the beneficial, long-term and cumulative effects of the Proposed Action.	**Section 4.8.2 (page 4-80 to page 4-84)** • Would cause a variety of different actions on recreation in the vicinity. It is probable that construction of the reservoir would have minor to moderate, short-term adverse impacts. • Recreational opportunities at the project site are likely to be moderately beneficial, long term and medium in extent. • Infrequent minor to moderate adverse impacts may occur to the Legacy Ridge Country Club golf course. • Overall cumulative effects related to recreation are generally beneficial, and the LBCR would contribute to these. • A potential downside is that with 48,000 projected additional residents in Fannin County, and similar demographic trends in ROI generally, some outdoor recreation sites and facilities could face overcrowding, which would diminish the visitor experience.

Visual Resources	**Section 4.9.1 (p. 4-85 to p. 4-86)** • Visual aesthetics 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. • Cumulatively, over the long run, by not developing a lake with a protected green perimeter, this alternative would deny future residents a positive visual element in a county that would be both more populous and more developed.	**Section 4.9.2 (p. 4-86 to p. 4-89)** • Due to its size and salience, the proposed dam and reservoir would have a major, long-term impact on visual resources, but 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 in question. • Many members of the public would likely appreciate the aesthetic features of a lake. • 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.
Land Use	**Section 4.10.1 (p. 4-89)** • Present trends in land use change 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 Metroplex and Fannin County increase over the decades. • Would not contribute to any cumulative changes in county land use over the long term but the country would become more urbanized in any case.	**Section 4.10.2 (p. 4-89 to p. 4-91)** • Impacts are expected to be major in magnitude, long term, direct, medium in extent, probable, and moderate in precedence and uniqueness. • Whether or not these long-term, indeed permanent, changes in land use of major magnitude are considered adverse or beneficial – or both – depends on the particular interests and values of the observer. • Similar or greater population growth as in the No Action Alternative would likely occur, leading to an increase in the percentage of land dedicated to residential and commercial uses and a corresponding decrease in rural farmland and open space.
Utilities	**Section 4.11.1 (p. 4-91)** • Does not provide the needed water supply for NTMWD members and customers. • Thus, would be expected to be adverse, major in magnitude, long-term, direct, medium in extent, probable, and slight in precedence and uniqueness to the NTMWD service area.	**Section 4.11.2 (p. 4-91 to p. 4-93)** • 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. • Construction of the Lower Bois d'Arc Reservoir would help ensure that future water needs of the NTMWD region are met. • New water supply capable of meeting the demands of the new population growth directly and indirectly related to the creation of the LBCR. However, over time, new electric supply (generation, transmission, distribution) to meet population growth would also be necessary.

Transportation	**Section 4.12.1 (p. 4-93)** • No impacts to transportation resources would occur as there would be no change in traffic on the roadways, no road closures or reconfigurations. • Anticipated growth and development in Fannin County would bring about significant cumulative effects in the county's road transportation network and traffic situation.	**Section 4.12.2 (p. 4-93 to p. 4-99)** • Short-term adverse effects on transportation and traffic, would be of major magnitude, due to the number and length of roads requiring temporary or permanent closure and relocation. • Short-term and long-term effects to road network would be mixed. After completing the proposed dam, the reservoir would effectively close the secondary roadways, and motorists would be rerouted in some fashion. • Anticipated growth and development in Fannin County would bring about significant cumulative effects in the county's road transportation network and traffic situation. • The reservoirs' contribution to these cumulative effects related to transportation would be minimal.
Environmental Contaminants and Toxic Waste	**Section 4.13.1 (p. 4-99)** • No impacts are expected.	**Section 4.13.2 (p. 4-99)** • No adverse effects expected. • If the proposed reservoir is built, NTMWD, TCEQ, and perhaps other state or federal agencies would be conducting periodic assessments of water quality, so that if a source of contaminants were to become evident, it would be addressed in the appropriate manner.
Socioeconomics	**Section 4.14.1 (p. 4-100 to p. 4-101)** • In the absence of the proposed project, the population projections for the six counties may not materialize to the fullest. • Could affect counties in ROI in the form of foregone indirect economic benefits. Neither water supply nor projected population growth would be directly affected under this alternative. • Job and income creation associated with the construction and operation of the dam & reservoir would not take place. • Real estate and business development around the reservoir would not occur. • Over the long term, would have adverse socioeconomic impacts of	**Section 4.14.2 (p. 4-101 to p. 4-118)** • Overall impacts 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 adverse and beneficial economic impacts would be considered significant, although magnitude of long-term of beneficial effects is much greater than magnitude of long-term adverse effects. • Adverse fiscal and social impacts are more weighted toward the short-term; at the same time, there would also be a major short-term economic stimulus associated with construction of the reservoir and related facilities. • Over time, socioeconomic impacts associated with the Proposed Action would become more and more positive or beneficial. On net, over the life of the

Socioeconomics (cont.)	major magnitude, large (multi-county) extent, probable likelihood, and moderate to severe precedence. • Adverse socioeconomic impacts would be significant.	proposed facility (50-100 years or more), socioeconomic effects would be positive for Fannin County. • 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).
Environmental Justice and Protection of Children	**Section 4.15.1 (p. 4-119)** • No impacts related to environmental justice and protection of children. • Would not result in any cumulative impacts on environmental justice.	**Section 4.15.2 (p. 4-119 to p. 4-124)** • Does not entail long-term environmental justice impacts. • Would neither benefit nor disadvantage minorities disproportionately either during construction or operation. • Long-term impacts of the Proposed Action on children would be primarily beneficial. • Any long-term cumulative effects from the LBCR and LRH on environmental justice would be slight but likely beneficial, from increased economic and recreational opportunities.
Cultural Resources	**Section 4.16.1 (p. 4-124)** • There would be no impacts to cultural resources from the Proposed Action, as it would not be built or operated. • However, over the long term, any cultural resources within the reservoir footprint and mitigation sites would be largely unprotected by federal law, since they are on private properties. Thus, cumulatively and over the long term, impacts to cultural resources from the No Action alternative are unknown.	**Section 4.16.2 (p. 4-124 to p. 4-126)** • No effect on properties currently listed on the National Register of Historic Places. • No effect on State of Texas historical markers. • Would adversely affect the Wilks Cemetery within the reservoir footprint. • Regardless of 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. • 34 structures and/or buildings are within the APE, none of which are eligible for the NRHP. Thus, the Proposed Action would have no effect on significant historic buildings or structures. • Impacts to at least 5 and as many as 24 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

Cultural Resources (cont.)		deterioration of organic remains. • In sum, without mitigation, the Proposed Action's impacts on cultural resources, primarily archeological sites, would be considered significant under NEPA. • Impacts can 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.

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 that would be impacted by construction of the proposed reservoir. NTMWD has purchased a 14,960-acre parcel of land known as 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 within the proposed 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 Texas Commission on Environmental Quality (TCEQ), and stipulated in the Draft Water Right Permit issued by TCEQ to NTMWD. Appendix E of the Draft EIS contains the detailed Mitigation Plan and Appendix F, the Draft Operation Plan, also includes additional mitigation measures.

Section 404 Permit

This Draft EIS furnishes important information to 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 thereof; 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).

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

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1.0 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). In accordance with the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 *et seq.*), the USACE has determined that issuance of such a permit may have a significant impact on the quality of the human environment and, therefore, requires the preparation of an Environmental Impact Statement (EIS).

1.1 THE PROPOSED ACTION

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

The proposed dam and reservoir would be located on Bois d'Arc Creek (Figure 1-1), in the Red River watershed (Figure 1-2), 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 mostly upland deciduous forest.

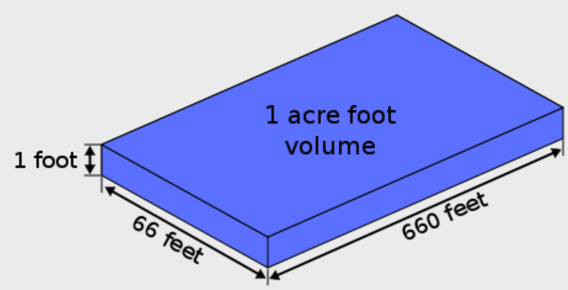
As will be explained further in Section 1.5, the purpose of the proposed project is to impound the waters of Bois d'Arc Creek and its tributaries to create a new 16,641-acre (26-square mile) water supply reservoir for the NTMWD. An additional 427 acres would be required for the construction of the dam 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. State population projections show the population of the NTMWD service area increasing from 1.6 million to 3.3 million by 2060. The LBCR would provide a new source of supply to help meet the increasing water demands of this growing population. Lower Bois d'Arc Creek Reservoir 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

Acre-Foot

The acre-foot is a unit of volume commonly used in the United States when measuring or referring to large quantities of water such as the capacity of reservoirs, the annual flow of rivers or the annual consumption of cities.

One acre-foot equals 325,851 gallons. It is defined as the volume of water needed to cover one acre (43,560 square feet, or an area 660 ft. long and 66 ft. wide) to a depth of one foot.

A rough rule of thumb in water management is that a typical suburban American household or family of four annually consumes about one acre-foot of water for domestic purposes, including exterior landscape irrigation.



spillway would be located at the right (east) 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.

Figure 1-1. Bois d'Arc Creek within the footprint of the proposed reservoir

Raw water from the reservoir would then be transported by approximately 35 miles of new pipeline 90-96 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 (Freese and Nichols, 2013).

In order to provide the ability to treat additional water from Lower Bois d'Arc Creek Reservoir 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 proposed water treatment plant to an outfall on Pilot Grove Creek. This creek is a tributary of the East Fork of the Trinity River, and as initially proposed in the original individual Section 404 permit application, this new 14-mile, 66-inch pipeline would have delivered raw water from LBCR to Lake Lavon, in the Trinity River basin.

However, upon further evaluation, NTMWD decided not to transfer water from the proposed reservoir to Lake Lavon via this 14-mile section of pipeline and Pilot Grove Creek. In a February 2011 letter to the Tulsa District, NTMWD requested that the transmission pipeline from the proposed North Water Treatment Plant to Pilot Grove Creek and associated discharge structure be removed from the Section 404 permit application and EIS (NTMWD, 2011).

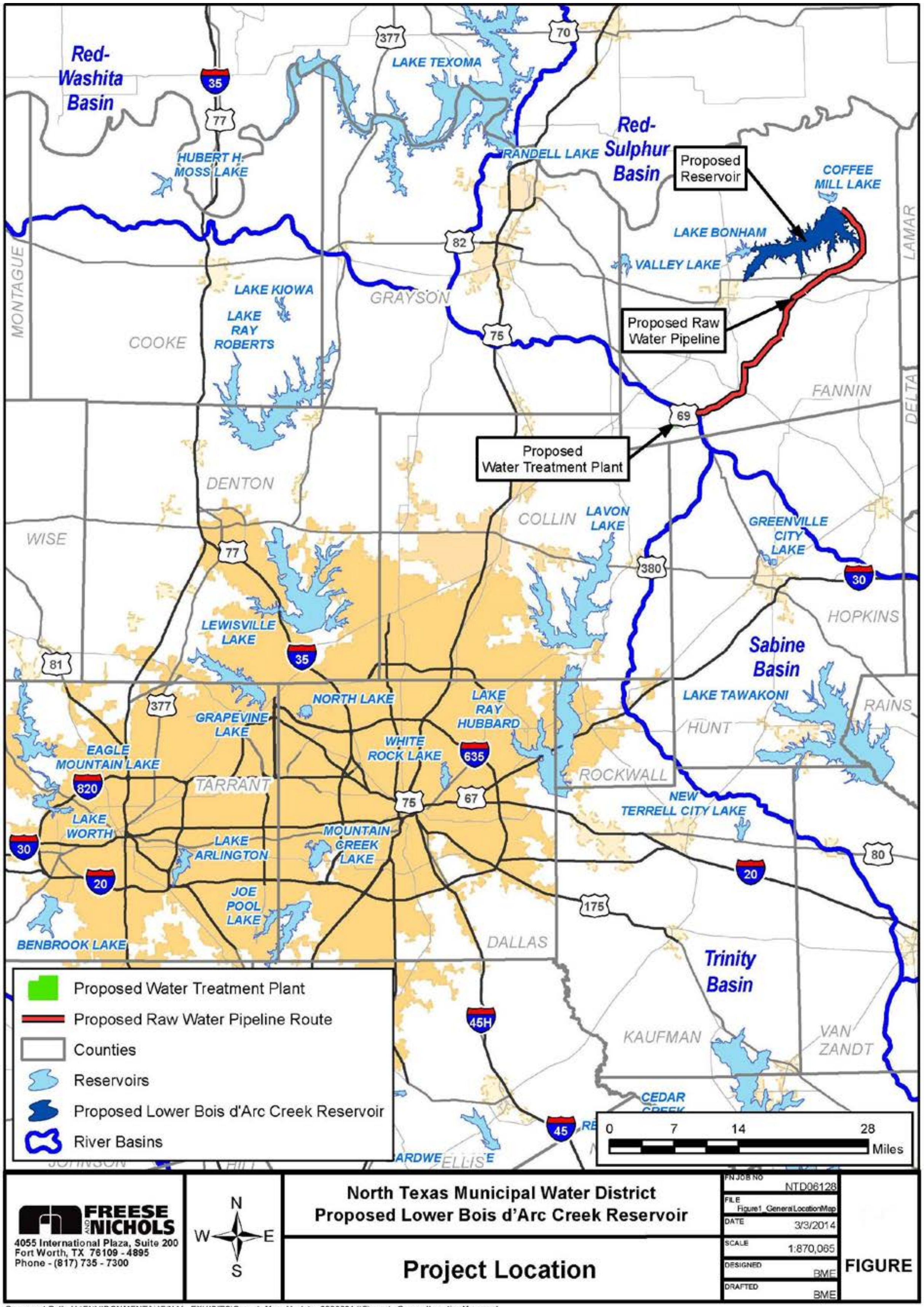


Figure 1-2. Project location (upper right) within North Texas watersheds (basins)

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 (49.8 linear miles) of existing perennial streams, 99 acres (73.5 miles) of intermittent streams, 87 acres of open water, 4,602 acres of forested wetlands, 1,223 acres of herbaceous wetlands, and 49 acres of shrub wetlands would all be impacted. Additionally, construction of the raw water pipeline, new terminal storage reservoir, and water treatment plant, in combination, would impact 0.44 acre (4,335 linear feet) of streams and 0.1 acre of open waters.

1.1.2 Applicant

The North Texas Municipal Water District (NTMWD) is a conservation and reclamation district and political subdivision of the State of Texas. It was created 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 (NTMWD, no date-a).

The primary mission of the NTMWD is to meet the needs of its member and customer cities (Table 1-1) for drinking water, wastewater treatment, and solid waste disposal. NTMWD acts as a regional wholesaler of water 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. NTMWD Water System			
Member Cities			
Allen	Garland	Princeton	Royse City
Farmersville	McKinney	Richardson	Wylie
Forney	Mesquite	Rockwall	Frisco
Plano			
Direct Customers			
Bonham	Forney Lake WSC	Melissa	Rowlett
Caddo Basin SUD	Gastonia-Scurry SUD	Milligan WSC	Sachse
Cash SUD	GTUA	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	
Fate	Lucas	Rose Hill SUD	

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 (see Figure 1-3). Lake Lavon (see Figure 1-3) serves as the NTMWD's main raw water supply source, with the NTMWD holding water rights in the reservoir. Lake Lavon also serves as a terminal reservoir for additional supplies that are transferred to the reservoir to augment supplies. The NTMWD holds water rights for raw water supplies from Lake Lavon, Lake Texoma, Jim Chapman Lake, Lake Bonham, and the Wetland (East Fork Raw Water Supply Project). Additional temporary supplies are available through a 20-year contract with provisions for two, 10-year extensions with the Sabine River Authority (SRA)

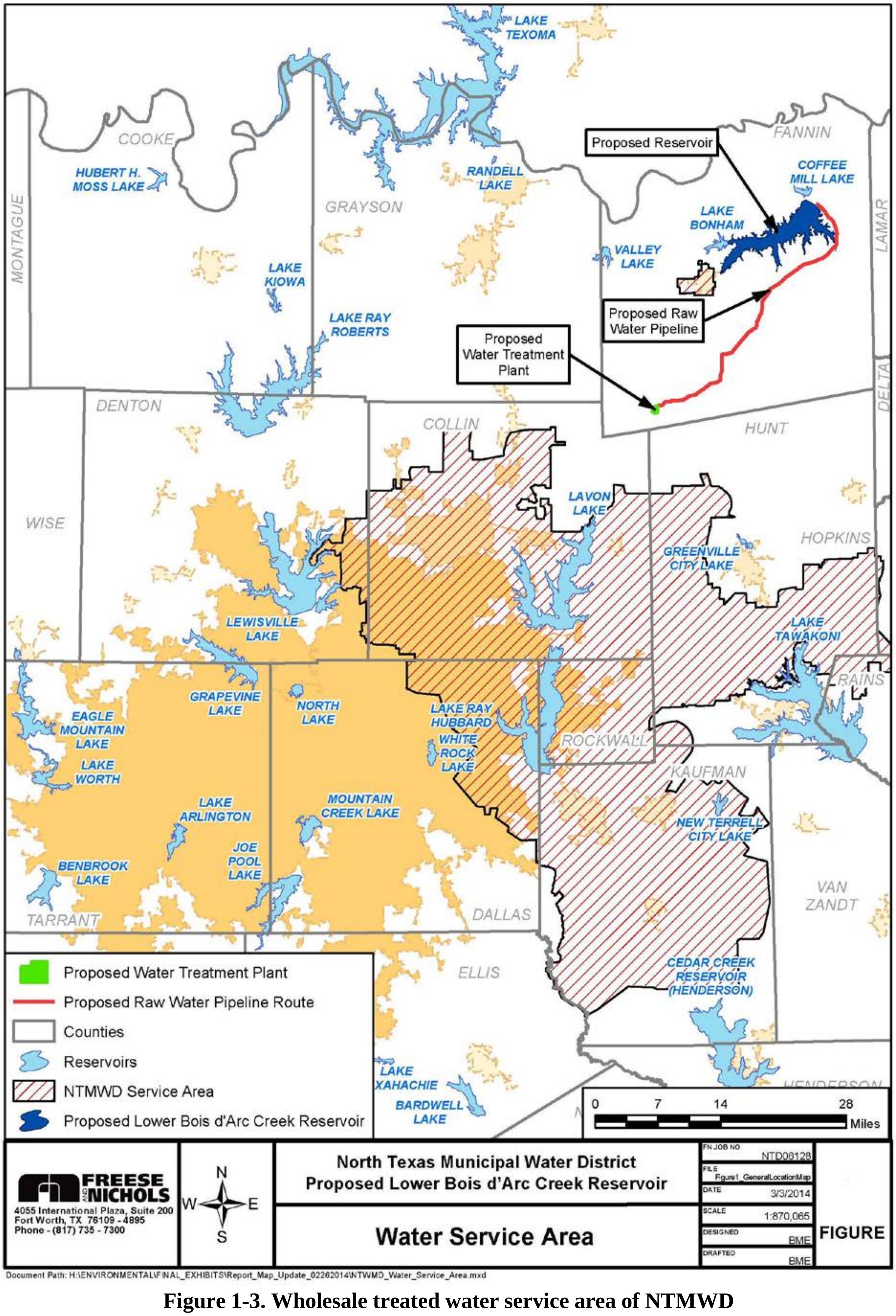


Figure 1-3. Wholesale treated water service area of NTMWD

that was signed October 13, 2005, providing for water transfer to Lake Lavon from Lake Tawakoni. A 10-year Raw Water Lease Agreement with the Greater Texoma Utility Authority for additional supplies from Lake Texoma that was effective February 6, 2006 was cancelled in 2012. NTMWD has recently entered into a temporary contract with the City of Dallas to purchase up to 60 million gallons per day (MGD) of raw water. This contract expires in 2016.

During the 2008-09 Water Year (August 2008 - July 2009), the NTMWD treated and delivered 93.2 billion gallons of water for a three percent increase over the prior water year (see Figure 1-4). Member Cities of the Water System received 85 percent of the total supply delivered, and those listed as "Direct Customers" in Table 1-1 the remaining 15 percent.

In April 2009, the NTMWD placed into service the Wetland, or the East Fork Raw Water Supply Project, a raw water supply included in the Texas 2007 State Water Plan. At 1,840 acres, the Wetland is the largest constructed wetland in the U.S. using reclaimed water to augment a surface water supply source. At its rated capacity, the Wetland will provide 102,000 acre-feet of water per year. Biologists selected more than 20 native aquatic wetland plant species based on their ability to enhance, or "polish" water quality and provide a natural wildlife habitat (Figure 1-5).

The NTMWD recently began serving the residents of the City of Bonham in Fannin County with a supply from Lake Bonham that is treated at the newly constructed, state-of-the-art Bonham Water Treatment Plant (WTP).

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 fill for development, water resource projects such as dams and reservoirs, infrastructure, and mining. Section 404 requires a permit from the USACE Regulatory Program 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, including construction and dredging, in navigable waters. 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).

In evaluating permit applications, the USACE considers the views of other federal, state and local agencies, interest groups, as well as the general public. 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 (mitigating) 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).

Figure 1-4. View of facilities at NTMWD raw water treatment plant in Wylie, TX

Figure 1-5. Egrets take flight at East Fork Raw Water Supply Project Wetlands

The proposed action is located within the USACE's Tulsa District, headquartered in Tulsa, Oklahoma. As noted at the outset of this chapter, in June 2008, the Tulsa District Regulatory Office received an application for a 404 permit from NTMWD to construct the Lower Bois d'Arc Creek dam and reservoir (Freese and Nichols, 2008b). In accordance with NEPA, the USACE determined that issuance of such a permit could potentially result in significant impacts on the quality of the human environment and, therefore, required the preparation of an EIS. The USACE is the lead agency in preparing this EIS. Several federal and state agencies (identified below) are acting as Cooperating Agencies in carrying out the NEPA process.

1.2.2 U.S. Environmental Protection Agency

The mission of the U.S. Environmental Protection Agency (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, teaches people about the environment, and publishes information (USEPA, 2010a).

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

- Develops and interprets policy, guidance and environmental criteria used in evaluating permit applications
- Determines 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 assures that its own actions comply with NEPA (USEPA, 2010b). The Region 6 Office of EPA, located in Dallas, TX, is participating as a Cooperating Agency with the USACE in the EIS for the Lower Bois d'Arc Creek Reservoir project. EPA assisted with Habitat Evaluation Procedures (HEP – described below) analysis of the proposed reservoir and mitigation sites and also participated in the inter-agency instream flow studies associated with the project.

1.2.3 U.S. Forest Service

Established in 1905, the U.S. Forest Service (USFS) is an agency within the U.S. Department of Agriculture. Nationally, the USFS manages some 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. The Grasslands provide grazing land for cattle and habitat for wildlife, as well as offering a range of outdoor recreational opportunities. The most popular activities are hiking, camping, fishing, hunting, horseback riding, mountain biking, wildlife viewing, and photography. The habitats provided by Caddo Grasslands support white-tailed deer, small mammals, coyotes, bobcats, red fox, waterfowl, bobwhite quail, turkey, and songbirds.

Caddo National Grasslands encompasses 17,785 acres and three lakes. The largest of these, Lake Coffee Mill, is 651 acres in size with one developed recreation area containing 13 picnic units and an improved boat ramp. Lake Davy Crockett is 388 acres in size and has two developed recreation areas. West Lake Davy Crockett has 11 camping units, while the east side has four picnic units and an improved boat ramp. Forty-five acre Lake Fannin is accessible for fishing from the east side only and has an unimproved earthen boat launch site (USFS, 2008).

The USFS is participating as a Cooperating Agency with the USACE in the EIS for the LBCR project 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 U.S. Fish and Wildlife Service (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, 2009a).

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, 2009a).

In the context of the proposed action, USFWS is a Cooperating Agency. Its ecological services staff participated actively in applying the USFWS-developed Habitat Evaluation Procedure (HEP) to both the proposed LBCR site (Figure 1-6) and the proposed Riverby Ranch mitigation site. HEP is a habitat-based approach for assessing the environmental impacts of proposed water and land resource development projects (USFWS, 1996). The philosophy behind the HEP is that a given area, such as a project site, can have various habitats, and these habitats can have different suitabilities for wildlife species that may occur in that area. Furthermore, HEP assumes that these suitabilities can be quantified (via Habitat Suitability Indices [HSIs]) and that the different habitats have measurable areal extents. Thus, the overall suitability of an area for a species can be represented as a product of the areal extent of each habitat and the suitability of those habitats for the given species (USGS, 2010).

The HEP method can be used to document the quality and quantity of available habitat for selected wildlife species. The procedures provide information for two general types of wildlife habitat comparisons: the relative value of different areas at the same point in time; and the relative value of the same areas at future points in time. By combining the two types of comparisons, the impact of proposed or anticipated land and water use changes on wildlife habitat can be quantified.

As the agency charged with protecting federally threatened and endangered species, USFWS would evaluate potential impacts to any federally threatened and endangered species that might occur on the project site. USFWS staff also participated on the instream flow study team.

Figure 1-6. Applying the HEP to the proposed reservoir 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 U.S. Department of Agriculture (USDA) has expanded to embrace 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 that care 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 around the country (NRCS, no date-a). NRCS serves Fannin County, TX with an office in Bonham.

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, 2010a). Via the Wetlands Reserve Program (WRP), NRCS provides technical and financial support to help landowners with their long-term wetlands conservation and restoration efforts. The WRP offers permanent easements to private landowners who meet certain conditions. Through this program, NRCS aims to optimize wetland functions and values as well as wildlife habitat. As of 2008, a cumulative total of 2,000,169 acres had been enrolled nationally in the WRP, of which 64,380 acres were in Texas (NRCS, 2010b; NRCS, 2010c). 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 a century 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. TCEQ conducts Section 401 certification reviews of projects, such as the proposed LBCR, requiring a Section 404 permit from the U.S. Army Corps of Engineers 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 EPA approval. These standards serve as the yardsticks for measuring whether 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 this state (TCEQ, 2004).

There are two types of 401 certifications – 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 Lower Bois d'Arc Creek Reservoir 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 will be outlined in a letter from the TCEQ to the USACE. TCEQ follows comment deadlines established in the joint public notice. Once the USACE resolves all issues to their satisfaction, they will issue a Statement of Findings or a Decision Document. The TCEQ has 10 working days to make a 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 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. Its use 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 provides which water uses 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 applied to TCEQ for a Texas Water Right for LBCR in December 2006 (Freese and Nichols, 2006).

TCEQ staff also assisted in conducting the HEP analysis and the instream flow study 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's mission is a vital part of Texas' overall vision and its mission and goals, which relate to maintaining the viability of the state's natural resources, health and economic development. To accomplish its goals of planning for the state's water resources and for providing affordable water and wastewater services, TWDB provides water planning, data collection and dissemination, and financial and technical assistance services to the citizens of Texas (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. SB1 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 grew. 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 to incorporate each of the regional plans. TWDB then developed planning guidance documents to guide preparation of regional water plans, delineated the state's 16 planning areas, and designated the planning group representatives (TWDB, 2010b).

The state water plan is based on a "bottom-up," consensus-driven approach to water resource planning that involves 16 regional water planning groups, one for each of the 16 regional water planning areas in the state (Figure 1-7). The proposed Lower Bois d'Arc Creek Reservoir 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 2011 Region C Water Plan was finalized and submitted to the TWDB in October 2010 (Region C Water Planning Group, 2010). The corresponding 5-year state plan – the 2012 State Water Plan – was adopted by the Board 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.

1.2.8 Texas Parks and Wildlife Department

The mission of the Texas Parks and Wildlife Department (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).

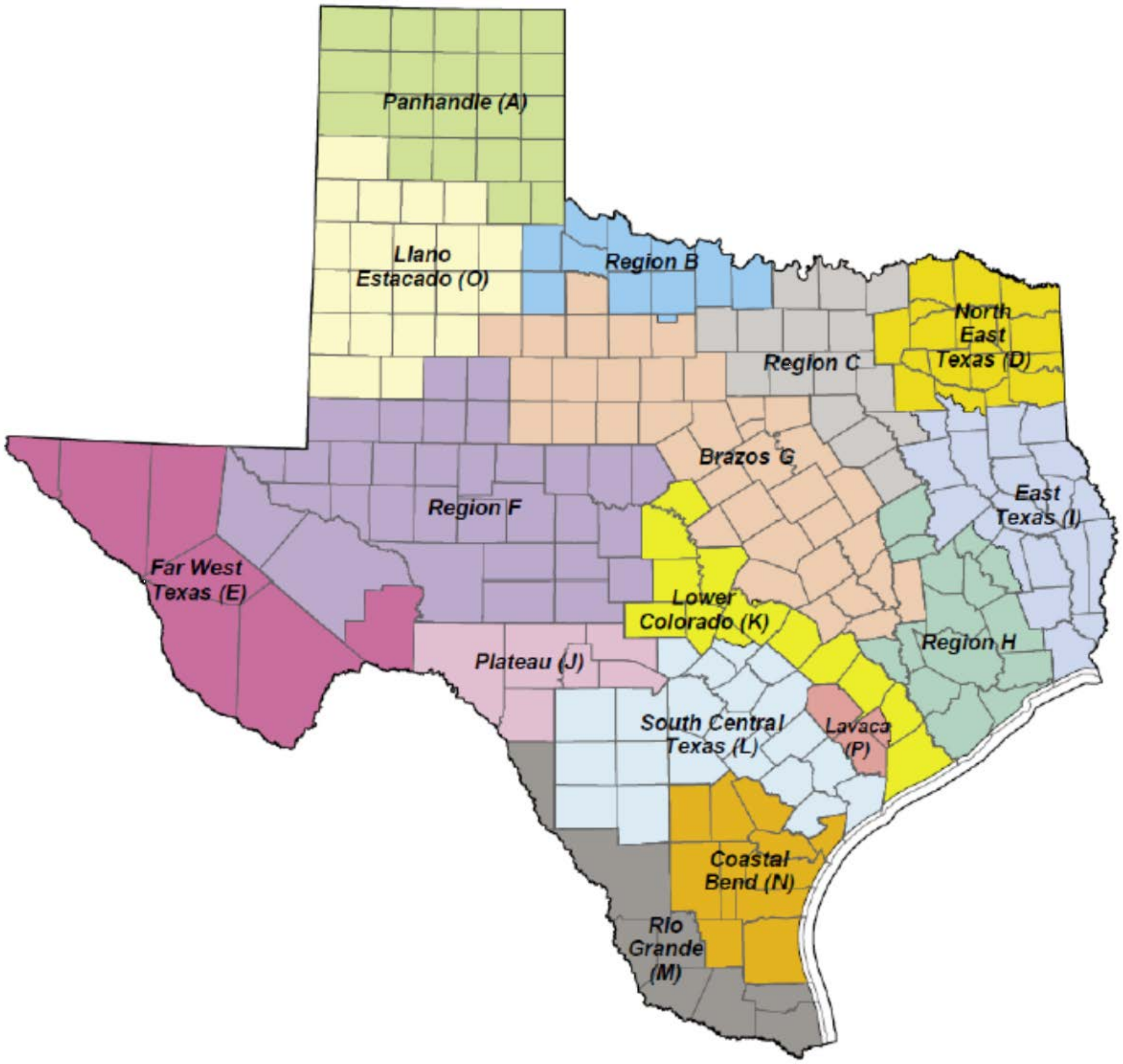


Figure 1-7. Regional water planning areas or regions in Texas

During the 1960s the department was made responsible for the administration of the Texas Water Safety Act and for the Land and Water Conservation Fund. When the Texas Endangered Species Act was adopted in 1973, TPWD began to implement it. In 1983 the Legislature passed the Wildlife Conservation Act, giving TPWD the authority to manage fish and wildlife resources in all Texas counties, without being subject to review by local county commissioners as was previously the case in some areas. In 1985 TPWD started Project WILD, a conservation-education program for public schools.

By the late 1980s the Texas parks system had grown to include 129 parks, natural areas, and historic sites, comprising more than 433,000 acres. TPWD was responsible for the protection and management of the fish populations in more than 600 public reservoirs, 16,000 miles of streams and rivers, and 370 miles of coastline. It investigated any pollution that might contribute to the loss of fish or wildlife and participated in both administrative and judicial proceedings involving pollution, development, or other actions that might affect fish or wildlife. The department employed more than 500 game wardens to enforce hunting and fishing regulations and park-safety laws; in addition, wardens helped maintain order and provide aid during natural disasters, and also presented programs to school and civic groups. By the 1990s Texas parks were receiving more than 20 million visitors a year (Smyrl, 2010).

Currently, TPWD has 11 internal divisions: Wildlife, Coastal Fisheries, Inland Fisheries, Law Enforcement, State Parks, Infrastructure, Legal, Administrative Resources, Communications, Human Resources and Information Technology (TPWD, 2007a).

TPWD's Wildlife Division personnel annually conduct about 2,100 wildlife population surveys, provide recommendations concerning the management of about 1,200 vertebrate wildlife species, and perform about 75 wildlife research studies. The Division also manages 51 wildlife management areas totaling 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).

In the present EIS covering the proposed Lower Bois d'Arc Creek Reservoir, TPWD is acting as a Cooperating Agency to the USACE. TPWD assisted with HEP analysis of the proposed reservoir and mitigation sites as well as participating in the inter-agency instream flow studies associated with the project.

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 staff consults with citizens and organizations to preserve Texas' architectural, archeological and cultural landmarks. It is composed of 17 governor-appointed citizen members with staggered six-year terms. The agency's 220 employees work in various fields, including archeology, architecture, history, economic development, heritage tourism, and urban planning.

The Texas Legislature established the agency in 1953 as the Texas State Historical Survey Committee with the task of identifying important historic sites across the state. The Legislature changed the agency's name to the Texas Historical Commission in 1973. Along with the name change came greater powers of protection, an expanded leadership role and broader educational responsibilities (THC, no date-a).

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 or National Register) 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 National Register, 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 National Register. Listing in the National Register 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).

Both in considering the Section 404 permit application from the NTMWD for the proposed LBCR, and in conducting an EIS on this proposed action, the USACE must comply with its obligations under Section 106 of the NHPA. As such, the USACE and the THC are two of the signatories in a Programmatic Agreement for conducting a cultural resources survey of the proposed reservoir site (THC, 2010b).

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 Lower Bois d'Arc Creek Reservoir, 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 (or American Indian) 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, several of 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, recognized tribal rights of self-government and tribal sovereignty, and affirmed and committed 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. It also 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.

- National Environmental Policy Act (NEPA): calls for the federal government to invite the participation of any affected Native American tribe in the environmental review process.

- National Historic Preservation Act (NHPA): enhanced Native American tribal roles in historic preservation by creating 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 contract 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 Native American Tribes (33) plus the Bureau of Indian Affairs (BIA) in the Department of the Interior were included in public notice mailings for this proposed action:

- 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 Programmatic Agreement (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, amendments to the federal Water Pollution Control Act added what is commonly called Section 404 authority to the Department of the Army's existing regulatory program under Section 10 of the Rivers and Harbors Act of 1899. The federal Water Pollution Control Act was amended further in 1977 and given the common name of "Clean Water Act" (CWA). 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).

Section 404 jurisdiction encompasses Section 10 waters, their tributaries, and adjacent wetlands and isolated waters where the use, degradation or destruction of such waters could affect interstate or foreign commerce. Activities requiring Section 404 permits are limited to discharges of dredged or fill materials into the waters of the United States.

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, or 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 some of the more obvious alternatives available to accomplish the project purpose, to discuss measures for reducing the impacts of the project, and to inform him/her of the factors the USACE must consider in its decision-making process.

Once a complete application is received, the formal review process begins. USACE districts operate under what is called 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 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 such as compliance determinations with the Section 404(b)(1) Guidelines (USACE, no date-a).

The USACE supports a strong partnership with states in regulating water resource developments. 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. Indeed, no permit is granted if the proposal is found to be contrary to the public interest. The public benefits and detriments of all factors relevant to each case are carefully evaluated and balanced. Relevant factors 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. The following general criteria are considered in evaluating all applications:

- the relevant extent of public and private needs;
- where unresolved conflicts of resource use exist, the practicability of using reasonable alternative locations and methods to accomplish project purposes; 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.

Public involvement plays a central role in the USACE's regulatory program. 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 on the public interest. 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, which also forms the main framework for overall evaluation of the project. 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 specific decision, but rather the decision represents the net effect of balancing all relevant factors, many of which are frequently in conflict (USACE, no date-a).

Applications for fill in waters of the U.S. are also evaluated using the Section 404(b)(1) Guidelines developed by EPA in conjunction with the Department of the Army. These guidelines are heavily weighted towards preventing environmental degradation of waters of the United States (including wetlands) and so place additional constraints on Section 404 discharges.

There are also external safeguards which work to maintain objectivity of the 404 permitting process. One is the EPA's Section 404(c) or so called "veto" authority. The EPA may prohibit or withdraw the specifications of any disposal site if the EPA Administrator determines that discharges into 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.

Section 404(q) of the CWA requires the Department of the Army to enter into interagency agreements to minimize duplication, needless paperwork, and delays in the Section 404 permit process. Individual state permitting and water quality certification requirements provide still 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).

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 Code of Federal Regulations (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.

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 Lower Bois d'Arc Creek Reservoir EIS was published in the *Federal Register* on November 13, 2009 (Vol. 74, No. 218, p. 58616-58617). The scoping process itself often involves actual face-to-face participation of the interested public. The USACE then investigates substantive issues raised in scoping, conducts research and analysis, and drafts an EIS. Availability of the Draft EIS (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 proposal itself. Again, with these 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 announcement of it will be incorporated into the notice of availability of the NEPA document. The public is also informed through notice of the availability of the final EIS, any EIS supplement, and the availability of the decision maker's record of decision. Thus, a permit application requiring preparation of an EIS can involve five or more notices to the public during the review process (USACE, no date).

ABOUT ENVIRONMENTAL IMPACT STATEMENTS

An EIS is intended to help agencies make environmentally well-informed decisions about major actions. It focuses on providing the 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. Later, 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 making a decision, which is documented in a Record of Decision (ROD). The public may again comment on the final EIS under NEPA.

1.5 PURPOSE AND NEED OF THE PROPOSED ACTION

1.5.1 Overall Project Purpose/Basic Project Purpose

The purpose of the proposal is to develop an additional supply of water to address the growing demand of NTMWD's customers. The specific action proposed by NTMWD to meet this purpose is impounding up to 367,609 acre-feet (AF) of water from Bois d'Arc Creek and its tributaries in a new 16,641-acre water supply reservoir for NTMWD. This project would produce an estimated firm yield of 126,200 acre-feet of water per year. State population projections show the NTMWD service area population increasing from 1.6 million to 3.3 million by 2060. The Lower Bois d'Arc Creek Reservoir 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 (discussed further below), 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 areas in the state of Texas. This growing population and the location of this 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 Lower Bois d'Arc Creek Reservoir will provide new supply to the proposed northern plant to help meet this increasing demand (Freese and Nichols, 2008a).

The primary water supply sources now available to NTMWD include: 1) raw water from three reservoirs (Lakes Lavon, Texoma, and Chapman), and 2) wastewater reuse from the NTMWD's Wilson Creek Wastewater Treatment Plant and the East Fork Raw Water Supply Project. The amounts of water expected to be available from these sources in 2010 and 2060 are shown in Table 1-2 and Figure 1-8. To meet its immediate needs, the NTMWD has also contracted with the Sabine River Authority for interim water supplies until new sources can be developed. Earlier, dating from 2004, NTMWD also had an agreement with the Greater Texoma Utility Authority (GTUA) for up to 25,000 acre-feet per year (AFY) of interim supplies from Lake Texoma, but this was formally terminated in 2012 because NTMWD had been effectively prohibited from diverting any water from Lake Texoma following the discovery of zebra mussels there in the summer of 2009 (Parks, 2012). Including interim supplies from Lake Tawakoni, the total amount of water currently available to NTMWD was 396,008 AFY in 2010 and will be 421,405 AFY in 2060 (Table 1-2).

Table 1-2. Water supply available to NTMWD from existing sources

Source	**Supply available (acre-feet per year)[a]**	
	2010	**2060**
Lake Lavon	112,033	105,700
Lake Texoma (NTMWD right)	77,300	77,300
Lake Jim Chapman	47,132	47,132
Wilson Creek Reuse	50,000	71,882
Lake Bonham	5,340	5,340
East Fork Reuse	51,790	102,000
Upper Sabine Supplies (Lake Tawakoni)	49,718	9,356[b]
Direct Reuse	2,695	2,695
Total	**396,008**	**421,405**

[a] Supply is from the *2011 Region C Water Plan* and rounded to the nearest acre-foot.
[b] Upper Sabine supplies (Lake Tawakoni) will be replaced gradually with more permanent sources.

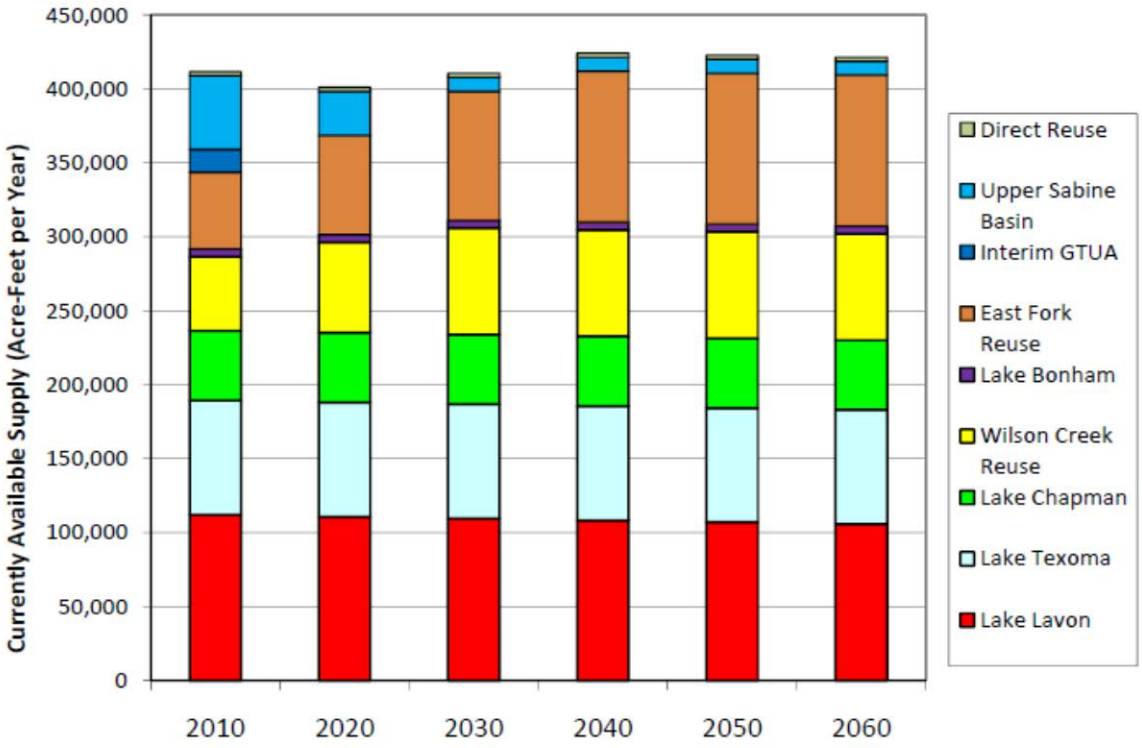


Figure 1-8. Currently available water supplies for the NTMWD, 2010-2060
Source: Figure 3.5, *2011 Region C Water Plan* (Region C Water Planning Group, 2010).

With the overall population of the NTMWD service area projected to approximately double over the coming fifty years, the overall demand for water from existing and potential members and customers is similarly projected to virtually double, from 387,574 acre-feet annually in 2010 to 789,676 acre-feet annually in 2060 (see Tables 1-3 and 1-4). To help meet these needs, the NTMWD is actively promoting conservation measures with its member and customer cities. NTMWD is also implementing the largest wastewater reuse program in Texas. However, even with advanced conservation measures and increases in wastewater reuse, NTMWD's current water supplies will be unable to meet the projected, long-term growth in demand. By 2020, NTMWD will have a projected deficit of 91,665 acre-feet per year, increasing to 368,271 AFY by 2060 (see Table 1-5) (Region C Water Planning Group, 2010). Figure 1-9 shows this shortage or deficit graphically.

To address these shortages and provide a reasonable reserve for future growth and unforeseen conditions, the 2012 Texas State Water Plan recommends multiple water management strategies for NTMWD, including additional conservation and reuse, the connection of existing sources, and the development of new water supplies. The development of the Lower Bois d'Arc Creek Reservoir is one of the strategies recommended in the 2012 Texas State Water Plan for NTMWD (TWDB, 2012), as well as by the Region C Water Planning Group in the current *2011 Region C Water Plan* (Region C Water Planning Group, 2010). As shown in Figure 1-10, the Lower Bois d' Arc Creek Reservoir will provide additional water supply to help meet NTMWD's water shortages beginning by 2020. After about 2030, the NTMWD will need to implement additional recommended water management strategies to continue to meet its growing water demands. Table 1-6 lists the strategies recommended by the Region C Water Planning Group (2010).

Figure 1-11 is an updated, more detailed chart depicting NTMWD's projected water demand growth and projected supplies from existing and planned sources through 2040.

Table 1-3. Current and projected Water User Group demands on NTMWD, 2010-2060*

Water User Group (WUG)	2010	2020	2030	2040	2050	2060
Allen	20,207	24,699	27,663	27,694	27,694	27,694
Anna	1,441	2,736	4,187	5,653	7,329	12,356
Blackland WSC	483	699	842	999	1,197	1,433
Bonham	2,348	2,527	3,172	4,337	5,881	7,253
Caddo Basin SUD	1,210	1,501	1,893	2,423	3,382	4,787
Cash SUD	646	800	1,010	1,346	1,792	1,792
College Mound WSC	758	1,155	1,582	1,853	2,187	2,623
Collin Co. Other	409	371	338	306	277	252
Crandall	730	657	657	872	872	872
Culleoka WSC	908	1,350	1,625	1,883	2,185	2,506
Danville WSC	845	1,153	1,417	1,693	1,990	2,306
East Fork SUD	1,239	1,378	1,501	1,637	1,777	1,942
Fairview	3,469	3,992	5,012	6,593	6,593	6,593
Farmersville	627	1,176	1,680	2,520	3,696	5,041
Fate	2,091	3,968	4,943	5,842	6,496	6,945
Forney	2,097	4,033	4,973	5,763	6,422	7,048
Forney Lake WSC	1,376	1,694	2,096	2,592	3,222	4,028
Frisco	36,153	45,670	59,090	72,333	83,110	83,110
Garland	42,484	42,055	42,789	42,462	42,190	42,190
Gastonia-Scurry SUD	771	1,104	1,262	1,506	1,840	2,255
Hackberry	69	137	202	231	246	253
Heath	1,952	2,727	3,393	4,116	4,964	5,980
High Point WSC	362	517	616	728	865	1,044
Howe	286	473	720	968	1,120	1,248
Hunt County Other	108	128	157	203	313	485
Josephine	259	346	415	499	580	668
Kaufman	1,322	1,716	2,013	2,264	2,511	3,029
Kaufman County Other	1,457	1,446	1,436	1,425	1,414	1,414
Lavon WSC	559	1,746	2,414	2,997	3,796	5,015
Little Elm	4,035	5,365	6,652	7,625	7,625	7,625
Lowry Crossing	366	458	541	554	551	551
Lucas	1,032	1,533	1,828	2,344	3,327	4,537
McKinney	34,366	53,767	73,929	94,092	102,157	102,157
McLendon-Chisolm	272	296	320	347	396	467
Melissa	699	4,864	7,419	10,645	14,947	16,462
Mesquite	26,245	30,312	33,874	34,469	34,521	34,532
Milligan WSC	202	196	191	185	183	183
Mt. Zion WSC	442	436	430	425	421	421
Murphy	4,234	8,556	8,556	8,556	8,556	8,556
Nevada	247	528	631	1,254	2,090	5,226
North Collin WSC	876	1,116	1,321	1,525	1,757	2,005
New Hope	267	383	632	944	1,416	3,148
Oak Grove	124	148	172	201	236	283
Parker	1,494	4,078	5,950	9,669	14,132	19,338
Plano	75,208	76,828	77,318	77,570	77,818	78,097

Water User Group (WUG)	2010	2020	2030	2040	2050	2060
Post Oak Bend City	85	138	226	369	602	982
Princeton	1,329	2,657	3,871	6,452	10,753	16,130
Prosper	1,998	3,239	5,669	7,829	12,688	13,498
RCH WSC	642	911	919	918	912	912
Richardson	32,383	36,123	35,993	35,602	35,343	35,343
Rockwall	9,855	17,597	21,596	25,162	25,826	25,826
Rockwall Co. Other	385	385	385	383	383	383
Rowlett	11,619	13,731	15,447	16,801	17,759	18,694
Royse City	2,501	4,422	5,959	7,789	9,561	11,521
Sachse	4,399	5,124	5,806	5,746	5,746	5,746
Saint Paul	192	468	930	1,479	1,756	1,848
Scurry	87	102	118	138	160	186
Sunnyvale	1,770	2,454	3,135	3,820	4,514	4,618
Talty WSC	813	1,717	2,337	3,024	3,878	4,948
Terrell	3,807	10,385	14,780	19,138	21,731	24,643
The Colony	576	778	861	881	901	909
Van Alstyne	54	961	2,060	2,692	2,969	3,099
Wylie	6,810	8,737	10,586	12,601	12,601	12,601
Non-Municipal Customers						
Collin County Manufacturing	3,280	3,810	4,327	4,843	5,306	5,788
Collin County Irrigation (Demand for Rowlett Creek & Stewart Creek Reuse Projects)	1,847	1,847	1,847	1,847	1,847	1,847
Collin County Mining	146	146	146	146	146	146
Dallas County Manufacturing	6,482	7,180	7,818	8,401	8,874	8,927
Dallas County Steam Electric	67	86	238	240	240	240
Denton County Manufacturing	53	62	70	79	87	94
Fannin County Manufacturing	73	82	90	98	105	114
Grayson County Manufacturing	70	78	85	91	96	104
Kaufman County Irrigation	1,987	1,805	1,805	1,805	1,805	1,805
Kaufman County Manufacturing	760	813	869	928	993	1,061
Kaufman County Steam Electric	0	1,121	1,121	1,121	1,121	1,121
Rockwall County Irrigation	848	848	848	848	848	848
Rockwall County Manufacturing	20	23	26	29	32	35
Total	**371,713**	**468,648**	**548,830**	**625,443**	**685,657**	**729,767**

* In acre-feet per year
Source: Appendix H, *2011 Region C Water Plan* (Region C Water Planning Group, 2010)

Table 1-4. Potential future customers of the NTMWD, 2010-2060

Potential Future Customers	2010	2020	2030	2040	2050	2060
Ables Springs WSC	0	845	1,054	1,299	1,644	2,090
Blue Ridge	0	365	893	1,569	2,342	2,651
Celina	0	1,500	3,000	5,000	5,000	5,000
Ector	0	9	33	57	59	62
Fannin County Other	213	413	596	768	705	659
Honey Grove	0	96	268	460	564	671
Leonard	0	76	266	587	907	1,166
Savoy	0	13	35	57	59	61
South Grayson WSC	0	100	100	100	100	100
Southwest Fannin Co SUD	0	354	663	921	1,004	1,099
Trenton	0	131	368	694	1,077	1,464
Weston	0	451	1,316	4,124	7,300	12,592
Total	**213**	**4,351**	**8,593**	**15,635**	**20,760**	**27,614**
Total Treated Water Demands	371,926	472,999	557,423	641,078	706,417	757,381
Losses in Treatment & Delivery	14,877	18,920	22,297	25,643	28,257	30,295
Collin Co Steam Elec. raw water	771	715	1,000	1,200	1,600	2,000
Total Demand	**387,574**	**492,634**	**580,720**	**667,921**	**736,274**	**789,676**

Note: All values in acre-feet per year
Source: Appendix H, *2011 Region C Water Plan* (Region C Water Planning Group, 2010)

Table 1-5. Comparison of currently available supply to projected demand for NTMWD

Current Supply	2010	2020	2030	2040	2050	2060
Lake Lavon	112,033	110,767	109,500	108,233	106,967	105,700
Lake Texoma	77,300[1]	77,300	77,300	77,300	77,300	77,300
Lake Chapman	47,132	47,132	47,132	47,132	47,132	47,132
Wilson Creek Reuse	50,000	60,941	71,882	71,882	71,882	71,882
Lake Bonham	5,340	5,340	5,340	5,340	5,340	5,340
East Fork Reuse (with Ray Hubbard Pass through)	51,790	67,148	87,102	102,000	102,000	102,000
Upper Sabine Basin	49,718	29,646	9,573	9,501	9,428	9,356
Direct Reuse for Irrigation (Collin & Rockwall Co)	2,695	2,695	2,695	2,695	2,695	2,695
Total Supply	**396,008**	**400,969**	**410,524**	**424,083**	**422,744**	**421,405**
Supplies from current sources less projected demands	**8,434[2]**	**-91,665**	**-170,196**	**-243,838**	**-313,530**	**-368,271**

Note: All values in acre-feet per year
Source: Appendix H, *2011 Region C Water Plan* (Region C Water Planning Group, 2010)
[1]This was the projected amount for the year 2010 but due to zebra mussel infestation in Lake Texoma, no water could be pumped by NTMWD from there into Lake Lavon and the Trinity River Basin. NTMWD was able to provide sufficient water for its customers using a variety of stopgap measures, including water conservation and drought management protocols.
[2]In Appendix H, this figure was zero because there was no calculated need for additional supplies. It was adjusted to 8,434 AFY for this EIS to show the amount of potential surplus water in 2010. Due to the zebra mussel infestation in Lake Texoma in 2009, the supplies from this source have been eliminated and NTMWD had no surplus water in 2010.

Table 1-6. Water management strategies for NTMWD recommended by Region C Water Planning Group

Planned Supplies (Ac-Ft/Yr)	2010	2020	2030	2040	2050	2060
Projected Demands (including losses for Treatment & Delivery)	**387,574**	**492,634**	**580,720**	**667,921**	**736,274**	**789,676**
Existing						
Lake Lavon	*112,033*	*110,767*	*109,500*	*108,233*	*106,967*	*105,700*
Lake Texoma	*77,300*	*77,300*	*77,300*	*77,300*	*77,300*	*77,300*
Lake Chapman	*47,132*	*47,132*	*47,132*	*47,132*	*47,132*	*47,132*
Wilson Creek Reuse	*50,000*	*60,941*	*71,882*	*71,882*	*71,882*	*71,882*
Lake Bonham	*5,340*	*5,340*	*5,340*	*5,340*	*5,340*	*5,340*
East Fork Reuse (with Ray Hubbard Pass through)	*51,790*	*67,148*	*87,102*	*102,000*	*102,000*	*102,000*
Upper Sabine Basin	*49,718*	*29,646*	*9,573*	*9,501*	*9,428*	*9,356*
Direct Reuse for Irrigation (Collin & Rockwall Co)	*2,695*	*2,695*	*2,695*	*2,695*	*2,695*	*2,695*
Total Available Supplies	***396,008***	***400,969***	***410,524***	***424,083***	***422,744***	***421,405***
Need (Demand-Supply)	***-8,434***	***91,665***	***170,196***	***243,838***	***313,530***	***368,271***
Water Management Strategies						
Conservation (Wholesale Customers)	5,180	27,103	45,756	58,958	70,559	80,398
Texoma Pump Station Expansion	0	0	0	0	0	0
Additional Direct Reuse - Rockwall Co. Irrigation	64	64	64	64	64	64
Main Stem PS (additional East Fork)		34,900	15,100	0	0	0
Chapman Booster Pump Station	0	0	0	0	0	0
Lower Bois d'Arc Creek Reservoir		56,050	120,200	118,000	115,800	113,600
Additional Lake Texoma - Blend with new supplies			69,200	68,500	113,000	113,000
Fannin County Water Supply System		0	0	0	0	0
Marvin Nichols			87,400	87,400	174,800	174,800
Toledo Bend Phase 1					100,000	100,000
Oklahoma						50,000
Total Supplies from Strategies	**5,244**	**118,117**	**337,720**	**332,922**	**574,223**	**631,862**
Total Supplies	**401,252**	**519,086**	**770,144**	**778,905**	**996,967**	**1,053,267**
Reserve or (Shortage)	**13,678**	**26,452**	**167,524**	**89,084**	**260,693**	**263,591**

Source: Table 4E.7, *2011 Region C Water Plan* (Region C Water Planning Group, 2010)
Note: In original Table 4E.7, "Interim GTUA" was also included under available water supplies for 2010 (15,500 AFY), and "Renewed Interim GTUA" under Water Management Strategies for 2020, 2030, and 2040 (21,900 AFY); however, these have been deleted from this table due to NTMWD's inability to use this water because of zebra mussel infestation in Lake Texoma since 2009 and the subsequent 2012 termination of the agreement between NTMWD and GTUA.

The rows in Table 1-6 can be reconfigured so as to display existing water supplies and recommended management strategies to provide additional water in such a manner as to emphasize the respective roles and magnitude of water obtained from reservoirs (existing and proposed future) and water obtained from conservation and reuse (existing and proposed future). Table 1-7 contains the same information in Table 1-6, but rearranged to highlight the role of conservation and reuse in reducing (but not eliminating) projected needs and growing shortages. Table 1-7 indicates that by implementing existing water reuse supplies as well more aggressive water conservation and reuse strategies (recommended by the Region C Water Planning Group), NTMWD still faces a looming water supply deficit in the future, ranging from 64,498 AF in 2020 to 287,809 AF in 2060.

Table 1-7. Existing water supplies and prospective water management strategies for NTMWD, highlighting contribution of conservation and reuse

Planned Supplies (Acre-Feet/Year)	2010	2020	2030	2040	2050	2060
Projected Demands (including losses for Treatment & Delivery)	**387,574**	**492,634**	**580,720**	**667,921**	**736,274**	**789,676**
Projected Supplies from Existing Reservoir Sources [a]	*291,523*	*270,185*	*248,845*	*247,506*	*246,167*	*244,828*
Projected Need (Demand minus Supply from Existing Reservoirs)	96,051	222,449	331,875	420,415	490,107	544,848
Projected Water Reuse from Existing Sources [b]	*104,485*	*130,784*	*161,679*	*176,577*	*176,577*	*176,577*
Projected Net Need (Projected Need minus Projected Water Reuse from Existing Sources)	**-8,434**	**91,665**	**170,196**	**243,838**	**313,530**	**368,271**
Recommended Conservation and Reuse Water Management Strategies [c]	*5,244*	*27,167*	*45,820*	*59,022*	*70,623*	*80,462*
Projected Remaining Net Need (Projected Net Need minus Recommended Conservation and Reuse Water Management Strategies)	**-13,678**	**64,498**	**124,376**	**184,816**	**242,907**	**287,809**
Water Management Strategies involving New Supplies from Reuse, River Diversion, and Existing or Proposed Reservoirs [d]	*0*	*90,950*	*291,900*	*273,900*	*503,600*	*551,400*
Reserve or (Shortage)	**13,678**	**26,452**	**167,524**	**89,084**	**260,693**	**263,591**

[a] Lake Lavon, Lake Texoma, Lake Chapman, Bonham Lake, and Upper Sabine Basin
[b] Wilson Creek Reuse, East Fork Reuse with Ray Hubbard Pass through, and Direct Reuse for Irrigation (Collin & Rockwall Counties)
[c] Conservation (Wholesale Customers), Additional Direct Reuse - Rockwall County Irrigation
[d] Main Stem PS (additional East Fork), Lower Bois d'Arc Creek Reservoir, Additional Lake Texoma - Blend with new supplies, Lake Marvin Nichols, Toledo Bend Phase 1, Oklahoma

Source: Modified from Table 4E.7, *2011 Region C Water Plan* (Region C Water Planning Group, 2010) to remove Interim GTUA (2010) and Renewed Interim GTUA (2020, 2030, 2040)

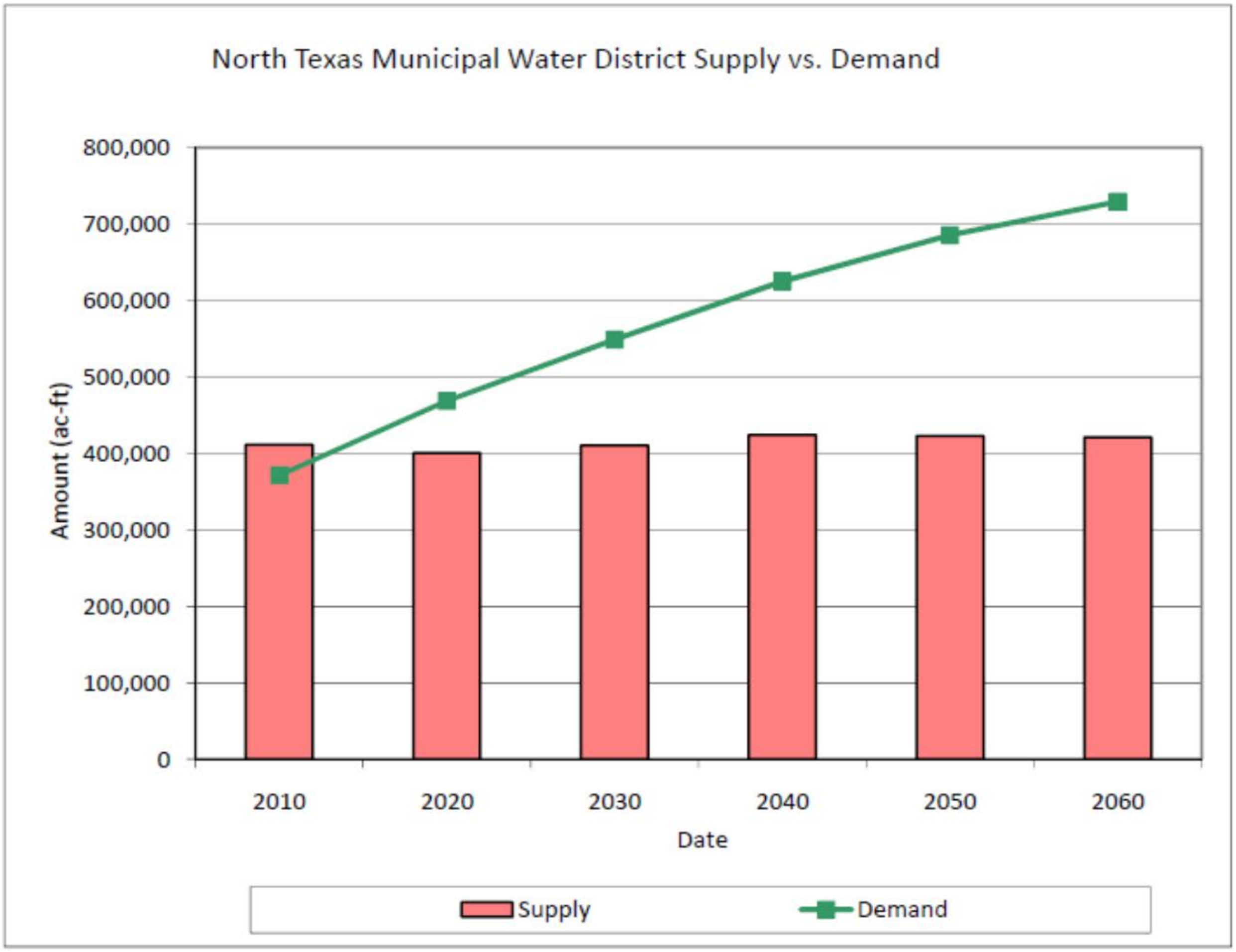


Figure 1-9. NTMWD supply versus demand from existing WUGs, 2010-2060
Source: Appendix H, p. H.33, *2011 Region C Water Plan*
Note: Supply for 2010 differs from Table 1-5 supply for 2010 because Interim GTUA included.

The USACE Regulatory Program accepts the use of the 2012 Texas Water Plan and subsequent updates to fulfill the purpose and need statement required in a Section 404 permit application for a water resources project identified in the 2007 and 2012 State Plans and the 2011 Region C Plan that was incorporated into the 2012 State Water Plan. The "bottom-up," comprehensive approach employed in the Texas planning process and advocated by the 1997 Texas State Legislature sufficiently validates the water resources needs of the State and its entities such as NTMWD (Woodley, 2007).

1.5.2 State and Regional Population Projections

1.5.2.1 Office of the State Demographer Projections

The population of Texas has grown rapidly in recent decades, and based on this fact and current and expected trends in a variety of factors, demographers project the population of Texas to almost double between the years 2010 and 2060, growing from approximately 25 million to approximately 46 million (Figure 1-12; TWDB, 2012). The Office of the State Demographer (OSD) has developed projections to the year 2040 for the state and its counties based on different demographic scenarios (OSD, 2009). These projections differ primarily because of different assumptions about migration rates; net migration is the most difficult to predict, and the most variable of the components of population change.

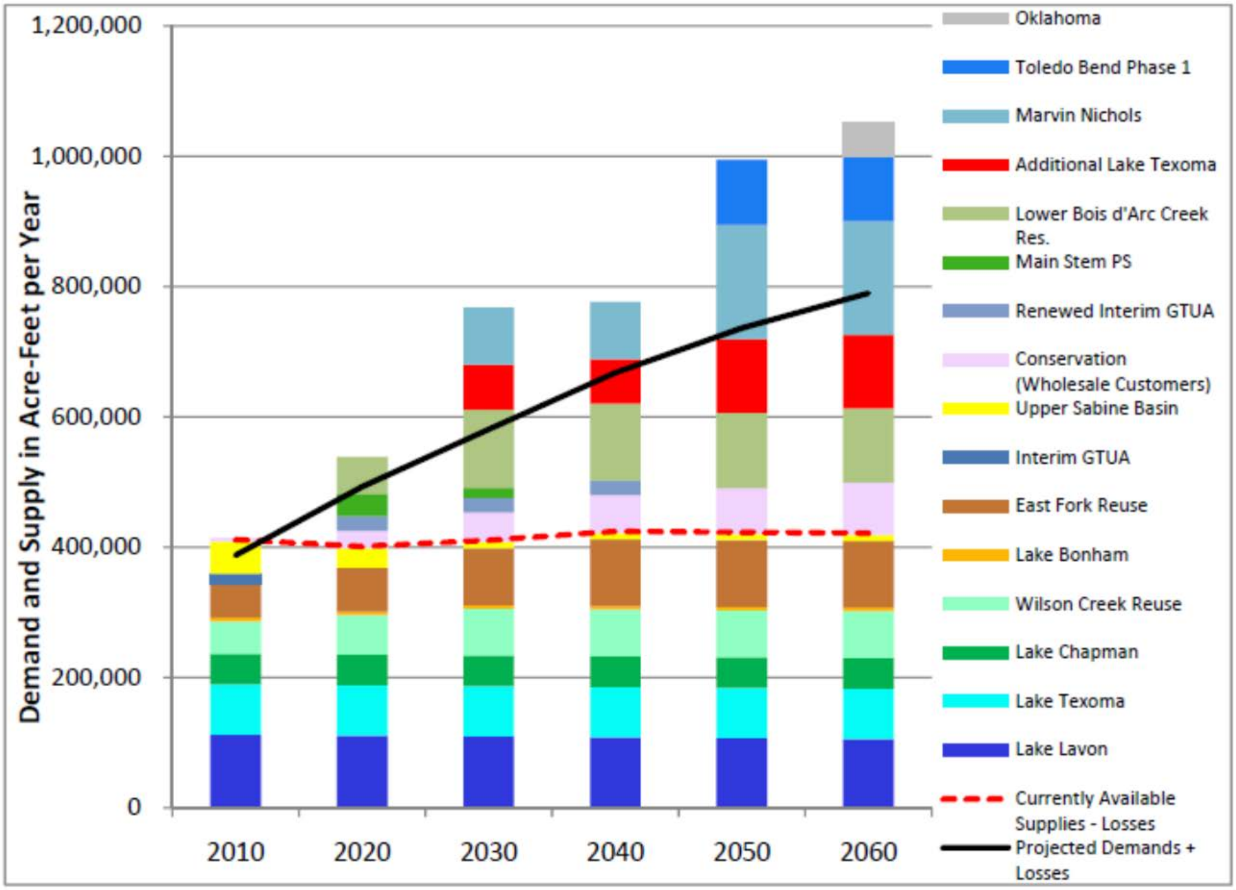


Figure 1-10. Water management strategies recommended for NTMWD by Region C Water Planning Group*

*Note: Two of the recommended strategies – Interim GTUA and Renewed Interim GTUA – are no longer available.

Four projection scenarios with four alternative sets of population values for the state are presented in Table 1-8. These scenarios each make the same mortality and fertility assumptions but differ in their assumptions about net migration. The net migration assumptions for three scenarios are derived from 1990-2000 patterns which have been altered relative to expected future population trends. This is accomplished by systematically modifying the adjusted 1990-2000 net migration rates by age, sex and race/ethnicity. The resulting scenarios are called the zero migration (0.0), the one-half 1990-2000 (0.5), and the 1990-2000 (1.0) scenario. The fourth scenario uses 2000 to 2007 estimates of net migration with the 2007 population values from the Texas State Data Center age, sex and race/ethnicity estimates (OSD, 2009).

The Zero Migration Scenario (0.0) assumes that in-migration and out-migration to Texas are equal (i.e., that net migration is zero), resulting in growth only through natural increase (the excess of births relative to deaths). This scenario is commonly used as a baseline in population projections and is useful in indicating what an area's indigenous growth (growth due only to natural increase) will be over time. Generally speaking, this scenario produces the lowest projected population increases for those counties with historical patterns of population growth through net in-migration and the highest population projections for counties with historical patterns of population decline through net out-migration. Overall, under Scenario 0.0, the state's population grows from 20,851,820 in 2000 to 26,085,109 in 2040.

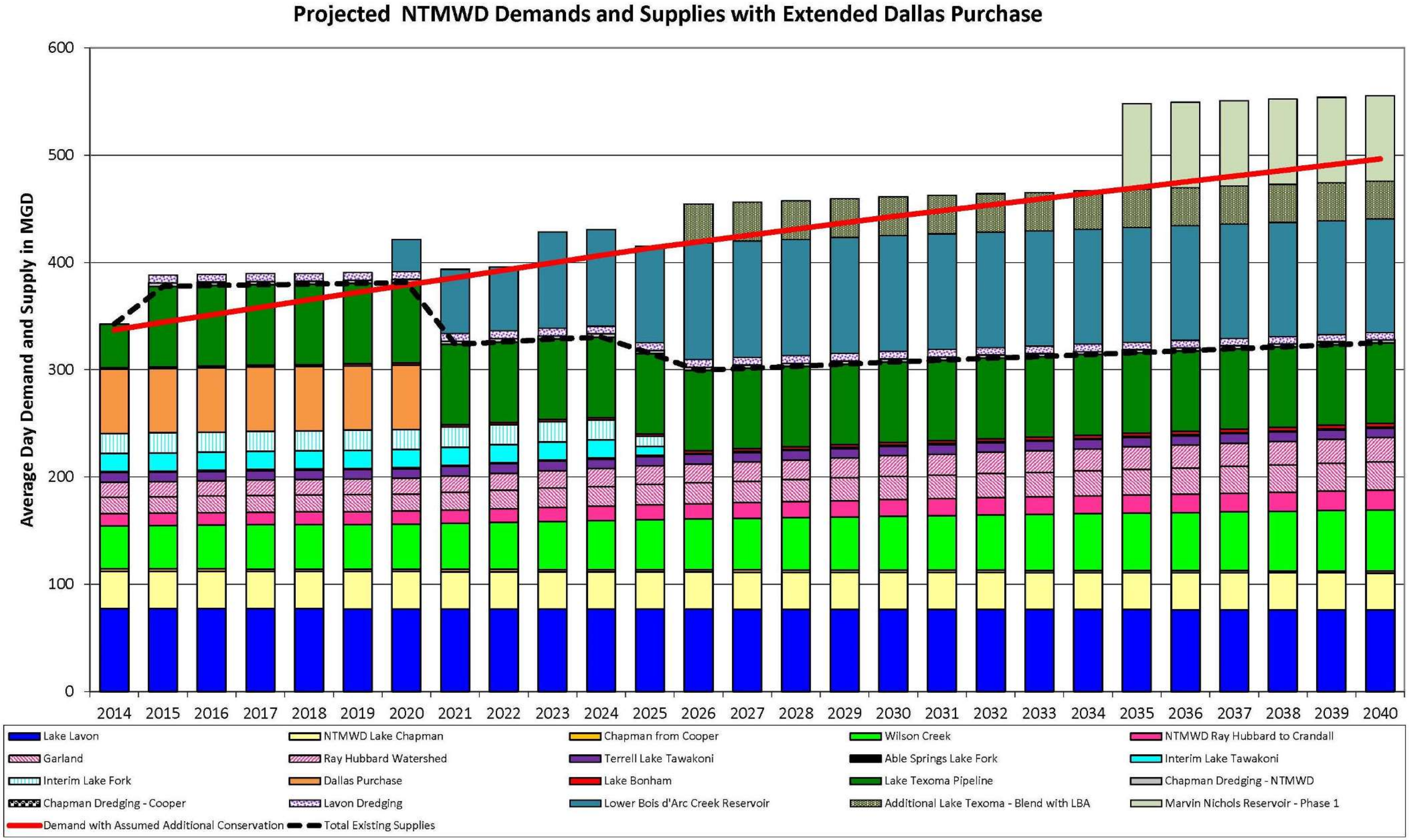
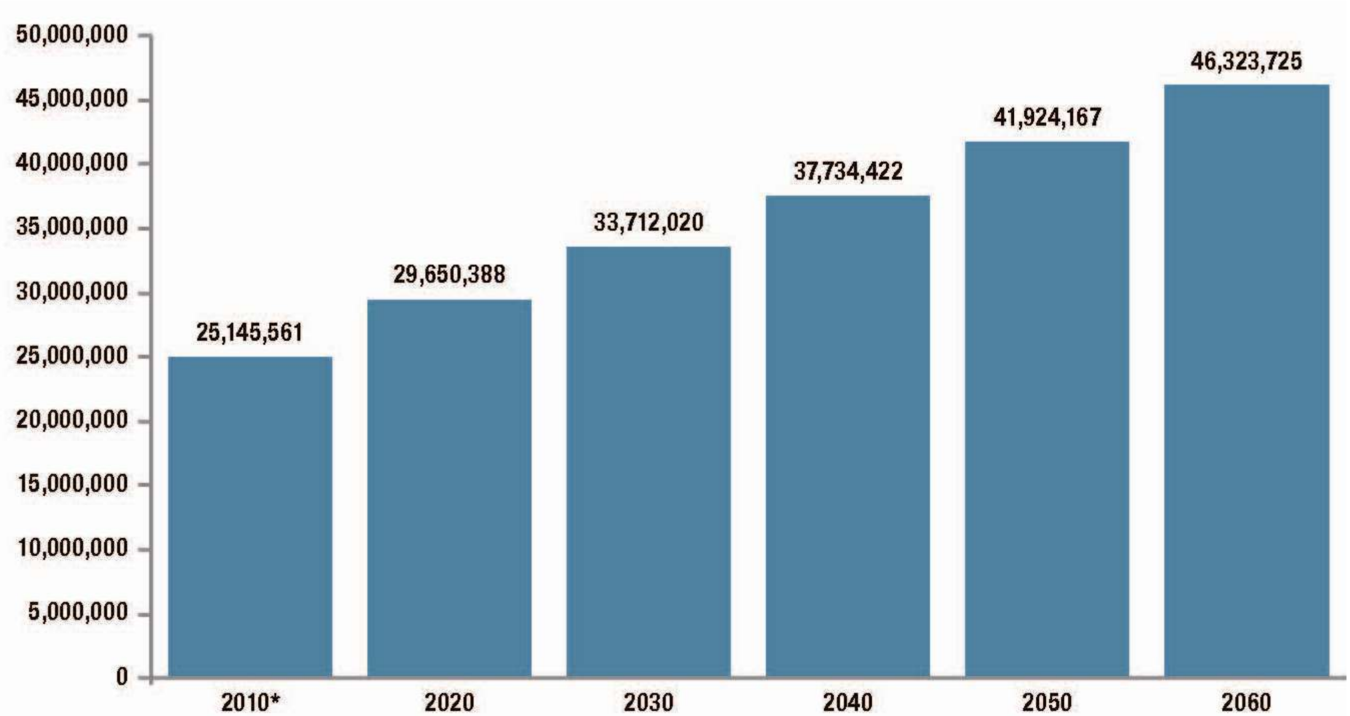


Figure 1-11. Projected NTMWD demands and supplies through 2040 with extended Dallas purchase



*2010 population is the official population count from the U.S. Census Bureau; 2020-2060 represent projected population used in the 2012 State Water Plan

Figure 1-12. Texas population projected to 2060
Source: TWDB, 2012

Table 1-8. Texas population growth projections to the year 2040

Year	Scenario 0.0	Scenario 0.5	Scenario 1.0	Scenario 2000-2007
2000	20,851,820	20,851,820	20,851,820	20,851,820
2005	21,874,143	22,556,046	23,276,607	22,973,810
2010	22,802,983	24,330,646	26,058,595	25,373,947
2015	23,625,653	26,156,723	29,213,840	28,015,550
2020	24,330,687	28,005,740	32,736,716	30,858,449
2025	24,942,836	29,897,410	36,682,200	33,936,986
2030	25,449,114	31,830,575	41,117,631	37,285,486
2035	25,830,944	33,789,697	46,105,919	40,927,000
2040	26,085,109	35,761,165	51,707,541	44,872,038

Source: OSD, 2009

OSD prepared the **One-Half 1990-2000 Migration (0.5)** Scenario as an approximate average of the zero (0.0) and 1990-2000 (1.0) scenarios. It assumes rates of net migration one-half of those of the 1990s. The reason for including this scenario is that many counties are unlikely to continue to experience the overall levels of relative extensive growth of the 1990s. A scenario which projects population growth rates approximately an average of the zero and the 1990-2000 scenarios is one that suggests slower than 1990-2000 but still steady growth (OSD, 2009). Under the Scenario 0.5, the population of Texas grows from 20,851,820 in 2000 to 35,761,165 in 2040, an increase of nearly 15 million, and a figure almost 10 million greater than the projected 2040 population of Scenario 0.0 (Table 1-8).

The **1990-2000 Migration (1.0) Scenario** assumes that trends in the age, sex, and race/ethnicity net migration rates of the 1990s will characterize those occurring in the near to mid-term future of Texas. The 1990s were characterized by rapid growth. This scenario is the state's high growth alternative because its overall pattern is one of substantial growth (i.e., 22.8% for the 1990-2000 decade for the state, a rate approximately twice that of the nation as a whole). Because growth was so widespread during the 1990s it is likely to be unsustainable over time and thus this scenario is presented here as a high growth alternative. For counties that experienced net out-migration during the 1990s, this scenario produces continued decline. Under Scenario 1.0, the state's population more than doubles from 20,851,820 in 2000 to 51,707,541 by 2040, an increase of almost 31 million. The 2040 population of Scenario 1.0 is 98% greater than the 2040 population of Scenario 0.0 and 45% greater than the 2040 population of Scenario 0.5.

The **2000-2007 Migration Scenario** accounts for post-2000 population trends. In Texas overall, and in some counties, the post-2000 period has resulted in reduced levels of net migration. In still other counties post-2000 net migration rates have been greater than those of the 1990s. Under this scenario the 2000-2007 age, sex, and race/ethnicity specific migration rates are assumed to prevail from 2000 through 2040. This scenario allows those who believe that the 2000-2007 period has produced fundamental long-term changes in population patterns to ascertain the probable future size and characteristics of the population. Under this scenario, by 2040 the population of Texas would grow to a level – 44,872,038 – roughly midway between those of Scenario 0.5 and Scenario 1.0 (OSD, 2009).

1.5.2.2 TWDB and Regional Population Projections

TWDB uses a complex water supply planning process that includes a sophisticated analysis of historical demographic trends and projected growth over a 50-year period. This analysis starts with data from the U.S. Census Bureau and the decadal federal censuses and then incorporates evaluation and demographic modeling by the OSD. OSD provides demographic projections at the state and county levels for a projected period of 30 years. The TWDB then projects the population trends for an additional 20 years to accommodate the 50-year planning horizon of large-scale water projects.

Using Census data, county populations are subdivided into water user groups (WUGs); WUGs are comprised of towns of 500 or more people, water supply corporations that supply 0.25 MGD or more, and the remaining "county-other" population. Regional water planning groups, such as the Region C group, are then given the chance to review population projections at the water user level and make adjustments if needed. Any recommended adjustment must be backed up by technical data, and total populations by region cannot be larger than the initial TWDB estimates (Kiel, 2014a).

TWDB's technique for projecting future county populations is called the cohort-component procedure. It is a standard demographic methodology which uses the separate cohorts (groups defined by common age, sex, race, and ethnicity) and the components of cohort change (fertility rates, survival rates, and migration rates) to calculate future populations. Projections of each particular cohort are then added together to obtain the total population. Cohorts used in the projection process are defined as single-year-of-age (0 to 75) sex and race/ethnic groups, which include four single-race/ethnic groups (Anglo, Black, Hispanic, and Other).

Fertility rates for each female cohort are included in the projection procedure for calculating the number of births anticipated to occur in each projection interval. Survival rates for each cohort are used to compute the change in the cohort size from the number of deaths anticipated to occur within each projection interval. The net migration rates for each cohort are used to compute the change in each cohort due to in-migration or out-migration in a specific county (TWDB, 2005).

The method has four main sequential steps. The first step is to project the population alive at the start of the period who will survive to the target year. The second step is to project net migration by multiplying net migration rates by the adjusted population in the launch year. The third step is to project the number of births and the net impact of mortality and migration on the youngest age group. The fourth and final step is to combine the results from the mortality, migration, and fertility modules. For each cohort but the youngest, the projected population at each age is calculated as the survived population plus net migration.

One noteworthy limitation in making demographic projections is the quality of the underlying data on which the projections are based. The limitations of census counts can in turn limit the accuracy of population projections and analyses. All censuses may undercount the number of actual residents, particularly minority populations. The U.S. Census Bureau has acknowledged undercounts at times. Because Texas population projections are based on federally adopted census counts, any undercount could lead to lower projections for some areas of the state, and actual growth may outpace the projections.

Since regional plans and State Water Plan projections start at the county level and are controlled to the state level, one of the more obvious limitations of such micro-level forecasting is that unpredictable events such as the unexpected opening or closing of a large factory or other large source of jobs can sometimes produce an unanticipated effect on population and water demand projections. Also, any unforeseen changes in the underlying factors affecting migration, fertility, or mortality rates can result in an under- or over-projection of the state's population. Demographers continually modify and update projections with assumptions that attempt to reflect ever-changing demographic realities in society.

Comparing the population projections for 2040 of TWDB (2012) and OSD (2009), it is evident that the projection that TWDB uses as a basis for projecting future state water demands closely matches, but is not identical with, Scenario 0.5 – 37.7 million (TWDB) versus 35.7 million (OSD). This may be considered the moderate or middle-series projection.

As suggested above, expected future growth rates from one region of the state to another are divergent; that is, they vary substantially. Some areas are on a trajectory to double or even triple their populations by 2060, while others are likely to grow slowly; yet other regions are anticipated to lose aggregate numbers of people. According to TWDB demographers, 43 counties and 297 cities are projected to at least double their population by 2060, but another 45 counties and 137 cities are expected to lose population or remain stable (neither growth nor decline). The rest of the state's counties and cities are expected to grow slightly (TWDB, 2007).

In projecting future population growth and associated water needs within its own service area, NTMWD cannot rely solely on the overall, generalized growth/decline trends for Texas as a whole, but must focus on likely demographic trends within the nine counties – Collin, Dallas, Denton, Fannin, Hopkins, Hunt, Kaufman, Rains and Rockwall – portions or all of which it serves. Using the same four scenarios in Table 1-8 above, the OSD has also developed population projections for these counties (and all others in the state) to 2040. Table 1-9 shows the projected 2040 population for each of these counties for each of the four scenarios.

One of the most striking features of the figures in Table 1-9 is the wide range between projected populations under the different migration scenarios for some, but not all of the counties. In Rockwall County, for example, the difference between the smallest and the largest projection is more than ten-fold, while in Rains County it is slightly more than two-fold. In all instances save one (Scenario 0.0 for Rains

County), the projected 2040 populations are larger than the 2000 populations for all counties and all scenarios.

Table 1-9. OSD-projected 2040 populations in counties served by NTMWD, by scenario

County	2000 Population	2040 Scenario 0.0	2040 Scenario 0.5	2040 Scenario 1.0	2040 Scenario 2000-2007
Collin	491,675	586,069	1,348,530	2,961,934	3,014,033
Dallas	2,218,899	2,822,991	3,919,591	5,799,645	3,250,069
Denton	432,976	551,464	1,245,264	2,770,562	1,993,530
Fannin	31,242	31,861	39,501	44,031	39,989
Hopkins	31,960	35,639	38,511	38,150	35,957
Hunt	76,596	88,316	142,307	246,344	123,495
Kaufman	71,313	85,522	169,280	332,250	326,973
Rains	9,139	8,526	12,931	18,204	12,289
Rockwall	43,080	51,962	109,912	228,994	528,745

Source: OSD, 2009

The population of Region C (in which most of the NTMWD service area is located) has grown from 987,925 in 1930 to 6,347,326 in 2008, an increase of more than six-fold in less than eight decades. As of 2008, Region C contained 26% of Texas' total population. From 1940 through 2008, the regional population increased at an average compound or exponential rate of 2.7% annually. The increase of 1,092,604 people (20.8%) in the eight years from 2000 through 2008 indicates that the region is still growing rapidly (Freese and Nichols, et al., 2010). Figure 1-13 is a graph of the historical population for Region C, as well as a population projection.

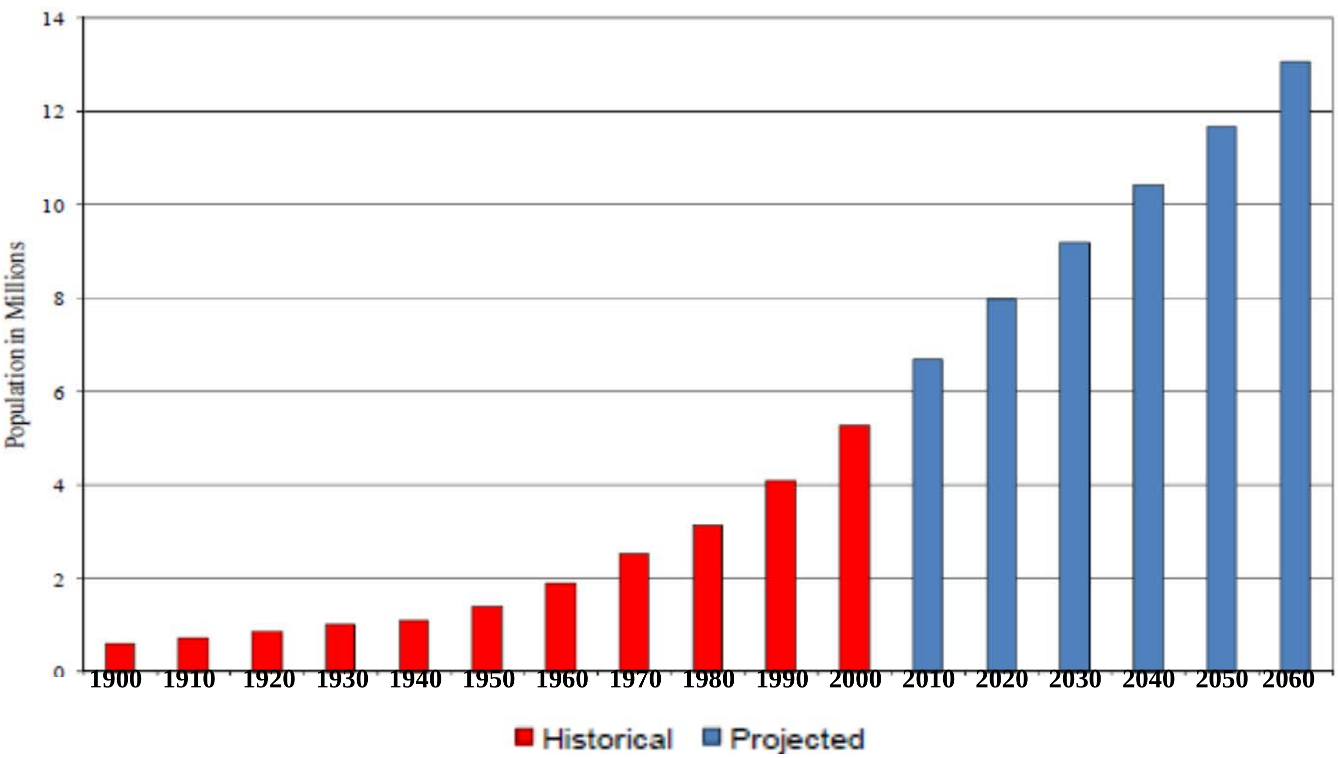


Figure 1-13. Historical and projected population growth of Region C
Source: 2011 Region C Water Plan, Figure 2.1 (Region C Water Planning Group, 2011)

Region C includes most of the Dallas and Fort Worth-Arlington metropolitan statistical areas (MSAs). The largest employment sector in the Dallas MSA is the service industry, followed by trade, manufacturing, and government. The Fort Worth-Arlington MSA's largest employment sectors are service, trade, and manufacturing. Both MSAs experienced strong economic growth in the 1990s (Freese and Nichols, et al., 2010).

The 2011 Region C Water Plan has developed population and water demand projections for all cities with populations over 500 and for any retail water supplier (such as a water supply corporation or a utility district) which provides over 0.25 million gallons per day of water supply. These are collectively referred to as the aforementioned water user groups (WUGs). The population projections are based on projections from the 2006 Region C Water Plan. Those projections have been updated based on suggested changes from the TWDB, recent population estimates from the OSD and the North Central Texas Council of Governments (NCTCOG), input from WUGs, and input from wholesale water providers (WWPs, such as the NTMWD) in Region C (Region C Water Planning Group, 2010).

For Region C in its entirety, the population projections recommended by Region C and adopted by the TWDB for the 2011 plan are very close to the projections from the 2006 Region C Water Plan. The revised total population is slightly higher in years 2000 through 2050 and slightly lower in 2060. In general, future population increases have shifted from urban areas to areas further from urban centers.

Table 1-10 and Figure 1-13 show the projected population for Region C counties, as adopted by TWDB. The projected 2060 population for Region C is 13,045,592. This figure is very close to the projected 2060 population – 13,087,849 – from the *2006 Region C Water Plan*. OSD population estimates from 2007 show that current population growth in Region C is generally equal to the growth that was projected in the 2006 Region C Water Plan.

While the graph of projected population growth in Figure 1-13 appears to climb steadily all the way to the year 2060, in fact, the decadal rate of population growth in Region C is expected to slow markedly from that prevailing historically, as shown by Figure 1-14. Nevertheless, projected growth in absolute population size from decade to decade (as opposed to percentage change or rate) remains quite high, as measured by the added population increment per decade, because applying a smaller rate of increase to a larger and growing base number still produces large decadal increases.

Figure 1-15 is a map of the projected percent change in population between 2006 and 2060 by county. Focusing on the six Region C counties served by NTMWD, by 2060 Dallas County is projected to increase in the 50-100% range, Collin and Fannin counties in the 100-200% range, and Denton, Kaufman, and Rockwall counties in the 200-300% range.

For Region C overall, the population projections recommended by Region C and adopted by the TWDB for the 2011 *Region C Water Plan* compare very closely with the projections from the 2006 plan for Region C. The revised total population for the region is slightly higher in years 2000 through 2050 and slightly lower in 2060. In general, the projected population increases in future years have shifted from urban areas within the region to areas more removed from urban centers, such as those within the service area of the NTMWD (Region C Water Planning Group, 2011).

The USACE-Tulsa District considers the methodology and procedures developed and implemented statewide by the TWDB as part of the integrated water planning process in Texas to be sound and the resultant population projections yielded by this methodology for Region C to be accurate and reasonable.

Table 1-10. TWDB-adopted county population projections for Region C

County	Historical 1990	Historical 2000	2010	2020	2030	2040	2050	2060
Collin	264,036	491,774	790,648	1,046,601	1,265,373	1,526,407	1,761,082	1,938,067
Cook	30,777	36,363	40,674	46,141	51,749	56,973	65,099	71,328
Dallas	1,852,810	2,218,774	2,512,352	2,756,079	2,950,635	3,128,628	3,365,780	3,695,125
Denton	273,525	432,976	674,322	889,705	1,118,010	1,347,185	1,573,994	1,839,507
Ellis	85,167	111,360	169,514	233,654	293,665	351,919	411,721	471,317
Fannin	24,804	31,242	38,129	42,648	49,775	60,659	74,490	86,970
Freestone	15,818	17,867	19,701	21,826	23,704	25,504	27,148	28,593
Grayson	95,021	110,595	126,099	152,028	179,725	203,822	227,563	253,568
Henderson	41,309	51,984	56,254	65,009	75,232	85,112	96,835	111,026
Jack	6,981	8,763	9,567	10,275	10,915	11,415	11,915	12,415
Kaufman	52,220	71,313	103,249	162,664	208,009	254,609	297,391	349,385
Navarro	39,926	45,124	52,752	58,919	65,331	72,374	80,168	89,638
Parker	64,785	88,495	121,653	193,559	262,053	301,760	324,546	342,887
Rockwall	25,604	43,080	89,144	141,386	171,373	199,044	215,312	232,186
Tarrant	1,170,103	1,446,219	1,800,069	2,061,887	2,337,390	2,646,559	2,964,622	3,353,509
Wise	34,679	48,793	66,366	89,347	108,711	127,068	148,020	170,071
Region C Total	**4,077,565**	**5,254,722**	**6,670,493**	**7,971,728**	**9,171,650**	**10,399,038**	**11,645,686**	**13,045,592**

Source: Table 2.1, *2011 Region C Water Plan* (Region C Water Planning Group, 2010)

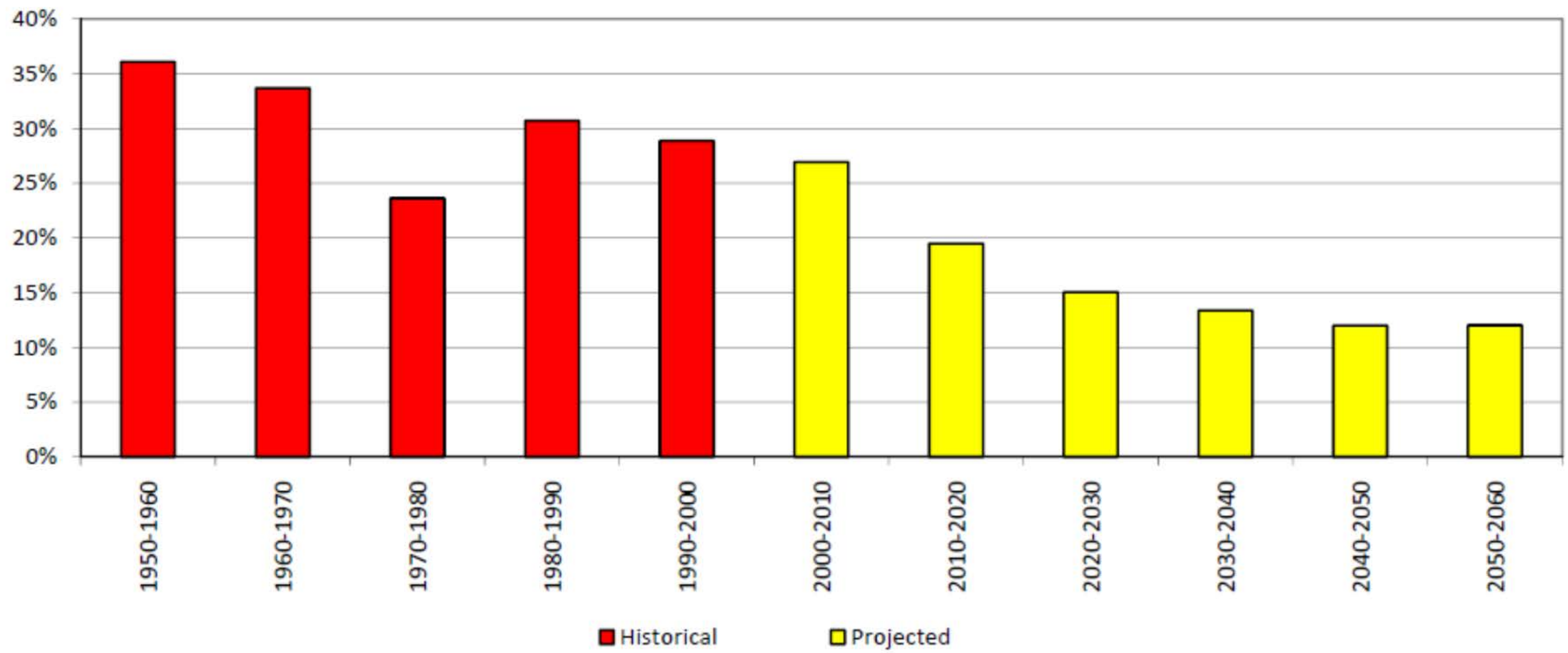


Figure 1-14. Historical and projected population growth rates by decade for Region C

Source: 2011 Region C Water Plan (Region C Water Planning Group, 2010)

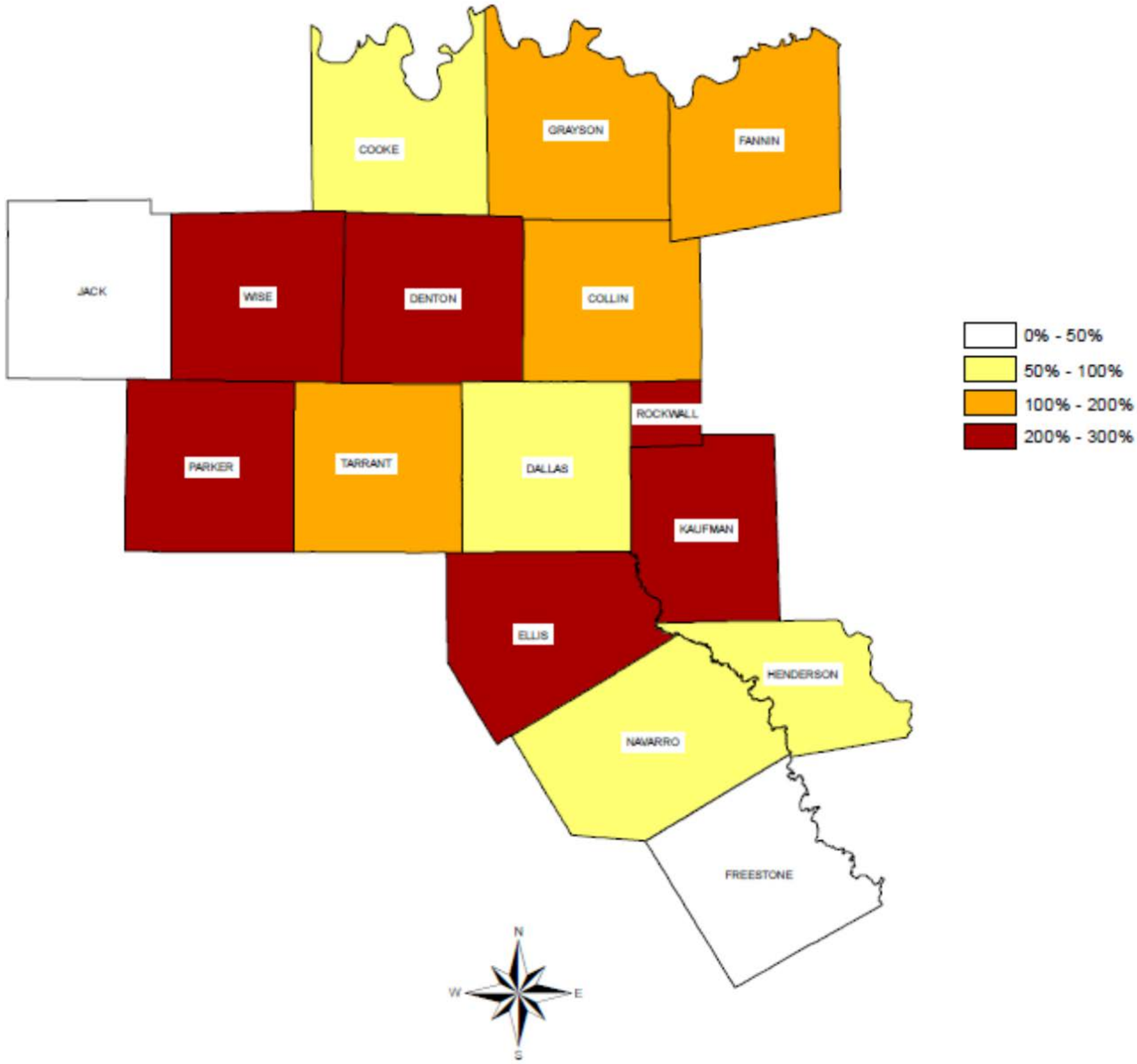


Figure 1-15. Projected 2006-2060 population increases in Region C counties
Source: Figure 2.5, *2011 Region C Water Plan* (Region C Water Planning Group, 2010)

1.5.3 Regional Water Demand Projections

Projections of municipal water demands in Texas are based on two key underlying variables: 1) historical per capita water use, and 2) projected population change. Reductions in water use associated with the 1991 State Water-Efficient Plumbing Act are taken into account separately by TWDB and provided to the regional planning groups, such as Region C. As in the case of population projections, the regional water planning groups can review the water demand projections at the water user level and recommend adjustments if needed and if supported by technical evidence. Demand projections for other water use categories in Texas are derived separately and are based on the best data available (Kiel, 2014a).

Municipal water use is reported to the TWDB on an annual basis by cities and other water suppliers such municipal utility districts like NTMWD. The types of information reported include groundwater and/or surface water use, source of the water (aquifer, river, reservoir, or stream), water sales and water purchases to other municipalities and end users, number of service connections, and estimated population served.

Per capita water use is the average amount of water used by each person, which is based on total water use divided by population size. Because of diverse climatic conditions, variable population density and density of commercial businesses, consumers' ability to pay for water as indicated by average incomes, effectiveness of local conservation programs, and availability of water across the state, Texas has a wide range of per capita water use.

The weather also influences the amount of water used annually. Rainfall frequency plays a large role in the volume of water used for municipal purposes, especially for outdoor uses. During below-normal rainfall periods, people tend to use more water than during normal weather conditions.

The state's methodology for water demand projections for the 2006 Regional Water Plans also served as the methodology for the 2011 regional water plans, since the 2011 plans were an update of the 2006 plans. While there are some differences between the methodologies for the 2011 Regional Water Plans and the 2016 plans now in preparation, the concept and approaches are very similar.

The volume of water used for municipal purposes in Texas (or anywhere) depends primarily on population size, climatic conditions, and water conservation practices. For the TWDB's planning purposes, municipal water use includes that consumed by residences (single and multifamily housing), commercial entities, and institutions. Commercial water use includes business establishments but excludes industrial water use. Residential, commercial, and institutional uses are all lumped together because of the similarity of these uses; that is, they all use water primarily for drinking, cleaning, sanitation, air cooling, and outdoor use (e.g., landscaping, washing cars) (TWDB, 2005).

The Region C Water Planning Group based its 2011 municipal water demand projections on per capita dry-year water use and the adopted population projections above. In turn, the per capita dry-year water uses are based on per capita water uses from the 2006 Region C Water Plan, which include water savings from plumbing code requirements for low-flow fixtures. The Region C Water Planning Group adjusted the per capita water uses from the 2006 Region C Water Plan as necessary, based on recent historical per capita information from TWDB and on input from water user groups (Region C Water Planning Group, 2010).

In addition, revisions to the demand projections were also made based on input from water user groups and wholesale water providers in Region C. Each WUG and WWP in Region C was surveyed regarding their water use projections. Each WUG was provided a copy of their water use projections from the 2006 Region C Water Plan and asked if they were in agreement with the projections. If the WUG was not in agreement with the projections they were asked to provide alternative projections. Some WUGs responded with suggestions for revisions to the demand projections. Additionally, interviews were arranged with certain WUGs and WWPs to gather more detailed information. Phone and email correspondence was also used to gather additional information. All data were compiled and used to develop a final set of recommended per capita and demand projections. As required by TWDB regulations, these projections were posted for public review on the Region C website well in advance of the Region C Planning Group Meeting at which they were considered for approval (Region C Water Planning Group, 2010).

Non-municipal water demand projections include manufacturing, steam-electric-power, irrigation, mining, and livestock; these are reported on a county-wide basis and were also based on the projections from the 2006 Region C Water Plan. Projections for manufacturing, irrigation, and livestock did not change. However, the steam-electric-power demands were revised based on available new information, including recent power plant development activity and mothballing of existing plants. Mining projections were also revised based on changed conditions, primarily recent exploration and mining of the Barnett Shale, which led to an increase in Region C mining water use.

Under guidance of the TWDB, the water planning regions in Texas, including Region C, are now updating population and water demand projections for the 2016 regional water plans (TWDB, 2014). Draft municipal water demand projections are obtained by multiplying the population projections by a per-person water use volume for each city, water utility and rural area (County-Other). The draft projections for 2016 will include 2011 per-person water use values (Gallons Per Capita Daily or GPCD) as the initial 'dry-year' water use estimate. TWDB staff then applies future anticipated reductions in water use due to natural replacement rates for adoption of water-efficient fixtures and appliances as required by law. For each municipal WUG, the 2011 GPCD, minus the incremental anticipated savings for each future decade due to water-efficient fixtures/ appliances, is multiplied by the projected population to develop the municipal water demand projections (TWDB, 2014).

The 2011 GPCD for each WUG is calculated by:

- Calculating the net water use of each water system surveyed annually by the TWDB (total intake volume minus sales to large industrial facilities and to other public water suppliers);
- Allocating all or portions of the system net use and applicable estimates of non-system municipal water use (private groundwater) to the planning water user groups (city boundaries or water utility service areas); and
- Dividing the total water use allocated to a water user group by 365 and by the 2011 population estimate.

Federal standards on plumbing fixtures, dish washers, and clothes washing machines have been upgraded, offering potential savings due to installation of more water-efficient units; these account for a small but significant portion of total water use. Anticipated savings due to water-efficient appliances and fixtures include 16 GPCD for toilets and showerheads, 1.6 GPCD for high-efficiency toilets, 1.6-1.9 GPCD for dishwaters, and 6.5 GPCD for washing machines (TWDB, 2014).

Table 1-11 shows the historical and projected total water demand for Region C counties, as adopted by TWDB. The year 2060 projected water demand for all of Region C is 3,272,461 acre-feet per year, up from 1,761,353 AFY in 2010, an increase of 86% during the 50-year time period in question. Table 1-12 and Figure 1-16 show adopted water demand projections of Region C by type of use. By far the largest use in Region C is municipal. Region C municipal use is projected to expand from 1,546,970 acre-feet in 2010 to 2,924,157 acre-feet in 2060 according to these projections, an increase of 89%. By comparison, NTMWD's annual water demand from current and potential customers is projected to increase from 387,574 acre-feet in 2010 to 789,676 acre-feet in 2060, an increase of 104%. The greater percentage increase (104% vs. 89%) in projected municipal demand for NTMWD than for municipal use in Region C as a whole is because NTMWD's service area is mostly located in more rapidly growing and developing parts of the region, on the periphery of the Dallas metropolitan area, rather than in more established, already built-up areas like Dallas proper.

The USACE-Tulsa District considers the water demand projection methodology developed and implemented by the TWDB as part of the integrated water planning process in Texas to be sound and the resultant water demand projections for Region C to be accurate and reasonable.

Table 1-11. TWDB-adopted county water demand projections for Region C

County	Historical Year 2006 Demand (Acre-Feet)	Projected Water Demand (Acre-Feet per Year)					
		2010	2020	2030	2040	2050	2060
Collin	160,712	217,512	286,372	340,681	405,122	461,762	502,770
Cook	8,324	9,863	10,870	11,645	12,332	13,426	14,381
Dallas	623,985	691,846	750,995	800,855	842,877	902,496	991,021
Denton	108,894	153,934	201,534	255,146	302,043	348,219	400,618
Ellis	32,980	38,067	49,730	61,287	74,192	87,403	101,095
Fannin	12,191	13,260	19,296	25,691	28,029	31,046	34,063
Freestone	14,797	16,733	23,192	25,765	29,484	33,982	39,396
Grayson	30,953	42,798	51,677	60,588	65,415	70,485	76,742
Henderson	8,343	10,942	12,395	20,591	23,074	25,978	29,342
Jack	2,892	5,515	5,906	6,140	6,366	6,610	6,867
Kaufman	21,683	30,609	43,906	52,411	60,848	68,246	77,308
Navarro	11,184	12,499	21,538	27,883	28,829	29,996	31,482
Parker	21,527	28,760	39,178	51,788	58,543	62,950	66,771
Rockwall	11,907	22,267	35,482	42,571	49,278	52,975	56,463
Tarrant	320,345	423,553	476,587	537,641	604,230	674,652	763,750
Wise	13,818	43,195	50,086	57,055	64,440	72,095	80,392
Region C Total	**1,404,535**	**1,761,353**	**2,078,744**	**2,377,738**	**2,655,102**	**2,942,321**	**3,272,461**

Source: Table 2.2, *2011 Region C Water Plan* (Region C Water Planning Group, 2010)

Table 1-12. TWDB-adopted water demand projections for Region C by type of use

Use	Historical Year 2006 Demand (Acre-Feet)	2010	2020	2030	2040	2050	2060
Municipal	1,274,014	1,546,970	1,833,671	2,087,597	2,344,115	2,612,176	2,924,157
Manufacturing	53,027	72,026	81,273	90,010	98,486	105,808	110,597
Steam Electric Power	15,997	40,813	64,625	98,088	107,394	116,058	126,428
Irrigation	31,067	40,776	40,966	41,165	41,373	41,596	41,831
Mining	10,367	41,520	38,961	41,630	44,486	47,435	50,200
Livestock	20,063	19,248	19,248	19,248	19,248	19,248	19,248
Region C Total	**1,404,535**	**1,761,353**	**2,078,744**	**2,377,738**	**2,655,102**	**2,942,321**	**3,272,461**

Source: Table 2.3, *2011 Region C Water Plan* (Region C Water Planning Group, 2010)

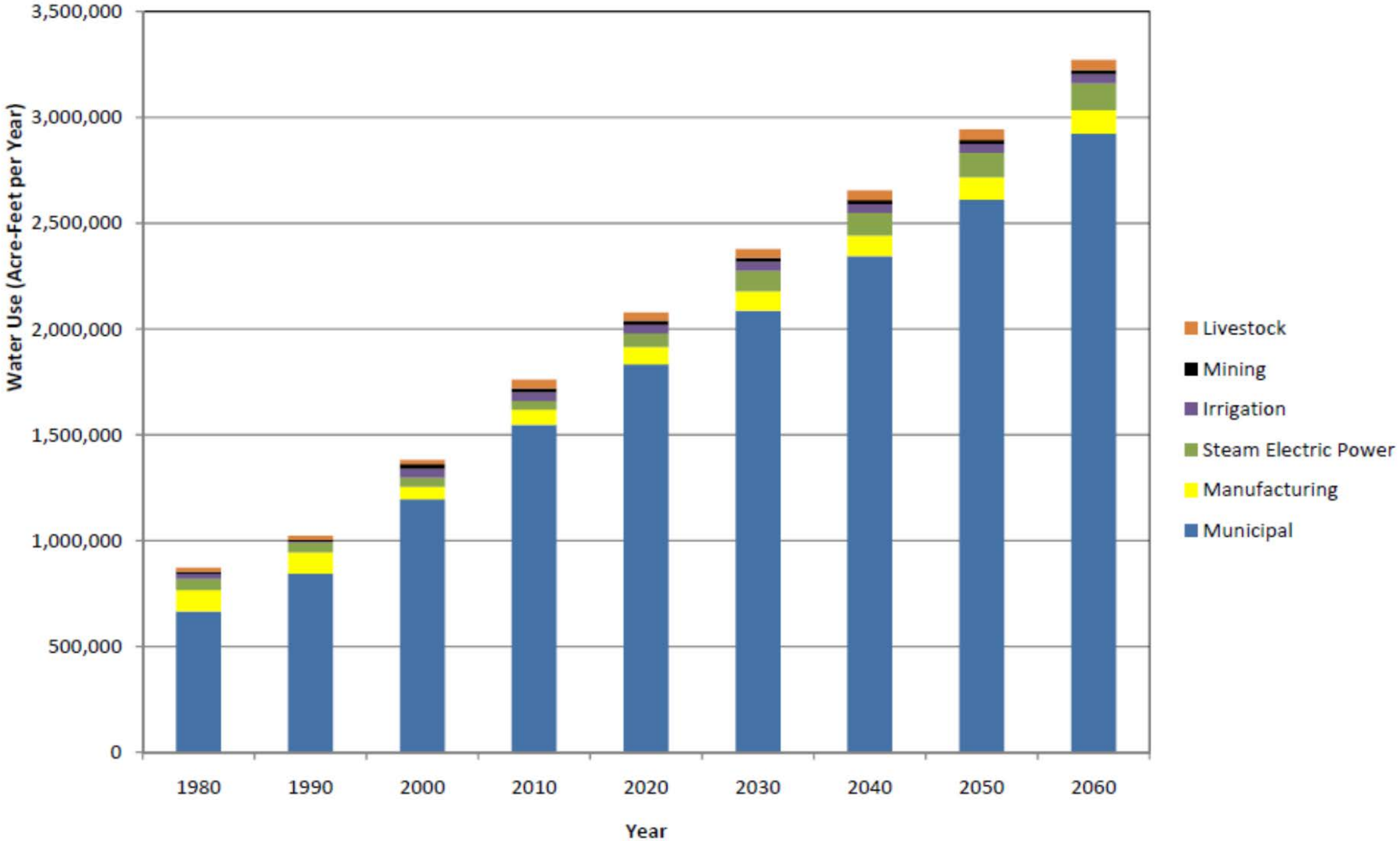


Figure 1-16. Historical and TWDB-adopted water demand projections by water use category in Region C, 1980-2060

Source: Figure 2.6, *2011 Region C Water Plan* (Region C Water Planning Group, 2010)

Note: In this chart, "irrigation" refers to agricultural irrigation and not municipal/residential irrigation, which is indistinguishable from other municipal uses.

Figure 1-17 is a map of the percentage change in projected water demand county-by-county between years 2006 and 2060 within Region C. In comparing Figure 1-17 with Figure 1-15 (projected percentage population increases by county), one observes the strong correlation between projected county population increases and projected increases in water demand within those same counties.

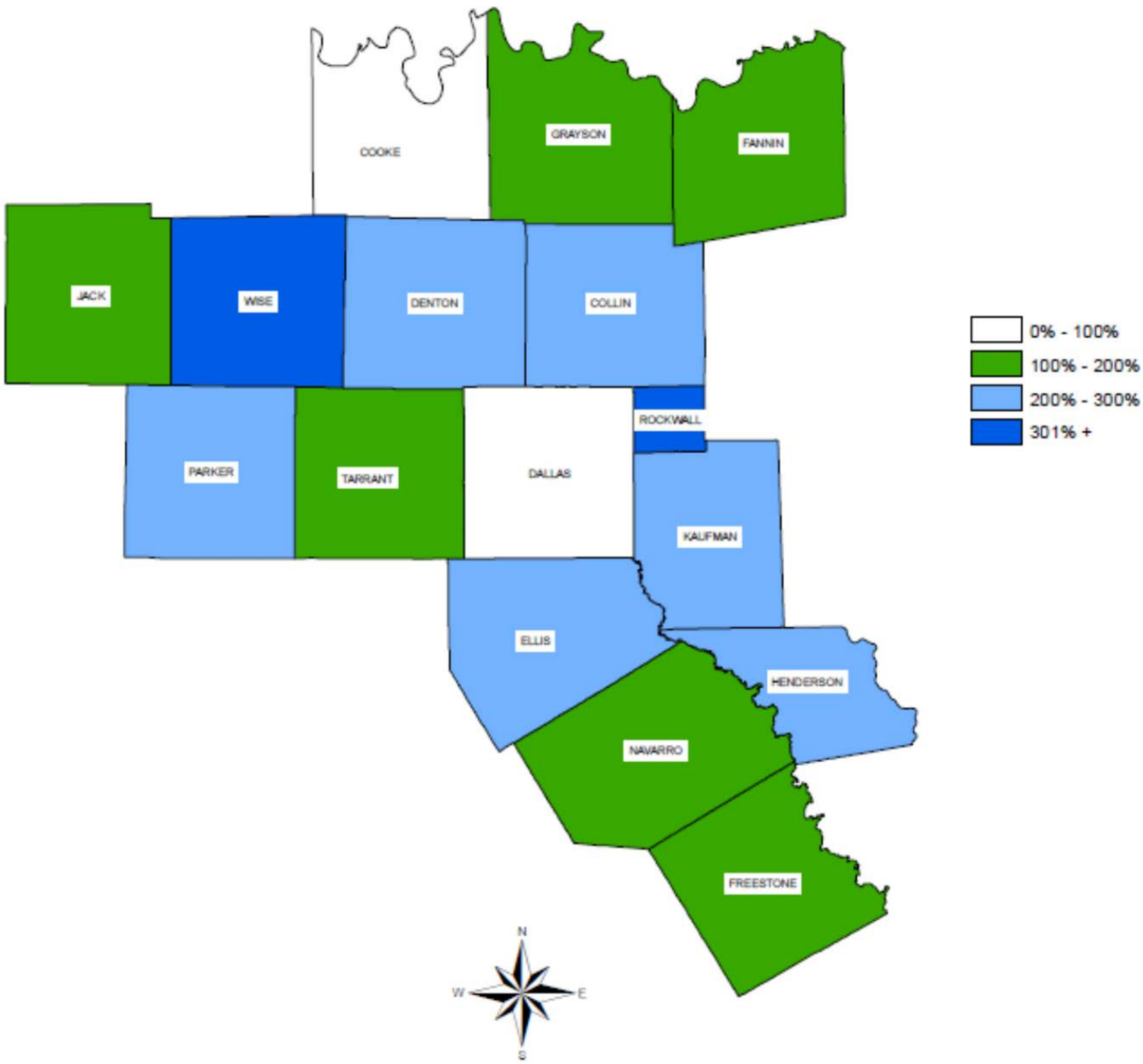


Figure 1-17. Projected 2006-2060 percentage increases in Region C water use by county
Source: Figure 2.8, *2011 Region C Water Plan* (Region C Water Planning Group, 2010)

1.5.4 Existing Water Sources and Supplies

The primary water supply currently available to NTMWD includes raw water from three existing reservoirs (Lakes Lavon, Texoma, and Chapman), wastewater reuse from NTMWD's Wilson Creek Wastewater Treatment Plant, and the East Fork Raw Water Supply Project (Freese and Nichols, 2008a).

Supplies expected to be available from these sources both in 2010 and 2060 are listed in Table 1-2. To meet its immediate needs, NTMWD has also contracted with the Sabine River Authority for interim water supplies until new sources can be developed. Including these interim supplies, the total amount of water available to NTMWD is 396,008 AFY in 2010 and 421,405 AFY in 2060.

Definition of terms for water supplies

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.

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

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.

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.
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1.5.4.1 Lake Lavon

Lake Lavon Dam (Figure 1-18) is located at river mile 55.9 on the East Fork of the Trinity River, approximately three miles east of Wylie, in Collin County, Texas. The lake is approximately 21,400 acres in area. It is part of the Trinity Project in the Fort Worth District of the USACE.

The Lake Lavon Project was authorized by Congress in 1945; construction began in 1948 and was completed six years later in 1954. The dam and lake have a drainage area (i.e., control runoff from an upstream watershed) of about 770 square miles, primarily located in Collin and Grayson Counties, surrounding the headwaters of the East Fork of the Trinity River. Lake Lavon's authorized purposes are flood control, water supply, and recreation (USACE, 2008a).

At Lake Lavon's normal conservation pool elevation of 492 ft. above sea level, it stores approximately 443,800 AF of water (162 billion gallons). Total lake storage, including flood storage, is 748,200 AF (245 billion gallons). NTMWD's water right in Lake Lavon is 118,680 AFY. NTMWD has the capability to divert and treat 770 million MGD from Lake Lavon at its local water treatment facility for wholesale distribution to its members and customers. However, NTMWD's ability to divert this quantity of water is affected by lake elevation. Some of this water is placed in Lake Lavon from other sources, which are discussed in subsequent sections. According to the Region C Water Planning Group, the water supply available (firm yield) to NTMWD from Lake Lavon in 2010 was 112,033 AFY per year and 105,700 AFY will still be available in 2060 (Table 1-2).

Lake Lavon receives about 1.6 million visitors annually. The lake has numerous recreational facilities to accommodate these visitors, including 16 parks, 244 picnic sites, 19 four-lane boat ramps, five beaches, 71 tent camping sites with water, 167 camping sites with electric and water hook-ups, a handicapped park, and six group shelters for large group picnics. There are also two privately owned marinas and one fishing pier. The lake's fish population includes several species of sport fish, including crappie, white bass, black bass, channel catfish, striped bass and hybrid bass. Adjacent to the lake are 6,500 acres for wildlife and hunting. Game species include squirrel, cottontail rabbit, mourning dove, bobwhite quail, waterfowl and feral hogs (USACE, 2008a).

Figure 1-18. Lake Lavon Dam near Wylie, Texas (USACE photo)

1.5.4.2 Lake Chapman

Jim Chapman Lake (Figure 1-19) (also known as Lake Chapman or Cooper Lake) is a 19,305-acre impoundment that provides water supply storage for NTMWD, the Sulphur River Municipal Water District, Upper Trinity Regional Water District and the City of Irving. The drainage area upstream of the dam is 479 square miles. Water from Lake Chapman for NTMWD is transmitted by pipe to Lake Lavon for diversion to NTMWD's Wylie WTP. According to the Region C Water Planning Group, the water supply available (firm yield) to NTMWD from Lake Chapman in 2010 was 47,132 AFY and the same amount will still be available in 2060 (Table 1-2). NTMWD's water right to Lake Chapman is 54,000 AF; another 3,214 AFY is available per a contract with the City of Cooper, for a total supply of 57,214 AFY. However, Lake Chapman is over-permitted, and 57,214 AFY would not be sustainable through a drought.

The Cooper Lake Project was authorized in 1955; construction started in 1986 and finished in 1991. The lake is located within the South Sulphur River watershed between Delta and Hopkins Counties. The USACE built the lake both to control flooding on the Sulphur River and to serve as a water supply. The lake was renamed Jim Chapman Lake in 1998 but is still widely known as Cooper Lake, and the Cooper Lake State Park and Cooper Dam retain the name. The area provides recreational opportunities that include two state parks and a wildlife management area. USACE uses partnerships to manage more than 29,000 acres of public land at Jim Chapman Lake. Over 15,000 acres of land and water are leased to the TPWD for the management of fish and wildlife resources. TPWD also leases approximately 1,905 acres of land to provide recreational facilities in both Hopkins and Delta counties. NTMWD manages the water intake facility that provides the water supply to several communities (USACE, 2010c).

Figure 1-19. Cooper Dam and Jim Chapman Lake (USACE photo)

1.5.4.3 Lake Texoma

Impounded by the Denison Dam on the Red River in Bryan County, Oklahoma and Grayson County, Texas, Lake Texoma is the 12th-largest USACE reservoir in the country and the largest in the Tulsa District. The lake has a normal surface area of 86,910 acres (136 sq. miles), a volume of 2,516,232 AF, 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).

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, at which point Denison Dam was America's largest rolled, earth-filled dam. The dam is now the 12th largest in volume in the U.S.

According to the Region C Water Planning Group, the water supply available to NTMWD from Lake Texoma in 2010 was 77,300 AFY and the same amount will still be available in 2060 (Table 1-2). NTMWD's water right in Lake Texoma is 197,000 AFY, which includes:

- 84,000 AFY from the original permit which can be conveyed by pipeline to Sister Grove Creek and hence to Lake Lavon. However, due to estimated channel losses in Sister Grove Creek, only 77,300 AFY of this Lake Texoma water may be withdrawn from Lake Lavon.

- 113,000 AFY that cannot be discharged into Lake Lavon, but must be taken directly to a water treatment plant. The high salinity of this water would require it to be blended with water from another lower salinity supply source or treated by advanced, and more expensive, water treatment methods. Facilities to transfer or treat this water have not been constructed.

Until recently, NTMWD made an annual interim purchase of approximately 16,000 AF from GTUA. This temporary ten-year contract was to have expired in February 2016, and may have been extended at that time. However, as noted earlier in this chapter, NTMWD terminated this contract in December 2012.

As mentioned elsewhere in this chapter, Lake Texoma water has been inaccessible to NTMWD during the last five years as a result of zebra mussel infestation of the Texoma waters. This problem has been resolved at great expense with the passage of special legislation and the construction of a $300 million pipeline to deliver the water directly to the Wylie WTP, bypassing gravity flow within Sister Grove Creek. In general, any future transfers of raw water between surface waters will raise potential invasive species issues and costs.

Lake Texoma is the most developed and popular lake within the entire USACE Tulsa District, attracting approximately six million visitors a year, many of them from the Dallas-Fort Worth Metroplex, about an hour south of the lake. Fishing, boating, water-skiing, and other water-oriented activities abound in the lake's clear waters. Popular sport fish include striped, largemouth, smallmouth, white, and hybrid striped bass, white and black crappie, and channel and blue catfish. The USACE alone has 10 different campgrounds (Figure 1-20) with more than 600 campsites around Lake Texoma. Forty miles of equestrian trails and the scenic, 14-mile Cross Timbers hiking trail wind above the lake on rocky ledges and through blackjack oak woodland. Also available adjacent to the lake are overnight accommodations, boat rental, slip rental and supplies at many of the 22 commercial concessions (USACE, no date-b).

Figure 1-20. Campsite at Platter Flats Campground on Lake Texoma

Two national wildlife refuges on the lake – Hagerman and Tishomingo – occupy 30,000 acres both in Oklahoma and Texas. These refuges attract thousands of migratory Canada, snow, white-fronted, and Ross' geese, various species of ducks, shorebirds, and bald eagles. Resident wildlife includes deer, wild turkey, bobcats, coyotes, fox squirrels, hawks and songbirds (USACE, no date-b; USFWS, no date).

1.5.4.4 Wilson Creek Wastewater Treatment Plant Reuse

In 2010, NTMWD reused approximately 49,000 acre-feet of treated wastewater annually from its Wilson Creek Regional Wastewater Treatment Plant (WWTP) by recycling the effluent through Lake Lavon. Development of additional facilities at this site and increased available treated effluent due to growth will raise its total available reuse supply to 71,882 AFY by 2060. Treated wastewater effluent from the Wilson Creek Regional WWTP is returned to the Lake Lavon watershed, where it is discharged into Wilson Creek upstream from Lake Lavon. There the treated effluent is mixed or blended with (i.e., diluted in) Lake Lavon waters and subjected to the same treatment at the Wylie facility to upgrade it to potable water quality (NTMWD, 2006).

1.5.4.5 East Fork Raw Water Supply Project

NTMWD has constructed a man-made wetland called the East Fork Raw Water Supply Project (Figures 1-21 and 1-22), which uses natural filtration to further cleanse raw water from the East Fork of the Trinity River and augment NTMWD's water supplies. Water is pumped from the East Fork near Crandall into the artificial wetland. As the water passes through 1,840 acres of wetland, aquatic plants "polish" it – a natural process that removes about 95% of sediments, 80% of nitrogen and 65% of phosphorus (NTMWD, no date-b).

Cleansed water from the wetland is then piped 40 miles to the north end of Lake Lavon and blended with NTMWD's other raw water sources that include Lake Lavon, Lake Chapman and Lake Texoma, as well as with treated effluent from the Wilson Creek WWTP (Alan Plummer Associates, no date). In 2010, 51,790 acre-feet of reuse water was available from the East Fork Raw Water Supply Project for transport to Lake Lavon; by 2060, this will increase to 102,000 acre-feet per year, as additional return flows become available from growth.

Figure 1-21. Artificial wetlands of East Fork Raw Water Supply Project with Dallas in background

Figure 1-22. Phase I planting in 2004 at Area A, East Fork Reuse Project

1.5.4.6 Sabine River Authority Contracted Upper Basin Supply

Under contract, NTMWD can purchase up to 50,000 AFY from the Sabine River Authority (SRA) in eastern Texas if SRA determines that amount of water is available. The water is withdrawn from SRA's Lake Tawakoni in the Upper Sabine Basin. By 2060 the amount obtained from SRA is projected to decrease to less than 10,000 AFY. Lake Tawakoni is a major water supply source for Dallas. Presently, the yield is over-contracted (i.e., there is no additional supply available for NTMWD).

Lake Tawakoni Reservoir is impounded by the Iron Bridge Dam, a 5.5-mile long, rolled-earth embankment across the Sabine River in Van Zandt and Rains counties. Construction on this dam began in 1958 and finished in 1960. The drainage area upstream of the reservoir is 752 square miles while the surface area of the reservoir itself at spillway crest is about 36,700 acres.

Like most reservoirs, Lake Tawakoni has become an important outdoor recreation attraction. Its 200-mile shoreline furnishes extensive recreational opportunities; both private and public facilities have been developed around the lakeshore for swimming, boating, picnicking, fishing, duck hunting, and other uses (SRA, no date-a).

1.5.4.7 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 supports native emergent vegetation, including cattail, pondweed, and American lotus, as well as native submerged vegetation such as bushy pondweed and coontail. It also supports a fishery, whose predominant fish species are largemouth bass, channel and blue catfish, sunfish, and crappie (TPWD, 2007b).

The Lake Bonham water right transferred to NTMWD in November 2010, and the lake is now utilized for water supply by NTMWD. Lake Bonham is used to meet the City of Bonham's demands, which are about 2,350 AFY in 2010. The reliable supply for NTMWD from Lake Bonham is about 5,340 AFY.

1.5.5 Texas State Water Planning Process

As previously discussed, the state of Texas has been publishing state water plans every five years since the 1990s, with previous state water plans dating back to 1938. The regional water planning process, which was developed by the state in the late 1990s, provides the framework for purpose and need development and identification of alternatives that are required as part of the NEPA process. This planning process does not supplant the NEPA process but rather complements it. As such, a description of the Texas state water planning process is provided below.

Subsequent to the passage of Senate Bill 1 (SB 1) by the 75th Legislature in 1997, TWDB began the regional water planning process in Texas by developing and publishing draft rules for regional and state water planning. After extensive consultation with other state agencies, stakeholders, and the public, TWDB adopted its final rules in February 1998. These rules outlined the required elements in the regional and state water plans, the composition of planning groups, and guidelines for financial assistance from the TWDB (TWDB, 2012).

SB 1 directed TWDB to designate regional water planning areas, considering such factors as river basin and aquifer delineations, water utility development patterns, socioeconomic characteristics, existing regional water planning areas, political subdivision boundaries, public comment, and other relevant factors. Regional water planning area boundaries were delineated and adjusted accordingly. This process eventually resulted in 16 regional water planning areas (Figure 1-7). TWDB is required to review, update, and if indicated, adjust these boundaries at least once every five years. The planning area boundaries in the 2012 State Water Plan are identical to those in the 2007 and 2002 State Water Plans (TWDB, 2007; TWDB, 2012).

Each regional water planning area has its own planning group. Members of this group represent the interests of its planning area and are responsible for developing a regional water plan every five years. As required by SB 1, TWDB selected the initial members of the planning groups. These members, known as initial coordinating bodies, were selected from 11 interests identified in SB 1 and other relevant interests in the regional water planning areas. SB 1 required that interests including but not limited to public, counties, municipalities, industries, agriculture, environment, small businesses, electric-generating utilities, river authorities, water districts, and water utilities be represented. The initial coordinating bodies then added other members as appropriate, as they transitioned into planning groups. To replace members who leave the planning groups, the groups themselves vote to approve new members. Each planning group approved its own bylaws to govern its methods of conducting business and each designated a political subdivision, such as a river authority, groundwater conservation district, or council of governments, to administer the planning process and manage any contracts related to developing regional water plans (TWDB, 2007; TWDB, 2012).

Ongoing work of the regional water planning process consists of seven major tasks:

- describing the regional water planning area
- quantifying current and projected population growth/decline and water demand
- evaluating and quantifying current water supplies

- identifying surpluses and needs
- evaluating water management strategies and preparing plans to meet the needs
- recommending regulatory, administrative, and legislative changes
- adopting the plan, including the required level of public participation.

Planning groups first describe their areas. These descriptions include information on major water providers, current water use, groundwater and surface water sources, agricultural and natural resources, the regional economy, local water plan summaries, and any other information considered relevant by the planning groups (TWDB, 2007; TWDB, 2012).

Next population growth/change and water demand projections are reviewed. Planning groups review the demographic and water demand projections provided by TWDB and propose revisions resulting either from new conditions or new information. In the most recent planning round (2011 regional water plans), most of the 16 planning groups in the state requested revisions to population and water demand projections for some of the water users in their regions but some did not. TWDB, after consulting with other state agencies, namely the Texas Department of Agriculture, TCEQ, and TPWD, formally approved requests for revisions that met established criteria.

The third task is to determine the water supplies that would be physically and legally available from existing sources during a repeat of the drought of record. Planning for a drought of record is required by SB 1 and is important in helping prepare for future droughts. To estimate existing water supplies, planning groups use surface water and groundwater availability models. If such models are unavailable, the groups use other available information (TWDB, 2007; TWDB, 2012).

Next, existing water supplies are compared with current and projected water demands to identify whether additional water supplies are needed for each identified WUG and WWP.

SB 1 mandated planning groups to address the needs of all water users. If existing supplies do not meet projected future demand, the planning groups are to recommend specific water management strategies to meet water supply needs. Examples of recommended water management strategies include advanced conservation of existing water supplies, new surface water and groundwater development, conveyance facilities like pipelines to move available or newly developed water supplies to areas of need, water reuse, water rights subordination agreements, and others. The Texas Legislature also required that each planning group assess the financing needed to implement the water management strategies and projects in their water plans (TWDB, 2007; TWDB, 2012).

To assess financing, the planning groups, 1) survey local governments, regional authorities, and other political subdivisions on how they propose to pay for water infrastructure projects in the plan and, 2) identify the appropriate role of the state in financing these projects. Assisted by TWDB, the planning groups also assess the social and economic impact of not meeting projected water needs. If it is not feasible to meet a need, the planning groups identify and explain the conditions that led to their inability to plan for fully meeting the need.

The regional plans include regulatory, administrative, and/or legislative recommendations as well as recommendations for designating unique reservoir sites and stream segments of unique ecological value; they also consider water conservation strategies and evaluate the impacts to the state's water, agriculture and natural resources. In the 2007 and 2012 plans, planning groups recommended significant amounts of water conservation and reuse compared to the 2002 State Water Plan (TWDB, 2007; TWDB, 2012).

All regional planning group meetings and functions are open to the public and participation is welcomed. The planning groups conduct special public meetings when they prepare scopes of work and hold hearings before adopting their regional water plans. This kind of public involvement helps guide the planning and determine which water management strategies to recommend. Building consensus within the planning groups is crucial to ensure sufficient support for adopting the plan. Planning group members adopt plans by vote at open meetings in accordance with each group's respective bylaws.

Planning groups also send non-voting representatives to adjacent planning groups. In addition, some joint meetings between adjacent planning groups serve both to coordinate water management strategies and to help circumvent later conflicts over the use of shared resources.

The regional water planning process has continued to evolve since its 1997 inauguration by planning for a more discrete level of water providers, considering water conservation strategies to meet all needs identified in the regional water plans, and evaluating the impacts of water development on agriculture and natural resources (TWDB, 2007; TWDB, 2012).

In 2001 and 2007, the Texas Legislature passed SB 2 and SB 3. These bills included the funding mechanisms to continue updating the regional water plans every five years. SB 2 provided the funding for the first update to the regional water plans which produced the 2006 Region C Water Plan, while SB 3 funded the current 2011 update to the regional water plans (Region C Water Planning Group, 2010).

The latest round of regional water planning in Texas has now culminated in the approval of all 16 regional water plans, including that of Region C, which was finalized in October 2010. During 2011, TWDB compiled and summarized all 16 regional water plans into the 2012 Texas State Water Plan, which provides overall guidance for the coming five-year period.

Region C covers all or part of 16 counties in North Central Texas. As shown in Figure 1-23, Region C includes all of Cooke, Grayson, Fannin, Jack, Wise, Denton, Collin, Parker, Tarrant, Dallas, Rockwall, Kaufman, Ellis, Navarro, and Freestone Counties and the portion of Henderson County that is in the Trinity Basin. Like other water planning regions, the Region C planning group includes representatives from 11 designated interest groups. There are actually 19 members of the Region C water planning group because some of the interest groups have more than one representative (Table 1-13). The Region C Water Planning Group hired a team of consultants to conduct technical analyses and prepare the regional water plan under the supervision of the planning group (Region C Water Planning Group, 2010).

Table 1-13. Number of representatives on Region C planning group from interest groups

Interest Group	Number of representatives	Interest Group	Number of representatives
Municipalities	4	Small business	1
Water districts	3	Counties	1
Environmental interests	2	Electric generating utilities	1
Public	2	River authorities	1
Water utilities	2	Agricultural interests	1
Industry	1	Small business	1

Source: Region C Water Planning Group, 2010

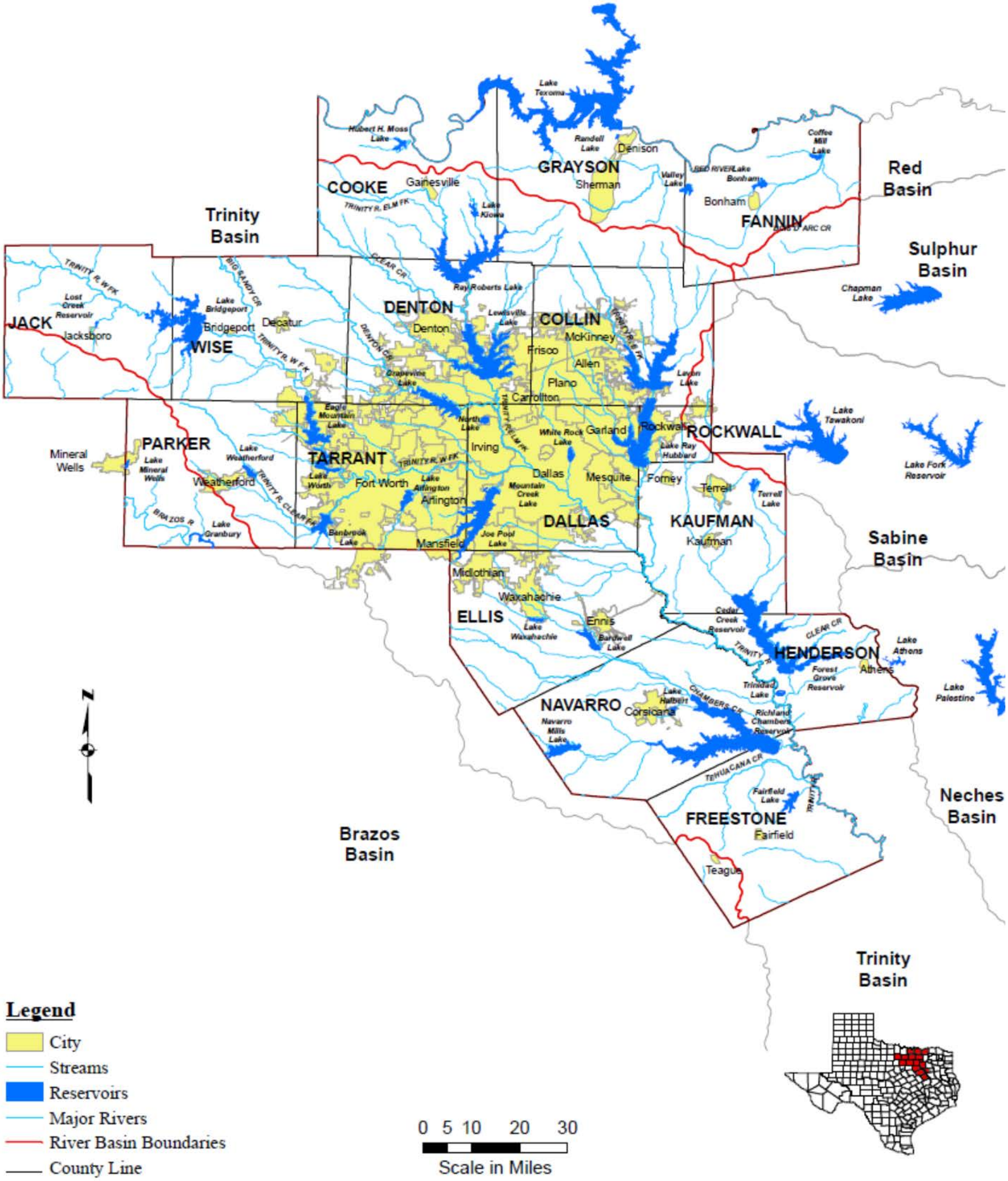


Figure 1-23. Region C and outside water supplies designated as Special Water Resources for Use in Region C

Source: Region C Water Planning Group, 2010

Sections 16.051(e) and 16.053(e)(6) of the Texas Water Code stipulate that the state and regional water plans should identify prospective sites of unique value for constructing reservoirs. Section 16.051(g) of the Code provides for legislative designation of sites of unique value for the construction of a reservoir. This means that a state agency or political subdivision of the state may not obtain a fee title or an easement to a designated site that would impede the construction of a reservoir there. Designation by the Texas Legislature thus provides a limited but important means of reserving proposed reservoir sites for future development. Lower Bois d'Arc Creek Reservoir was one of 19 potential reservoir sites in the state recommended in the 2007 State Water Plan for such a designation (TWDB, 2007). SB 3, in the 2007 legislative session, designated all of these recommended sites.

1.5.6 Water Conservation and Reuse

1.5.6.1 Water Conservation in Texas and Region C

In passing SB 2 in 2001, the 77th Texas Legislature emphasized the importance of water conservation as a water management strategy. SB 2 requires that regional planning groups consider water conservation practices for each need identified for a WUG (TWDB, 2007; TWDB, 2012).

The Texas Water Code §11.002(8) defines conservation as: "the development of water resources; and those practices, techniques, and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses" (TWC, no date).

Water conservation measures and drought/emergency water management measures both aim to save water. However, water conservation measures are fundamentally different from drought or emergency management measures in that they are designed to be long-term or permanent, whereas drought/emergency management measures are temporary. They are implemented when certain criteria are met and are stopped when these criteria are no longer met (Region C Water Planning Group, 2010).

Comparing the 2007 State Water Plan to the 2002 State Water Plan demonstrates the growing priority accorded to water conservation in Texas. For example, recommended water management strategies for conservation in the 2002 State Water Plan generated 14% of the water needed to meet the state's needs in 2050, or a total of about 990,000 acre-feet per year. By way of contrast, in the 2007 State Water Plan, conservation accounts for nearly 23% of required water in 2060, or a total of about two million acre-feet/year. These figures represent "active conservation," that is, those measures usually initiated by water utilities, individual businesses, residential water consumers, and agricultural water users to reduce water consumption. In the 2006 Regional Water Plans, 14 of the 16 planning groups included some water conservation strategies to meet needs, and 13 of the 16 planning groups included policy recommendations concerning water conservation (TWDB, 2007).

In 2003, the 78th Texas Legislature passed SB 1094, which considered a broad spectrum of issues related to water conservation and established the Water Conservation Implementation Task Force. This task force began to review, evaluate, and recommend optimum levels of water use efficiency and conservation for the state. It also developed a Best Management Practices (BMPs) Guide consisting of 21 municipal, 14 industrial, and 20 agricultural water conservation BMPs (TWDB, 2004a). The practices included in the BMPs Guide are voluntary efficiency measures that save a quantifiable amount of water, either directly or indirectly, and can be implemented within a specified timeframe.

The task force's municipal BMPs enable utilities to both improve water use efficiency of their own operations and for programs to improve the efficiency of their customers. The municipal BMPs are listed in Table 1-14.

Table 1-14. Best Management Practices for Municipal Water Users

-System water audit and water loss	-Water conservation pricing
-Prohibition on wasting water	-Shower head, aerator, and toilet flapper retrofit
-Residential toilet replacement programs	-Residential clothes washer incentive program
-School education	-Landscape irrigation conservation & incentives
-Water survey for single-family and multi-family customers	-Metering of all new connections and retrofit of existing connections
-Water wise landscape design and conversion programs	-Conservation programs for industrial, commercial and institutional accounts
-Athletic field conservation	-Golf course conservation
-Wholesale agency assistance programs	-Conservation coordinator
-Water reuse	-Public information
-Rainwater harvesting and condensate reuse	-New construction graywater
-Park conservation	

Source: TWDB, 2004a

Municipal water conservation strategies in the 2006 Regional Water Plans relied heavily on the Water Conservation Implementation Task Force's BMPs Guide and included such measures as aggressive plumbing fixture replacement programs, water-efficient landscaping codes, water loss and leak detection programs, education and public awareness programs, rainwater harvesting, and changes in water rate structures. Fourteen of the 16 planning groups recommended municipal water conservation as a potential way to meet future municipal water needs. In total, municipal water conservation strategies constituted nearly 617,000 acre-feet/year (7%) of water generated by all recommend strategies by 2060 (TWDB, 2007).

In addition to developing the BMPs that could be adopted as strategies, the task force made 25 recommendations related to water conservation. One of these was to create and fund a statewide water conservation public awareness campaign. The task force recognized the need to promote public awareness of water conservation issues and recommended implementing a program that focuses on delivering a simple, enduring, universal water awareness message. The thrust of the program is increasing the relevance of water conservation to all Texans and raising awareness that natural water resources are limited, that individual water consumption habits have consequences, and that changes in individual behavior can make a difference.

In 2004, TWDB contracted with consultants to conduct research to develop a market strategy and brand for a possible statewide water conservation public awareness program. The project was funded by a voluntary coalition of 36 water utilities, municipalities, businesses, and conservation groups.

Data from the 2004 research showed that only 28% of Texans "definitely know" the natural source of their drinking water. The research also showed a strong correlation between knowledge of water sources and willingness to conserve water. As part of the study, 11 logo and tagline variations were tested in focus groups in five cities around the state. "Water IQ: Know Your Water" was considered the most effective brand. It can be tailored with local information and informative tips. It also resonated with Spanish-speaking Texans with the tagline "*Conozca Tu Agua*" (TWDB, 2007).

Because of local drought impacts, four major regional water providers and one groundwater conservation district have embraced the "Water IQ" campaign concept. Their efforts will contribute print ads, public service announcements, and television spots that can be used in developing a statewide program. To date, NTMWD and four other major water providers around the state have begun implementing their Water IQ campaigns (Figure 1-24).

Figure 1-24. NTMWD's sport utility vehicle sporting the Water IQ message

Over the past decade, Region C water providers and water users have made noteworthy and growing efforts to conserve water. For several years, NTMWD has partnered with Dallas Water Utilities and Tarrant Regional Water District to jointly sponsor the North Texas Regional Water Conservation Symposium. Outdoor water conservation practices like time-of-day watering restrictions, have become part of local ordinances in Dallas, Fort Worth, and most of the larger cities in the area. Cities and water utilities have started allocating conservation staff and budgeting dollars as part of their full time water management strategies. These endeavors exemplify the ongoing, coordinated Region C effort to promote conservation as a permanent, valuable water management strategy (Freese and Nichols, et al., 2010).

In 2007, the 80th Texas Legislature, in passing SB 3 and House Bill 4, directed TWDB to appoint 23 members, who represent a cross-section of water-related interests, to the newly created Water Conservation Advisory Council (WCAC). The WCAC replaced the Water Conservation Implementation Task Force mentioned above. Duties of the WCAC include:

- monitoring trends in water conservation implementation and new technologies for possible inclusion as BMPs;
- monitoring the effectiveness of the statewide water conservation public awareness program;
- developing and implementing a state water management resource library;
- developing and implementing a public recognition program for water conservation;

- monitoring the implementation of water conservation strategies by water users included in regional water plans;
- monitoring target and goal guidelines for water conservation to be considered by the TWDB and TCEQ; and
- conducting a study to evaluate the desirability of requiring the TWDB to designate entities and programs that provide assistance to retail public utilities in developing water conservation plans as certified water conservation training facilities, and to give preference to certified water conservation training facilities in making loans or grants for water conservation training and education activities.

In December 2008, WCAC published the first of its biannual reports, *A Report on Progress of Water Conservation in Texas*, which included a number of detailed and technical recommendations regarding water conservation and regional water planning. The report also recognized that conservation is one of the most cost-effective tools in meeting the growing demand for water in Texas. Furthermore, it reiterated that according to the 2007 State Water Plan, conservation will account for nearly 23 percent of the projected additional water supply needed in 2060 – a total of about two million acre-feet per year, or enough to supply half of the current annual municipal use in Texas (WCAC, 2008).

Region C is placing more emphasis on water conservation than the state as a whole. In 2010, TWDB projected that by 2060, based on the strategies included in the 2006 regional water plans, Region C alone would account for 277,000 acre-feet of water savings annually, or 47% of all municipal conservation in Texas (Figure 1-25). In other words, Region C would conserve almost as much water as the rest of the state combined. By 2030, Region C expects to meet one-third of its municipal demand through a combination of conservation and reuse (Hardin, 2010).

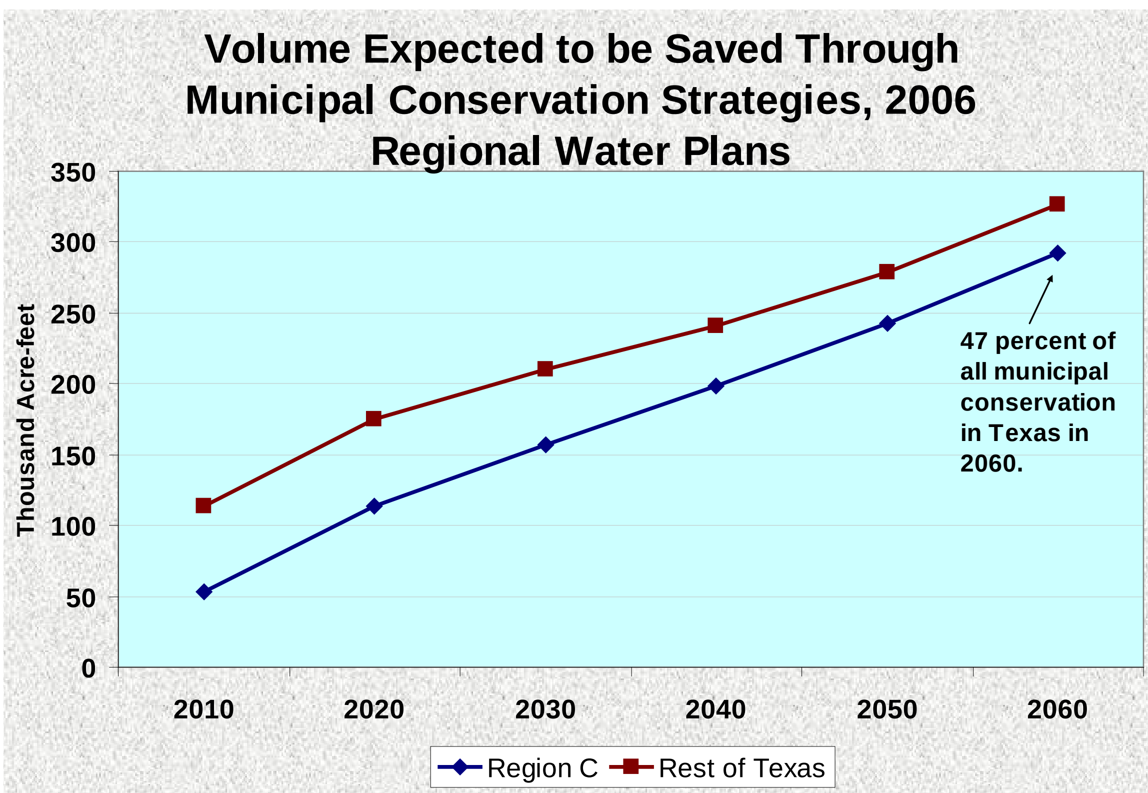


Figure 1-25. Water saved in Region C compared with rest of state, 2060
Source: Hardin, 2010

In 2000, of the 16 water planning regions in the state, Region C ranked third-highest in municipal water consumption per capita, as measured by GPCD. As a measure of municipal water use, GPCD is defined as the average daily total of residential plus commercial plus institutional water use, divided by the resident population of the city or region in question. It measures water used at home as well as water used at work. As such, GPCD tends to inflate Region C's apparent residential per capita water consumption because of the number of commuters who are residents of other regions but work in Region C (principally the Dallas-Fort Worth Metroplex). For example, in 2007, the total GPCD of Dallas was 240 and that of San Antonio 150, seemingly indicating that Dallas uses more water per capita than San Antonio. However, a more meaningful comparison of residential GPCD's of the two cities shows a much smaller difference – 92 (Dallas) and 86 (San Antonio) (Hardin, 2010).

All other things being equal, the GPCD is higher in those cities or regions wherein the daytime population is augmented by commuters who reside in a different city or region. Dallas adds 290,000 net commuters on a daily basis (23% of its residential population), while San Antonio adds less than 50,000 (3.8% of its residential population). This accounts for almost all of the apparent discrepancy between the municipal GPCD's of the two cities. Similarly, on a daily basis (2006 data), Region C's water users are augmented by 22% of the total workforce in the western counties of Region D (Delta, Hopkins, Hunt, Lamar, Rains, Van Zandt, and Wood) (Hardin, 2010).

1.5.6.2 Water Conservation in the North Texas Municipal Water District

Since 2006, NTMWD has invested $11.2 million in the development and implementation of the aforementioned Water IQ campaign, more than any other water provider in the North Texas region. The Water IQ campaign has had a demonstrably positive effect on water conservation among NTMWD's Member Cities and Customers. This campaign continues to be an integral part of NTMWD's overall efforts to foster a water conservation ethic among its customers and all Texans. NTMWD has made the Water IQ campaign materials available at essentially no cost to all water suppliers throughout the state (Rice, 2014).

NTMWD promotes water conservation in North Texas and across the state. It participates in Water Smart Innovations, the Texas A&M Agrilife Extension Service's Texas Water Star conferences and presentations, and Water Educators of North Texas. NTMWD staff attends and has presented at the Gulf Coast Water Conservation Symposium, the Central Texas Water Conservation Symposium, and the Water Smart Innovations national water efficiency conference. NTMWD collaborates with stakeholders such as landscapers, irrigators, nursery growers, homebuilders, and homeowners associations for presentations at various local, regional, and state meetings and conferences. NTMWD also makes presentations to civic/community organizations, schools, and local/state government agencies.

Since 2007, NTMWD has co-sponsored the annual North Texas Regional Water Conservation Symposium with Dallas Water Utilities (DWU) and Tarrant Regional Water District (TRWD) since 2007. Approximately 200 regional stakeholders from the Dallas-Ft. Worth Metroplex attend this symposium, which has presenters from across the United States with substantial expertise and experience in water conservation. These speakers inform the attendees of Best Management Practices (BMPs) for achieving water conservation, as well as programs designed for reducing water use. NTMWD, DWU, and TRWD collaborate to obtain sponsorship funding for the symposium, so as to allow attendees free admittance each year.

NTMWD adopted an updated Water Conservation Plan (WCP) on February 27, 2014. The WCP meets all of the requirements for submission to the TCEQ and TWDB. One part of the WCP is a Model Water Conservation Plan (Model WCP). It provides minimum guidelines for NTMWD's Member Cities and

Customers to use in the adoption of their plans. To date, the following Member Cities have adopted the Model WCP: Allen, Forney, Frisco, McKinney, Mesquite, Plano, Princeton, Richardson, Rockwall, Royse City, and Wylie. In adopting the Model WCP, these Member cities have adopted the following additional water conservation measures:

- Conservation oriented rates
- Reuse and recycling of wastewater
- Lawn watering restricted to 2 days per week year-round
- Prohibition on lawn irrigation between 10 am-6 pm from April to October
- Prohibit watering imperious surfaces
- Prohibit watering during rain or freeze events
- Prohibit use of poorly maintained systems
- Prohibit runoff and waste
- Require rain/freeze sensors and/or ET controllers
- Prohibit overseeding cool season grass
- Irrigation inspection at backflow inspection
- New irrigation systems meet state requirements
- Irrigation evaluations on periodic basis
- Prohibit filling of pond (>500 $ft.^2$)
- Hose end nozzle requirement
- Hotel/motel linen replacement program
- Restaurant water on request
- Existing systems be retrofitted
- New athletic fields separate irrigation system
- Other measures to encourage off-peak use
- Landscape ordinance
- Water audits
- Rebates for low-flow toilets, showerheads, etc.

NTMWD compiles and reviews water use data from its Member Cities and Customers; these data are then used to assist with regional water conservation efforts. NTMWD has partnered with Texas Agrilife Extension Service in implementing a regional network of weather stations to collect rainfall, humidity, wind, evaporation and evapotranspiration data. These data are used to develop site-specific, precise turf irrigation needs and publicly report them in real time. Meteorologically-based lawn irrigation guidelines are used by residences and businesses throughout NTMWD's service area to help minimize water use for irrigation by calculating the maximum amount of water required at a user's specific location to nourish and maintain healthy turf (Rice, 2014).

Over the past decade, NTMWD's conservation efforts have resulted in a substantial and sustained reduction in per capita water use, which started years before the onset of the current drought. In 2000, NTMWD's Member Cities and Customers averaged 224 GPCD. By 2013, this figure had decreased to 162 GPCD, a decline of 28 percent. Even as NTMWD continues pushing for further reductions in residential GPCD, it pursues programs to assist in reducing water use for its industrial, commercial, and institutional customers.

Since 2006, NTMWD's water use tracking reveals water savings of about 12 percent have been achieved on an annualized basis. During peak summer months, this results in conservation of about 250 MGD. These water savings correlate to GPCD reductions throughout NTMWD's service area (Rice, 2014).

1.5.6.3 Water Reuse

Reuse is emerging as an increasingly important source of water in Region C and throughout Texas. There are already a number of water reuse projects in operation in Region C, and many others are currently in the planning and permitting process. Direct reuse and indirect reuse have significantly different permitting requirements and potential applications. Direct reuse occurs when reclaimed water is delivered directly from a wastewater treatment plant to a water user, with no intervening discharge to waters of the state. Direct reuse requires a notification to TCEQ, which is routinely accepted as long as requirements to protect public health are met. The most common application of direct reuse is supplying water for landscape irrigation, particularly golf courses, and industrial uses, especially cooling for steam electric power plants (Region C Water Planning Group, 2010).

Indirect reuse is when treated effluent (wastewater) is discharged to a stream, reservoir, or aquifer and subsequently retrieved for reuse by being diverted downstream or pumped from the reservoir or aquifer. The discharged effluent mixes with ambient water in the stream or reservoir as it travels to the point of diversion. Many of the water supplies within Region C have historically included return flows from treated wastewater as well as from natural runoff. These return flows supplement supply and can be used as long as the return flows continue. An entity can ensure the ability to use its return flows through a water right permit from TCEQ. A wastewater discharge permit from TCEQ may also be required if the discharge location were to be changed as part of the reuse project (Region C Water Planning Group, 2010).

In general, reuse strategies require the use of multiple barriers (such as advanced wastewater treatment, blending, residence time, and/or advanced water treatment) to mitigate potential negative impacts to the aquatic environment and agricultural resources. Sources of wastewater effluent needed for new reuse projects are generally restricted to owners and operators of large wastewater treatment plants. In Region C, these include the Trinity River Authority, which operates several wastewater treatment plants in the region, NTMWD, the cities of Fort Worth and Dallas, and several smaller cities.

Return Flows

"Return flow" is the term used to describe water that has been beneficially used and then is discharged to a receiving water body. Existing streams and reservoirs have historically relied on these return flows for water supplies and instream uses.

The Region C plan proposes to reuse over 270,000 acre-feet of additional return flows in 2020 through both direct and indirect reuse projects, with most of this additional reuse occurring in the Trinity River Basin. By 2060, the total reuse from proposed and existing projects will be nearly 623,000 acre-feet per year (Freese and Nichols, et al., 2010).

The potential for additional reuse projects in Region C is dependent upon the amount of wastewater generated and the ability of prospective users to utilize treated effluent. Approximately 93% of the 1.76 million acre-feet of water used in the Trinity River Basin in Region C in 2010 could be attributed to municipal and manufacturing use. Municipal and manufacturing use in Region C is expected to increase to 3.2 million AFY by 2060. Of the total amount of water projected for use in Region C, a considerable amount is expected to be returned to the Trinity River Basin through return flows (Freese and Nichols, et al., 2010).

Potential applications for water reuse in Region C include:

- Landscape irrigation (parks, school grounds, freeway medians, golf courses, cemeteries, residential)
- Agricultural irrigation (crops, commercial nurseries)

- Industrial and power generation reuse (cooling, boiler feed, process water, heavy construction, mining)
- Recreational/environmental uses (lakes and ponds, wetlands, stream flow augmentation)
- Supplementing potable water supplies.

NTMWD is authorized to divert up to 71,882 AFY of return flows from the NTMWD's Wilson Creek WWTP at Lake Lavon. The NTMWD is also authorized to divert up to 157,393 AFY from the East Fork Raw Water Supply Project that was described above. This project began operation in 2009. The currently available return flows from the East Fork Raw Water Supply Project are estimated at 51,790 AFY. By 2060, the reliable supply from this project is estimated at 102,000 acre-feet per year as return flows increase and become available.

Dallas Water Utilities and NTMWD have entered into an agreement which would permit NTMWD to exchange return flows from its WWTPs discharging into Lake Ray Hubbard for Dallas return flows discharged to the main stem of the Trinity River. Under this agreement, Dallas will obtain the right to divert NTMWD return flows from Lake Ray Hubbard and will pump an equal amount of flow from the main stem of the Trinity River to the NTMWD East Fork Water Supply Project wetland for use by NTMWD. Furthermore, once water rights for Elm Fork return flows (from NTMWD WWTPs discharging to Lake Lewisville) have been secured by NTMWD, it will support Dallas Water Utilities' efforts to secure bed and banks transport, and storage and diversion rights for the Elm Fork return flows. In exchange, Dallas will pump a quantity equal to NTMWD's discharge of its future Elm Fork return flows to the East Fork Water Supply Project wetland for use by NTMWD (Freese and Nichols, et al., 2010).

Overall, Region C reuse strategies are projected to comprise 86% of all municipal reuse in Texas by 2030 (Hardin, 2010) (Figure 1-26) with the NTMWD's reuse program accounting for much of the reuse in Region C and Texas.

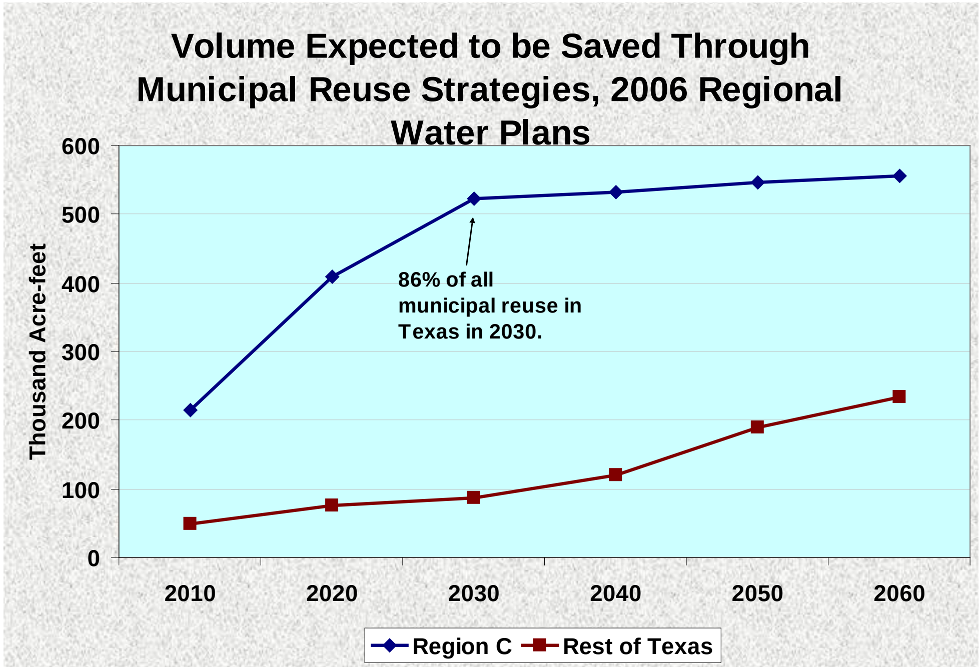


Figure 1-26. Water savings from municipal reuse strategies, Region C vs. rest of Texas
Source: Hardin, 2010

By implementing both water conservation and reuse strategies between 2010 and 2060, in keeping with the emphasis of the 2012 State Water Plan, Region C will close the gap between its per capita municipal water use and that of the rest of the state, on average (Figure 1-27). As noted earlier, part of the reason for this apparent gap in per capita consumption rates is commuting patterns, under which residents of other regions who work in Region C boost its municipal per capita water use while simultaneously reducing the water use in their home regions. Other contributing factors to differences in GPCD include climate, economic activity, and urban densities. By 2030, after savings from water conservation and reuse strategies have been accounted for, Region C will have reduced its municipal GPCD from third-highest to sixth-lowest of the 16 regions in the state.

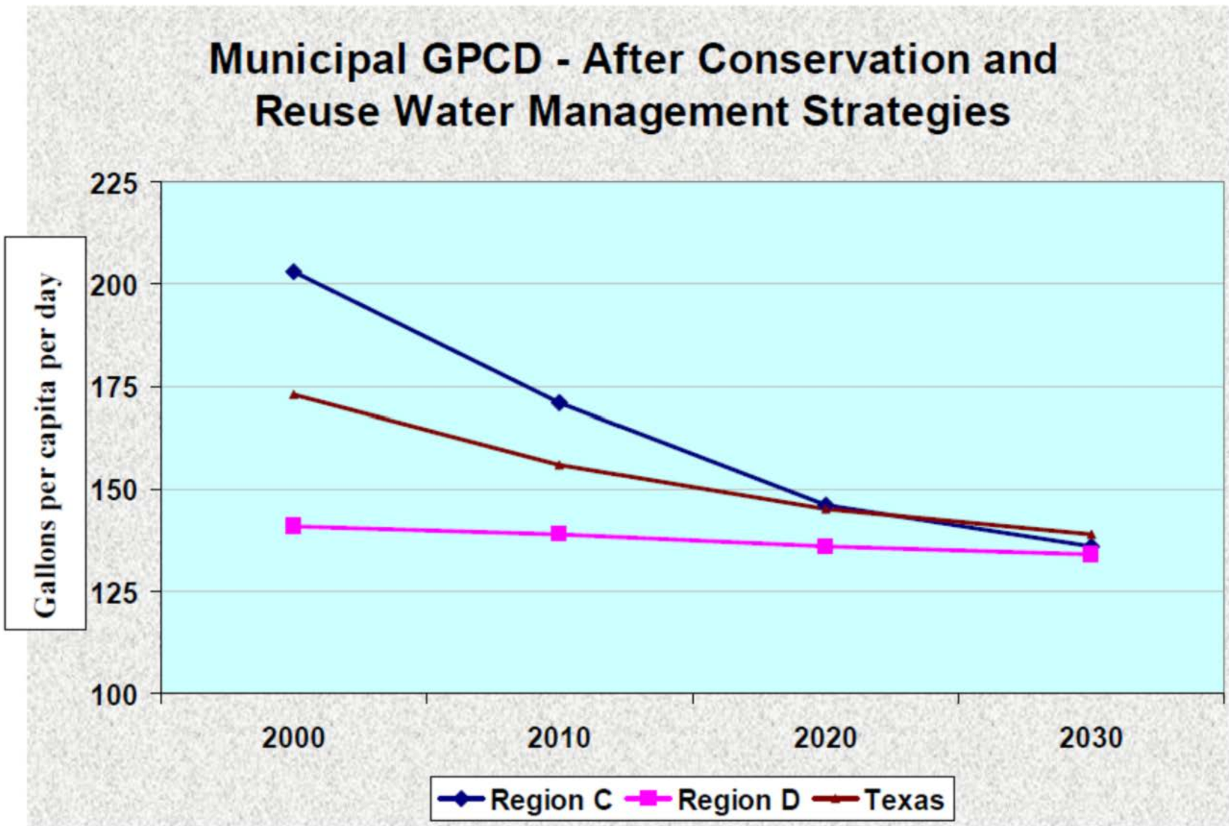


Figure 1-27. Converging municipal GPCD's after implementing conservation and reuse
Source: Hardin, 2010

NTMWD has spent several hundred million dollars developing the single largest water reuse supply in Texas, the East Fork Wetlands Project (Figures 1-20 and 1-21). In 2013 alone, NTMWD beneficially reused more than 100,000 AF of its water supplies, and that figure will continue to grow with discharges toward the permitted limits of almost 200,000 AFY. In addition to the reuse supply from the East Fork Wetlands Project, NTMWD beneficially reuses effluent from its Wilson Creek Wastewater Treatment Plant, which is currently permitted to discharge up to 64 MGD. NTMWD also provides treated effluent directly to neighboring golf courses from a number of NTMWD-owned and operated wastewater treatment plants. This irrigation use offsets the demands these customers would otherwise make on potable water. Member Cities also beneficially reuse treated effluent. An example is the City of Frisco, which directly reuses effluent from two NTMWD wastewater treatment plants for irrigation of city parks, medians, and other public greenways (Rice, 2014).

1.6 PUBLIC PARTICIPATION

In combination, 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 human 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 Clean Water Act. 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 is 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 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. 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:

a. The impoundment of 367,609 acre-feet of water and diversion of 126,200 acre-feet per year from the Bois d'Arc Creek basin to the Trinity River basin could result in significant adverse effects to the aquatic ecology of Lower Bois d'Arc Creek and its associated riparian environments.
b. The proposed project would result in the direct loss of approximately 4,602 acres of bottomland hardwood wetlands and altered hydrology for bottomland hardwood wetlands in the stream valley downstream of the proposed dam. Bottomland hardwood wetlands are a diminishing resource type in the region, and the EPA has identified them as an "aquatic resource of National importance".
c. The proposed project may result in adverse impacts to public lands within the Caddo National Grasslands, Bois d'Arc Unit, located downstream of the proposed dam. Although one of the proposed mitigation vehicles for impacts of lake construction would be to acquire additional lands within the proclamation boundary of the Caddo National Grasslands, this needs to be a part of the Section 404 and NEPA evaluation process for this project, considering the potential for both detrimental and beneficial effects on the Caddo National Grassland.
d. On a cumulative basis, two large reservoirs (Lower Bois d'Arc Creek and Lake Ralph Hall) proposed for construction within one county at more or less the same time have the potential to result in significant economic effects and would likely cause significant changes in existing development patterns and substantial or significant alterations to the rural nature of Fannin County.
e. Overall, natural resource agencies including the USFWS, TCEQ, and TPWD, in addition to one county official and one environmental organization (Texas Conservation Alliance), are concerned

about potential impacts associated with this project. The USFWS, EPA, and 45 other commentors requested that USACE prepare an EIS for this project.

f. The proposed project would displace numerous residents and result in the loss of livelihoods and substantial reduction to the functional size of adjacent landholdings.
g. The need to assure adequate and impartial evaluation of the availability of less environmentally damaging practical alternatives.
h. The absence of a detailed mitigation plan which would offset the extensive impact to wetlands and aquatic resources in the proposed lake basin.
i. The need for evaluation of potential secondary, indirect, and cumulative impacts related to the construction of related facilities, specifically the transfer pipelines and the proposed water treatment facility in Leonard.

In addition, USACE observed that the project appears 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 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 from "stakeholders" – including Tribes, the public (both private citizens and non-governmental organizations or NGO's), 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 in and of itself, but the perspectives and opinions as to which issues matter the most, and how, indeed whether, the agency should proceed with a given proposed action are equally important. Input from scoping thus helps shape the direction that analysis takes, helping analysts decide which issues merit consideration. Public input also helps in the development of alternatives to the proposed action, which is an integral part of NEPA.

1.6.2.1 <u>Public Scoping</u>

Scoping 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 Lower Bois d'Arc Creek Reservoir in Fannin County, Texas. Written 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 large facility looking at exhibits, maps, reports, and information arranged on tables. They could also speak informally and at length with representatives of USACE, TCEQ (concurrently conducting a public meeting on the 401 water quality certification associated with the 404 permit application), 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 1-28).

During scoping, 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) emails sent to the USACE; and 3) hard copy letters mailed to the USACE.

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. By this measure, some 630 comments were received in total.

Table 1-15 lists the top issues/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.

Figure 1-28. Attendees at the scoping open house in Bonham on December 8, 2009

Table 1-15. Top issues raised by public about proposed Lower Bois d'Arc Reservoir

Place	Issue/Topic	Number of commenters who cited
1	Impacts on native wildlife species and habitats	33
2	Adverse impact to agricultural economy & 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 & 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 &fluctuating lake will not be conducive to aquatic recreation opportunities	10
12	Upstream wastewater treatment plant discharges (treated & 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 Lake Lavon (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 won't be able to compete with established lakes that already offer high-quality recreational experience & 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

1.6.2.2 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 incorporates a summary of the agency scoping process.

1.6.3 Other Related Opportunities for Public Participation

Four meetings on the 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. 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 January 30 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 the opportunity to local residents of Fannin County and neighboring areas to ask questions regarding a wide variety of issues and topics related to the proposed action – reservoir construction and 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. 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 Forthcoming Opportunities for Public Participation

When this DEIS is released to the public, USACE will publish a Notice of Availability (NOA) in the *Federal Register* announcing the start of a 45 to 60 day review and comment period on the DEIS. A newspaper display ad and Public Service Announcements (PSAs) will also notify the affected public of the DEIS review and comment period. USACE will once again host an open house in Bonham and the public will be encouraged to comment in writing on the adequacy of the DEIS in analyzing the project's impacts on the human environment. By law, USACE must address all written comments. Responses to comments will be included in the Final EIS (FEIS), upon the release of which the public will have another opportunity to comment.

1.7 ISSUES DEVELOPMENT

The USACE considered all issues raised in 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

1.7.1.1 Inter-Basin Water Transfer Issues

If approved, the proposed action would eventually result in the transfer of approximately 126,200 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 126,200 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).

1.7.1.2 Wetlands and Other Waters of the U.S.

As noted earlier in Section 1.2.1, under Section 404 of the Clean Water Act, the USACE has the legal authority to regulate discharge of dredge 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 which 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.

1.7.1.3 Alternatives to the Proposed Action

During the scoping 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 water demands 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 the above. Chapter 2 of this EIS describes and analyzes the proposed action and alternatives to the proposed action.

1.7.1.4 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 1-14). The scale of the project – over 17,000 acres for the reservoir "footprint", plus additional acreage impacted by the proposed pipeline, the water treatment plant, and terminal storage reservoir – as well as the fact the proposed reservoir would impact wetlands and waters of the U.S., a diminishing supply of 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 will accordingly address 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 rattlesnake, bald eagle, cougar, wild turkey, freshwater mussels, and migratory birds. Another concern expressed by agency staff was the potential for the spread of invasive species, including both plants and animals.

1.7.1.5 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 potential for historic structures within the reservoir site. Construction of the reservoir would affect both known and as yet undiscovered cultural resources.

1.7.1.6 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.

1.7.1.7 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.

1.7.1.8 Land Use

The public listed a number of issues 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. Implementing the proposed action would mean markedly changing the land use on about 32,000 acres, or about five percent of the area of Fannin County.

1.7.1.9 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.

1.7.1.10 Socioeconomics

Socioeconomic issues were very important to the public 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 decried 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 themselves, 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.

1.7.1.11 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. Impacts to transportation will be evaluated as part of this EIS.

1.7.1.12 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. Impacts to air quality will thus be evaluated as part of this EIS.

1.7.1.13 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. Climate will thus be considered in this EIS.

1.7.1.14 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 our state's water resources to meet the growing demands of the greater North Texas area. Other issues related to water resources and quality were mentioned during the scoping process, which are listed in the Scoping Report (Appendix D).

1.7.1.15 Environmental Justice/Protection of Children

Two Executive Orders issued by presidents of the United States 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."

1.7.2 Issues Considered But Dismissed

1.7.2.1 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 Lower Bois d'Arc Creek Reservoir 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).

1.7.2.2 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 to drill into hydrocarbon-bearing formations located hundreds or thousands of feet below the bottom of the reservoir, and extraction of these liquid and gaseous fossil fuels without contaminating the overlying water. Whether or not this would be desirable or permitted is another matter. The point is that the presence of a water reservoir alone would not in and of itself preclude access to subsurface hydrocarbon reservoirs.

1.7.2.3 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 greater. A small cumulative effect from the increasing area dedicated to water surfaces on reservoirs throughout north-central Texas may be observable, but this has never been documented or quantified. Nevertheless, the Texas State Climatologist has documented an increase of precipitation overall in the state over the past century, and 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. Thus, 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 proper, this issue will not be considered further in the EIS.

1.8 AQUATIC RESOURCES MITIGATION SUMMARY

A mitigation plan for impacts to waters, wetland, and other aquatic resources has been prepared in view of pertinent federal rules, regulations, and guidelines. Comments from the public, state, and federal resource agencies on the Section 404 permit application for the proposed action and comments made during the EIS scoping process were also considered in developing the mitigation plan. Moreover, extensive coordination has taken place with appropriate state and federal resource agencies during the permitting process. Interagency teams from both the federal and state governments participated in the collection and analysis of data from the proposed reservoir site as well as the proposed mitigation site (Freese and Nichols, 2012; Freese and Nichols, 2014).

The aquatic resources mitigation plan was prepared 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 U.S. that would be impacted by construction of the proposed reservoir. Proposed compensatory mitigation for waters of the U.S. would be provided through in-kind mitigation that would occur through on-site or near-site mitigation strategies. On-site mitigation would be provided at the proposed reservoir site and near-site mitigation would be provided on an approximately 14,960-acre parcel of land known as the Riverby Ranch. This working ranch is located downstream of the proposed project within both the same watershed (Bois d'Arc Creek) and the same county (Fannin). It borders the Red River. NTMWD acquired the Riverby Ranch specifically because its biophysical features have the potential to provide appropriate mitigation for the proposed project.

Existing habitat at the proposed mitigation site consists largely of ecologically degraded ranch and farmland (Figure 1-29), providing the opportunity for mitigation actions to result in considerable gains in "ecological uplift" (increase over time in ecological values and functions). Another advantage of the proposed mitigation site is that it consists of one large, contiguous tract of land, thus avoiding the ecological and logistical problems associated with disconnected fragments of mitigation lands. Furthermore, the proposed site is located adjacent to the USFS-managed Caddo National Grasslands Bois d'Arc Unit and beside other privately-owned lands that are already protected in perpetuity by easement through the Wetlands Reserve Program (WRP); this could provide synergistic uplift to the resources at the mitigation site and to these other federally protected lands (Freese and Nichols, 2014).

Figure 1-29. Agricultural operations on the Riverby Ranch, proposed mitigation site

NTMWD proposes that the mitigation site be protected in perpetuity by a conservation easement and be transferred to a third party land manager following the fulfillment of mitigation requirements imposed by the USACE. The Tulsa District concurs that existing site conditions at the Riverby Ranch, including surrounding land uses, its soils, climate, and hydrology, make the site suitable for restoring waters of the U.S. However, the Tulsa District has communicated to NTMWD that pre-purchasing lands for mitigation is purely speculative on their part and only after the least environmentally damaging practicable alternative (LEDPA) is identified can mitigation be fully evaluated. Compensatory mitigation and habitat restoration/enhancement could begin prior to or concurrent with impacts at the reservoir site, thereby minimizing temporal losses of waters, wetlands, and aquatic resources.

2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter of the EIS is divided into three main parts: 1) alternatives available to the USACE; 2) the no action alternative; and 3) alternatives available to the NTMWD.

2.1 ALTERNATIVES AVAILABLE TO THE USACE

In evaluating the application for a Section 404 permit it has received from the NTMWD, the USACE has three basic options: 1) to issue the Section 404 permit; 2) to issue the Section 404 permit with conditions; or 3) deny the Section 404 permit.

2.1.1 Issue the Section 404 Permit

The first alternative available to the Tulsa District is to issue an individual Section 404 permit for a project of the purpose and approximate dimensions, configuration, size, and location as described in the application submitted by the NTMWD. In this alternative, 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 on Lower Bois d'Arc Creek may proceed.

2.1.2 Issue the Section 404 Permit With Conditions

Under the second alternative available to the Tulsa District, the USACE would also issue the Section 404 permit to NTMWD so that the water supply project at Lower Bois d'Arc Creek may be constructed. However, the permit would include conditions, stipulations and mitigation measures with which NTMWD would need to comply. Compliance with these conditions would not only reduce the project's adverse impacts on physical, chemical, biological, hydrological, and cultural resources but would aim to maximize its potential benefits for the human environment.

2.1.3 Deny the Section 404 Permit

Under the third alternative available to the Tulsa District, the USACE could 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 project as proposed on Lower Bois d'Arc Creek. NTMWD could challenge this denial in federal district court (Ryan, 2003). Alternatively, NTMWD could apply for another Section 404 permit if the project were substantially different, that is, a project of different size, location, and impacts. However, applying for an altogether new Section 404 permit is a costly and time-consuming endeavor.

Were the USACE to deny the Section 404 permit, the denial would be based on its public interest review of NTMWD's current application. The public interest review involves weighing and balancing of all beneficial and detrimental factors relevant to a proposal, leading to a permit decision that reflects the outcome of that balancing process, and which reflects the national concern for both protection and use of important national resources [33 CFR Part 320.1(a)].

Factors considered in the public interest review include: conservation, economics, aesthetics, cultural and historic resources, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership, and generally, the needs and welfare of the people.

The Tulsa District's decision of whether to issue the Section 404 permit to NTMWD will be based on an evaluation of the Lower Bois d'Arc Creek Reservoir's probable impacts, including cumulative impacts, and its intended uses (primarily water supply and secondarily recreation) on the public interest.

In addition to conducting the public interest review, the USACE will apply the 404 (b) (1) Guidelines in its evaluation of the Section 404 application. The Guidelines specify that if a project is not water dependent, that practicable alternatives are presumed to be available that are less damaging to the aquatic environment. 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 Tulsa District Engineer will grant a permit to the NTMWD unless he determines that it would be contrary to the public interest [Part 320.4(a)(1)].

Were the Tulsa District to decide to deny the Section 404 permit for the proposed Lower Bois d'Arc Creek Reservoir based on the criterion of the Section 404(b)(1) Guidelines, it would be because the District Engineer has determined that, 1) one or more practicable alternatives is available that would cause less damage to aquatic resources, or 2) significant degradation would occur to our nation's waters – specifically Bois d'Arc Creek and downstream to the Red River – that could not be avoided, minimized, or mitigated to below the threshold of significance.

The fundamental rationale of Section 404 of the Clean Water Act (CWA) is that no discharge of dredged or fill material should be permitted if there is a practicable alternative that would be less damaging to waters of the US, 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 US. It first requires demonstration of avoidance of impacts, followed by minimizing impacts and, finally, requires mitigation that compensates for unavoidable impacts to the aquatic environment (33 CFR 332.1c).

2.2 NO ACTION ALTERNATIVE

Section 1502.14(d) of the Council on Environmental Quality's (CEQ) Regulations for Implementing 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 Lower Bois d'Arc Creek Reservoir – "no action" simply 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 then, the No Action Alternative consists of neither building nor operating 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, i.e., not proceeding with the Proposed Action Alternative, will be compared to the results of proceeding with the Proposed Action. In a number of instances, but not all, the results of the No Action Alternative will be tantamount to describing the affected environment, because there will be no change from existing conditions. In other instances 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, reservoir, and water withdrawal.

It is important to specify that "existing conditions" refer to those that existed or prevailed in the 2008 timeframe, when the Section 404 permit was first applied for, not the year in which this EIS is released (2015). The reservoir habitat evaluation and the jurisdictional determination studies were conducted in 2007-2008, and that is the baseline to which changes are compared. In essence, if the USACE were to deny the Section 404 permit (Section 2.1.3), the outcome would amount to the No Action Alternative.

Analysis of the No Action Alternative in this EIS does not include any speculative action that NTMWD might undertake were the Section 404 permit to be 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 predictable, back-up option that could be acquired and developed by 2020 should the Tulsa District deny the Section 404 permit for the Lower Bois d'Arc Creek Reservoir. Thus, the No Action Alternative in this EIS consists specifically of not building and operating the reservoir.

2.3 ALTERNATIVES AVAILABLE TO THE NORTH TEXAS MUNICIPAL WATER DISTRICT

2.3.1 Constructing the Lower Bois d'Arc Creek Reservoir (LBCR) as Proposed by NTMWD

The dam site of the proposed LBCR is located in Fannin County, within the watershed of the Red River Basin, approximately 15 miles northeast of the City of Bonham. Lake Bonham itself 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 2-1 and 2-2 are location and vicinity maps of the proposed reservoir. The reservoir proposed 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 above 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 2-3 and 2-4 are photos within the proposed reservoir site.

2.3.1.1 Dam and Reservoir

The Lower Bois d'Arc Creek Reservoir Dam would be constructed as a zoned earthen embankment. The dam would be approximately 10,400 feet long – approximately two miles – and would have a maximum height of about 90 feet. The design top elevation of the embankment would be 553.5 feet MSL. The embankment would be 19.5 feet higher than the conservation pool of the reservoir, at elevation 534.0 ft. MSL, and 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 (Freese and Nichols, 2006; Freese and Nichols, 2008b). 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 2-5 and 2-6.

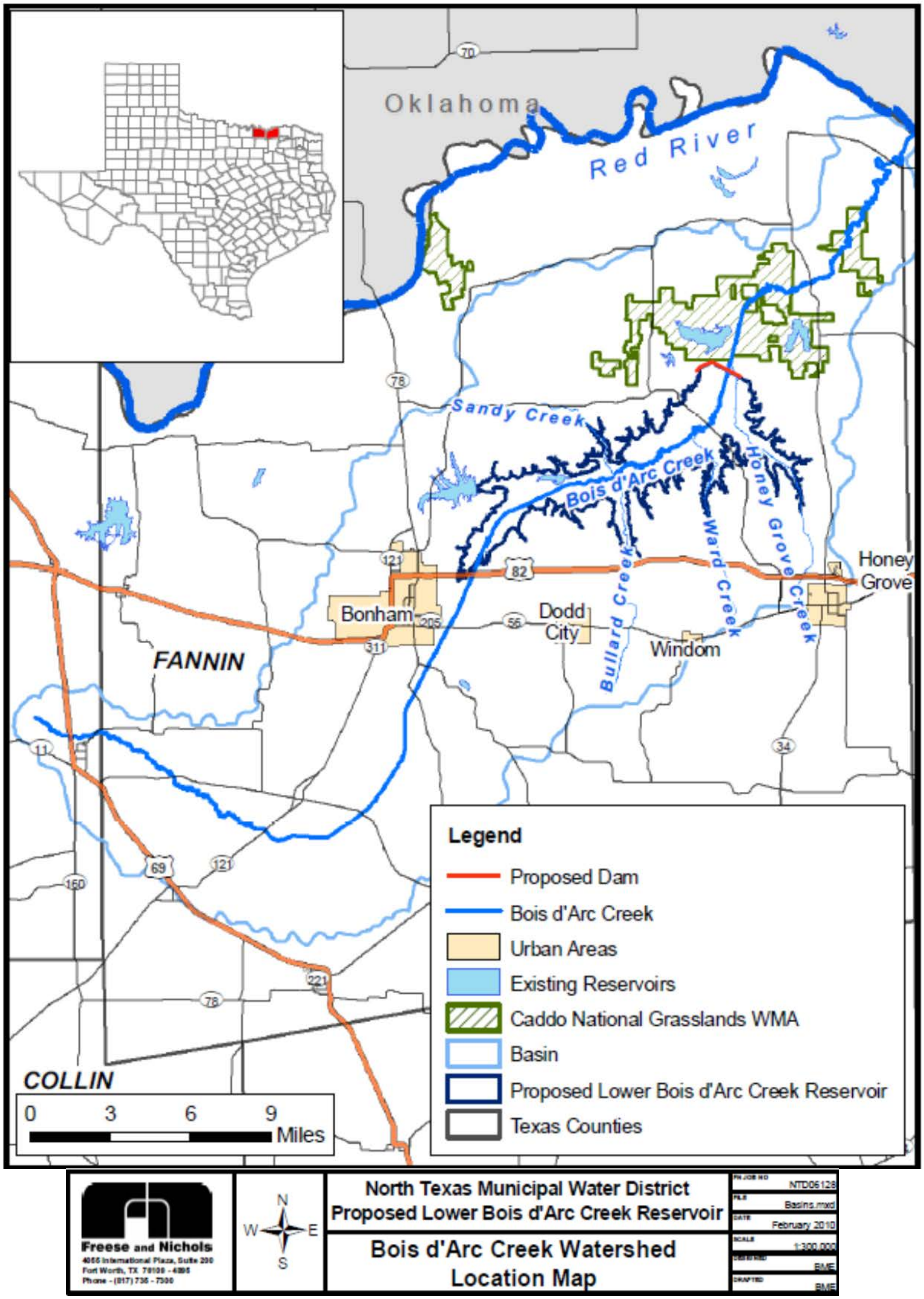


Figure 2-1. Lower Bois d'Arc Creek Reservoir location map

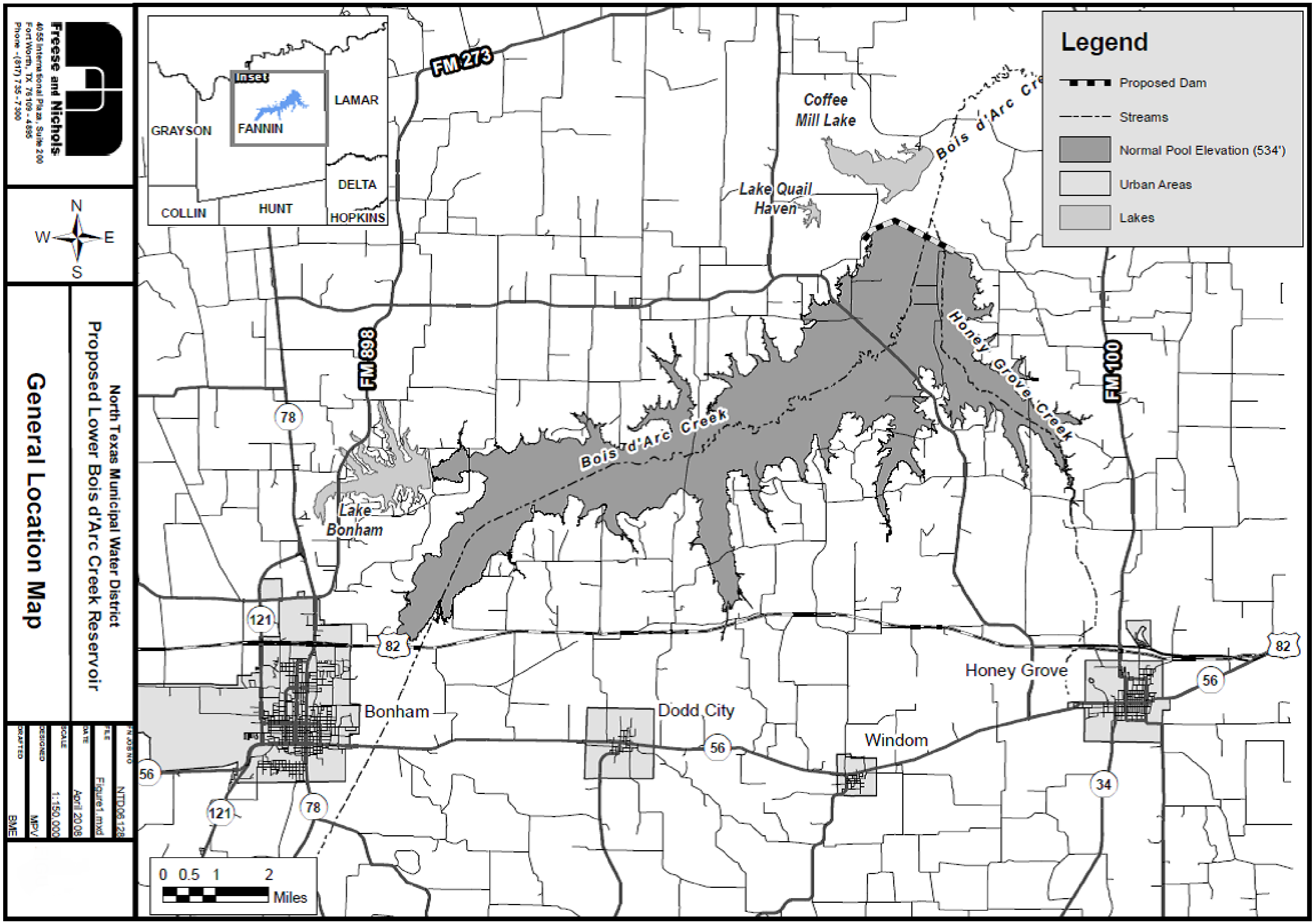


Figure 2-2. General vicinity map of the Lower Bois d'Arc Creek Reservoir

Figure 2-3. FM 1396 and grazing land within the proposed reservoir footprint

Figure 2-4. Bois d'Arc Creek and riparian corridor

Table 2-1 summarizes the quantities and three types of fill material to be deposited into Bois d'Arc Creek, Honey Grove Creek, and the wetlands abutting Bois d'Arc Creek.

Table 2-1. Types & amounts of fill needed for LBCR dam construction (cubic yards)

Location	Slurry material	Earthen material	Soil cement
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**

Source: Freese and Nichols, 2008b

2.3.1.2 Service Spillway and Outlet Works

The service spillway would be located at the right (east) abutment of the dam (Figure 2-5). The spillway would include an approach channel, a 150-foot uncontrolled concrete weir, chute, hydraulic jump stilling basin and outlet channel. Required low-flow release would be made through a 36-inch diameter low-flow outlet. The weir would consist of a concrete gravity, ogee-type section with a crest length of 150 feet. 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, at elevation 550.5 feet MSL.

The spillway structure would extend 958 feet downstream from the dam centerline downstream edge of the end sill. 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 with a 150-foot bottom width and then flow approximately 1,500 feet in Honey Grove Creek to its confluence with Bois d'Arc Creek.

Required low-flow releases would be made through a 36-inch diameter low-flow outlet located on the right (east) side of the floodplain near the toe of the right abutment. The conduit would extend through the dam and would have an impact basin as an energy dissipation structure. Its exit channel would extend to the service spillway exit channel and then back to Bois d'Arc Creek. The outlet would have a multiple-level intake tower in the reservoir to allow for required downstream releases.

An emergency spillway would also be located in the right abutment of the dam (Figure 2-5). The spillway would be a 1,400-foot wide uncontrolled broad crested weir structure with a crest elevation of 541 ft. MSL. This elevation was selected to contain the 100-year storm such that no flow passes through the emergency spillway during this event (Freese and Nichols, 2008b).

2.3.1.3 Reservoir Clearing

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 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 the areas shown on Figure 2-7. Reservoir clearing would take place before reservoir impoundment except for areas that would be cleared earlier during construction of the dam and associated facilities, as well as near the pump station and water intake structure.

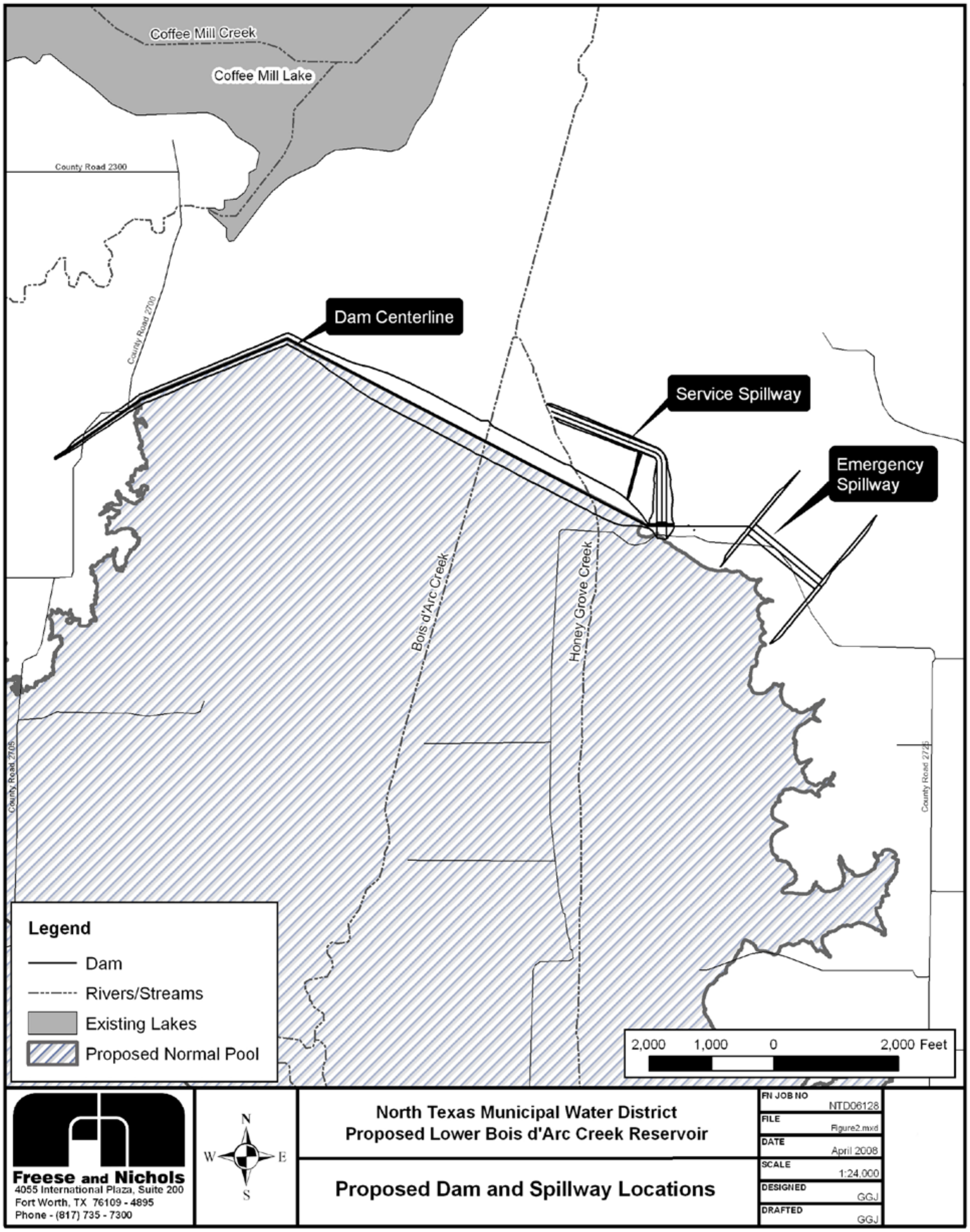


Figure 2-5. Proposed Lower Bois d'Arc Creek Reservoir – dam and spillway locations

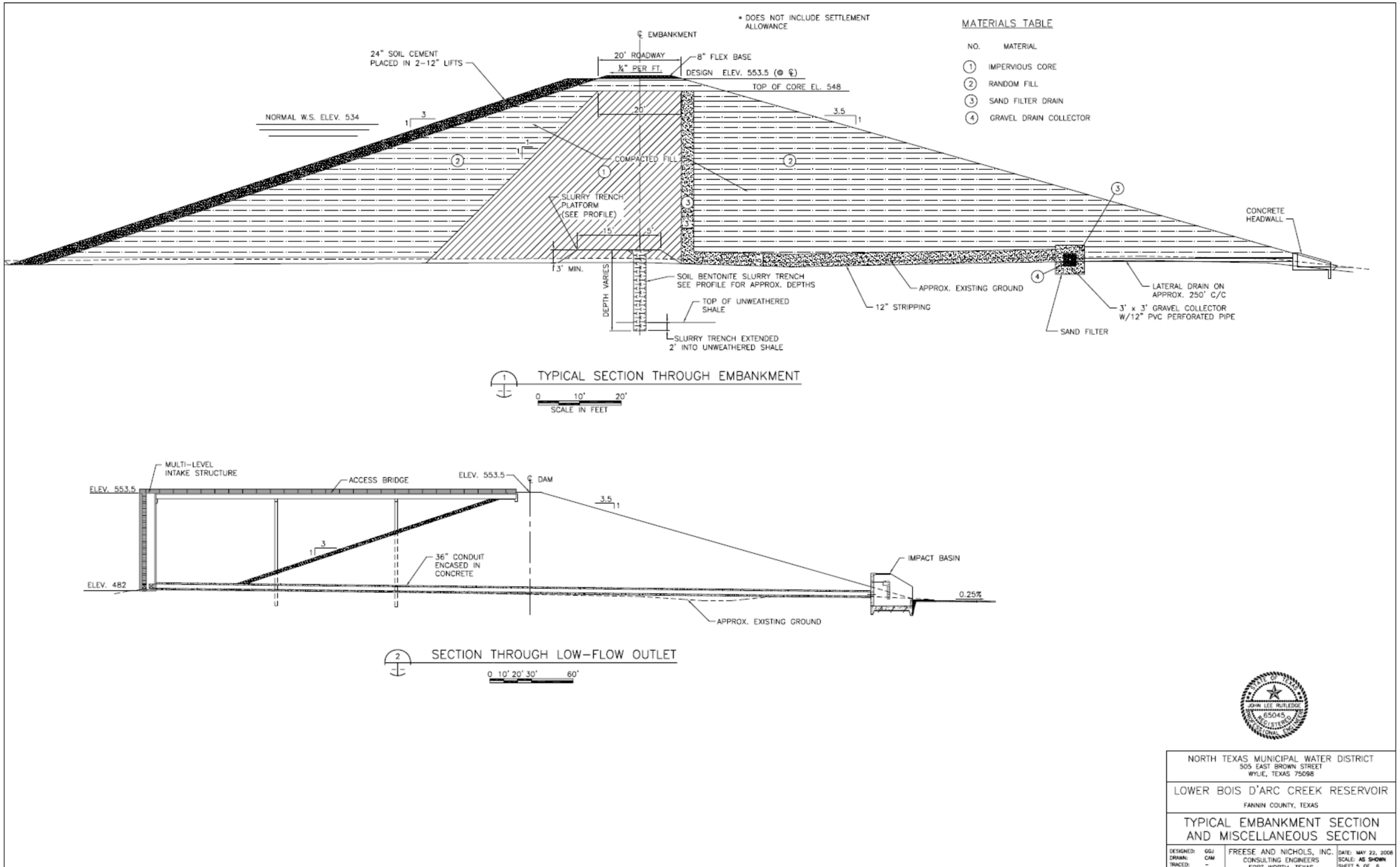


Figure 2-6. Preliminary drawings of Lower Bois d'Arc Reservoir dam cross-section

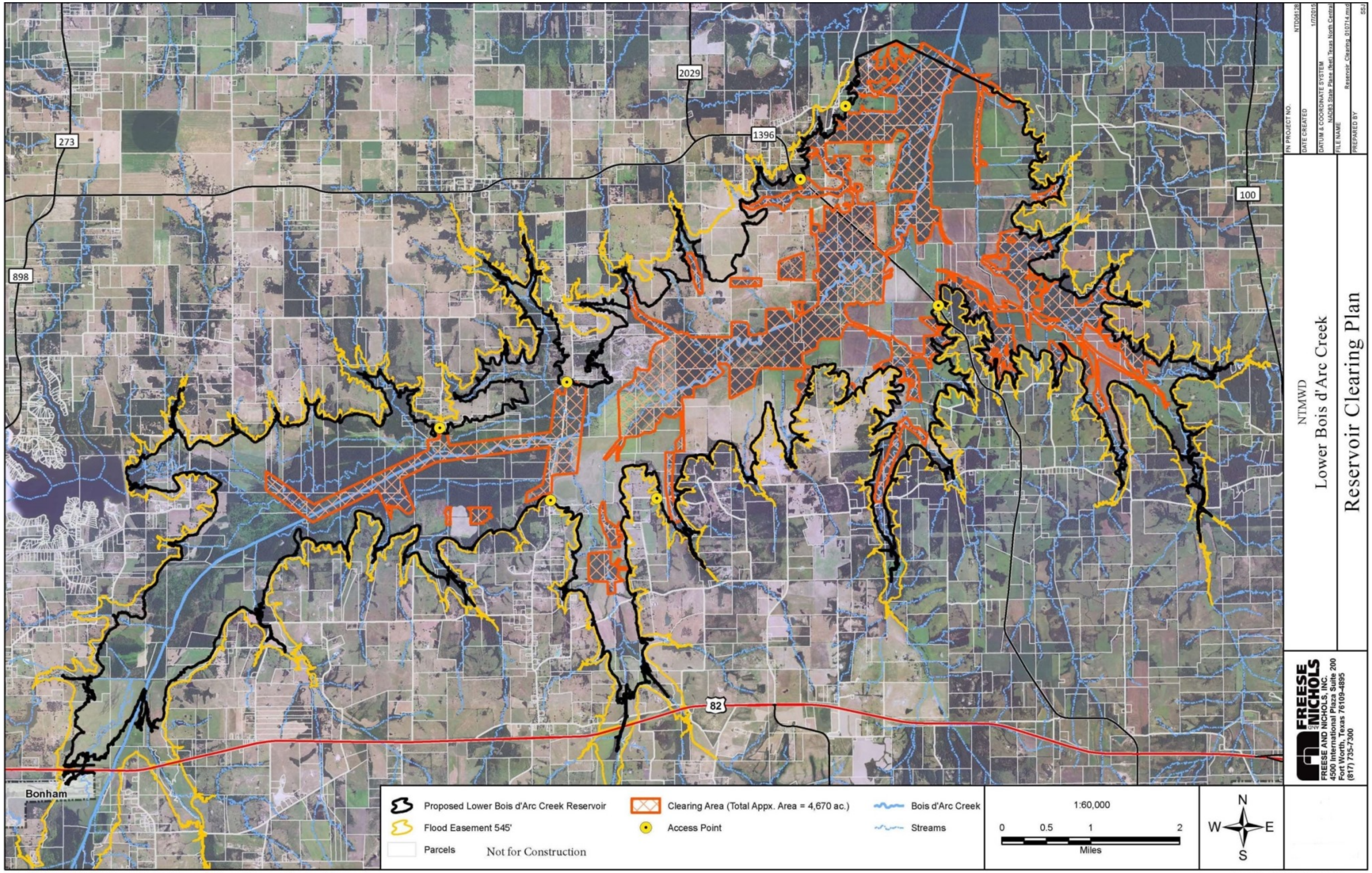


Figure 2-7. Conceptual reservoir clearing plan

The applicant prepared first a preliminary Reservoir Clearing Plan and then a Conceptual Clearing Plan to guide this 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; improve human access to shore locations by creating shore access locations for boat ramps, bank fishing, etc. through selective clearing of trees and shrubs; reduce hazards to boating safety and fishing resulting from large floating debris by minimizing the source of such debris; and create aesthetic views of the reservoir along selected segments of the shoreline (NTMWD, no date-d; NTMWD, 2015).

Both hand and machine clearing are proposed. 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.

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.

The designated areas on Figure 2-7 would be cleared using the 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.
- 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.

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, 2015).

2.3.1.4 Raw Water Transmission, Storage, and Treatment Facilities

As part of the Proposed Action, NTMWD would construct raw water transmission facilities. 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 areas of the NTMWD's service area. These proposed facilities include a raw water intake pump station and electrical substation at the reservoir site and approximately 35 miles of 90-96 inch diameter raw water pipeline. Originally, as described in Chapter 1 of this EIS, there was to have been an additional segment of approximately 14.5 miles of 66-inch pipeline from the future north water treatment plant (WTP) near Leonard to a discharge point in Pilot Grove Creek. However, this second segment has been eliminated and is no longer part of the project or the Section 404 application. Figure 2-8 shows the location of the proposed raw water transmission pipeline as well as ancillary and associated facilities, including the proposed pump station, electric substation, terminal storage reservoir (TSR), TSR outfall, WTP, and rail spur on the WTP site.

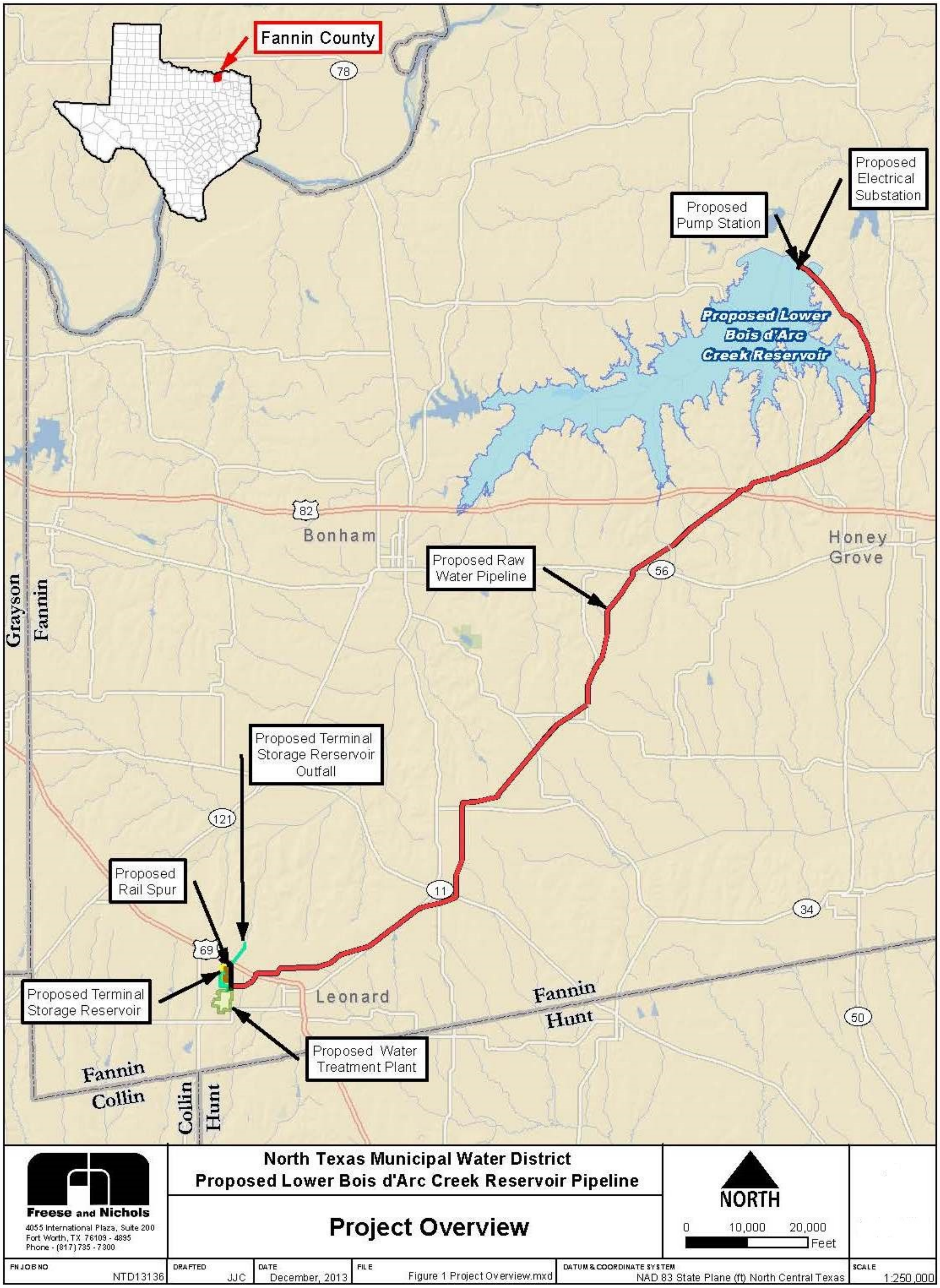


Figure 2-8. Proposed alignment of 90-96" diameter pipeline and location of associated facilities

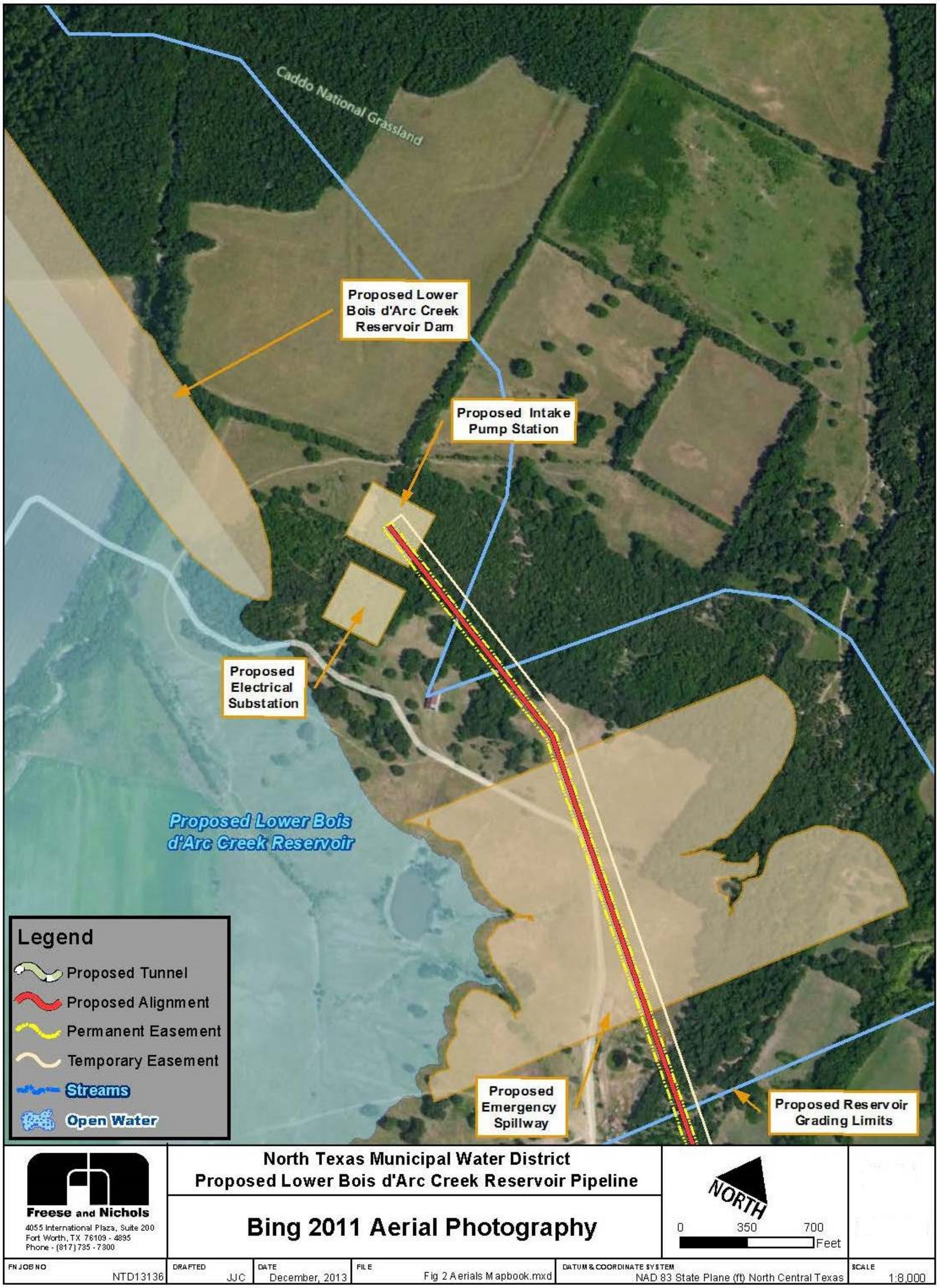


Figure 2-9. Location of proposed intake pump station and electrical substation

The transmission facilities for the LBCR would be constructed for an initial capacity of at least 170 MGD, which represents a 1.5 peaking factor over the yield from the lake (126,200 acre-feet per year or 113 MGD). However, the transmission system would be designed to allow for an ultimate peak flow capacity of at least 236 MGD, which is about 2.1 times the yield from the reservoir.

Since 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 simple 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 (Figure 2-9). Each pump would require about a 6,000-hp motor. A new dedicated 138kV – 6.9kV, low resistance grounded substation housing two transformers would be required to power these 6,000-hp motors in the new intake pump station. The 138kV distribution line reaching to the substation and servicing the intake pump station easement would potentially parallel the pipeline easement to the pump station site.

Raw Water Pipeline

NTMWD is proposing to build a pipeline that would convey raw water from the proposed reservoir site to the proposed north WTP site near the City of Leonard in southwest Fannin County (Figure 2-8). The proposed 90 to 96-inch diameter pipeline would generally 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 easement width of 70 feet. Construction of the proposed pipeline would be achieved primarily with open-trench construction methods. However, three stream crossings – including 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 (Freese and Nichols, 2013).

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 tracks, and minor utility crossings would be designed according to requirements of each facility's owner and permitted as required by the relevant permitting authority (Freese and Nichols, 2009).

It is anticipated to take at least two years to lay the pipeline. 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.

Intake Pump Station

In order to draw water from the proposed reservoir, a raw water intake pump station is proposed for construction close to the southeastern end of the proposed LBCR dam site (Figure 2-9). The dimensions of the raw water intake pump station site would be approximately 310 feet x 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 is still within the original proposed footprint of the proposed dam and spillways associated with the reservoir. Thus, it does not require additional acreage (Freese and Nichols, 2013).

Electrical Substation

In order to provide power to the proposed intake pump station, a new electrical substation would also be built near the southern end of the proposed LBCR dam site, next to the proposed pump station (Figure 2-

9). The electrical substation site would be approximately 325 feet x 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 pump station, this site is in a somewhat different location than in the Individual Section 404 Permit application submitted in June 2008. However, because it is still within the grading limits initially proposed, it does not entail additional acreage (Freese and Nichols, 2013).

Terminal Storage Reservoir

A TSR is proposed to be constructed west of the City of Leonard (Figures 2-8 and 2-10). 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 can 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 leads to a proposed drainage pipeline. The proposed drainage pipeline would be approximately 72 inches in diameter and 4,918 feet (almost a mile) in length; it would drain into Valley Creek to the north. The drain 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 located slightly south of the headwaters of Valley Creek with a footprint of approximately 0.36 acres (Figure 2-11) (Freese and Nichols, 2013).

North Water Treatment Plant

Raw water that is transported from the proposed Lower Bois d'Arc Creek Reservoir will be treated at a proposed WTP site (the "North Water Treatment Plant") that would be constructed near the City of Leonard, TX (Figures 2-8, 2-12, and 2-13. NTMWD currently owns an approximately 662-acre site that is located west of Leonard between State Hwy. 69 and FM 78 (Figure 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 (Freese and Nichols, 2013).

The North WTP is a facility that will be needed by NTMWD in the 2020 – 2021 timeframe, and it is being designed to ultimately 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, but no longer at this location.

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 seen at the District's Wylie and Bonham facilities and NTMWD's staff is accustomed to operating the process used at these 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 facilities.

The North WTP is anticipated to use conventional treatment with intermediate ozonation for primary disinfection and taste and odor (T & O) control. Major treatment facilities would include flow metering and distribution, rapid mix chambers, flocculation basins, sedimentation basins, ozone contact basins, biologically-active filters, and clearwell. Major support facilities would include a control and chemical feed building, a blower building, a reclaimed water basin, sludge lagoons, and a maintenance building. Sodium hypochlorite and liquid ammonium sulfate would likely be utilized for residual disinfection to avoid the risk management issues associated with 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.

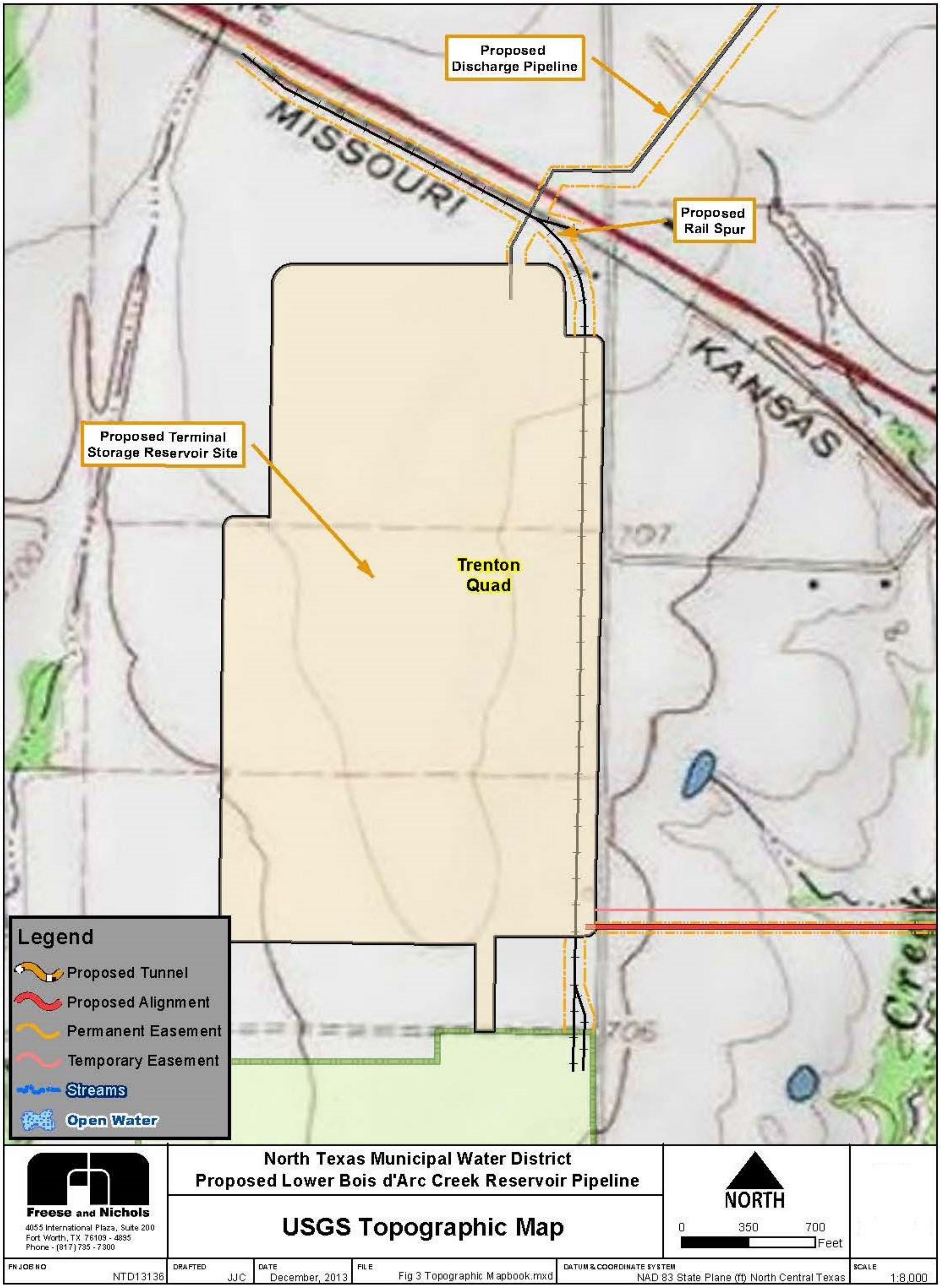


Figure 2-10. Location of proposed terminal storage reservoir next to North WTP

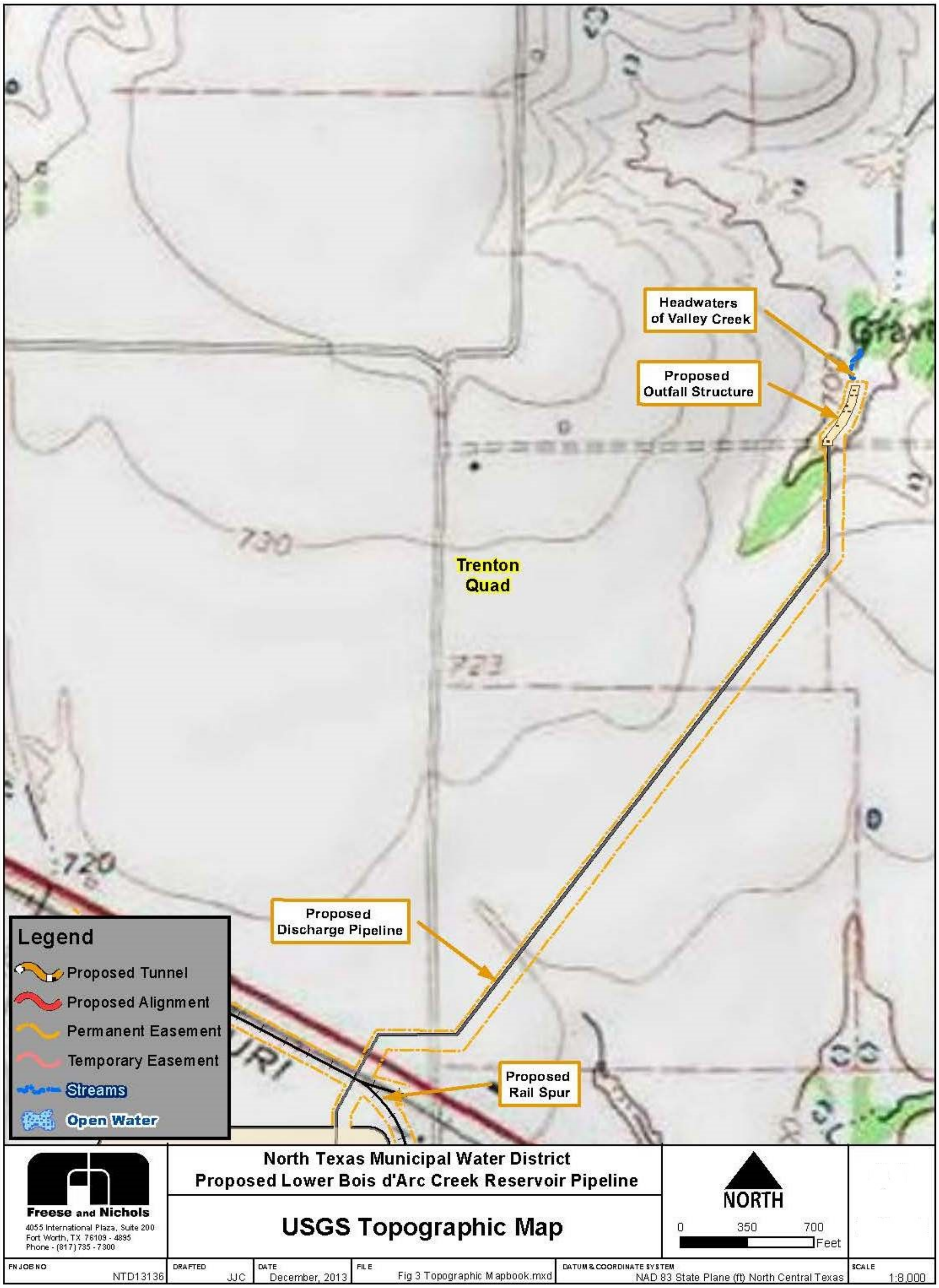


Figure 2-11. Location of proposed TSR discharge pipeline and outfall

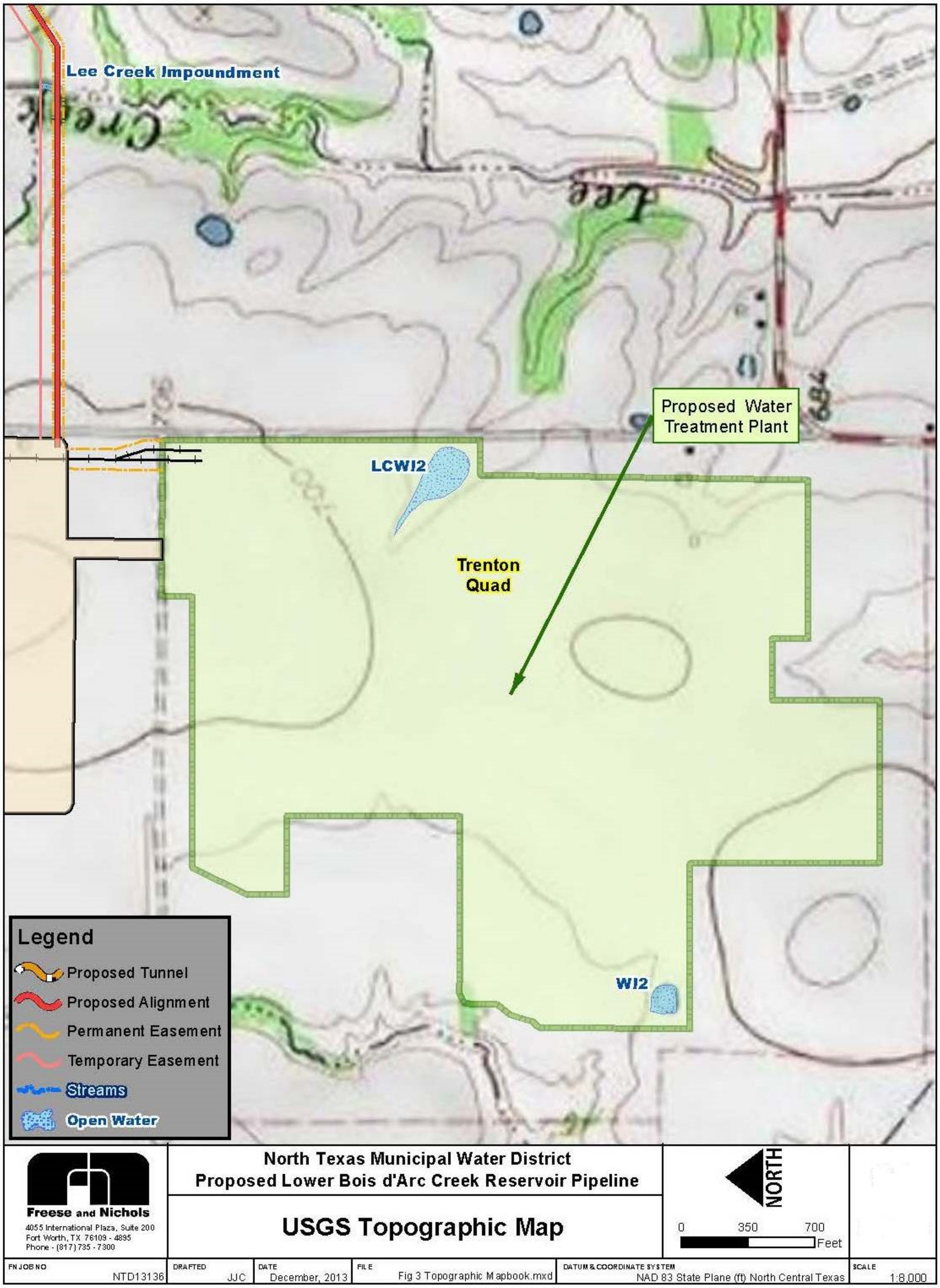


Figure 2-12. Location of proposed North Water Treatment Plant

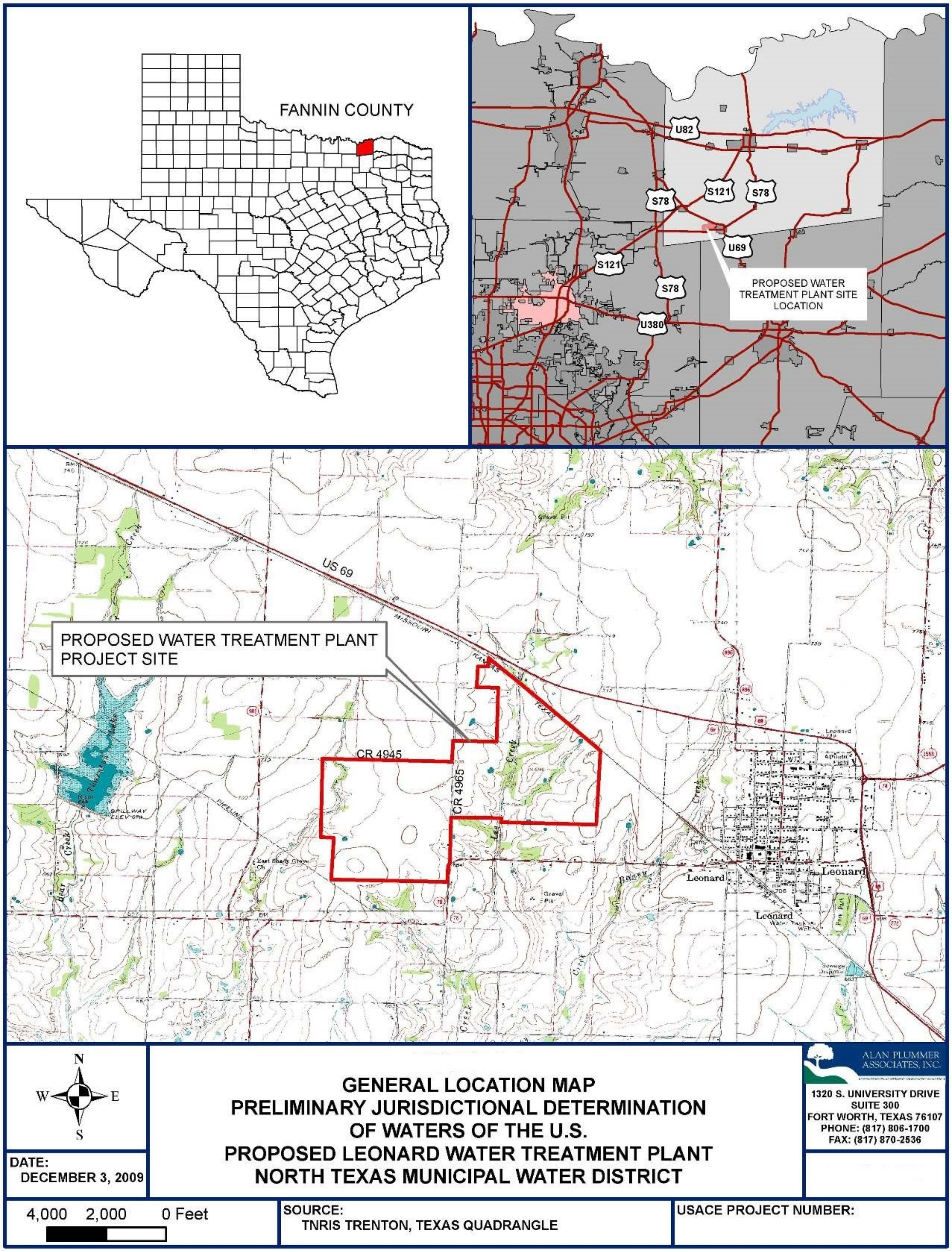


Figure 2-13. Location of NTMWD-owned property on which North WTP would be built

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 2-8 and 2-11). 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 (Freese and Nichols, 2013).

2.3.1.5 <u>Reservoir Operation</u>

Year-to-year and seasonal operation of the reservoir would be governed by an Operation Plan (NTMWD, 2014). In general, the LBCR would impound up to 367,609 acre-feet of water and produce an estimated firm yield of 126,200 acre-feet of water per year, an average of 113 MGD. The conservation pool, or normal water surface, of the reservoir would be maintained at elevation 534.0 ft. MSL, but as discussed in more detail in the section of Chapter 3 under water resources, the actual water surface and shoreline would continually fluctuate above and below this level. In a "typical" year, the reservoir is fullest in May and June. Reservoir elevations 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 reservoir content levels are more closely related to extended periods of dry conditions versus wet conditions rather than seasonal variations. Based on the long-term historical hydrologic record, the water surface would exceed 534.0 ft. MSL less than 10 percent of the time (that is, during 90% of an average year the lake would be below 534 msl), and would drop below 516.4 ft. MSL (40 percent full) approximately 10 percent of the time (Figure 2-14).

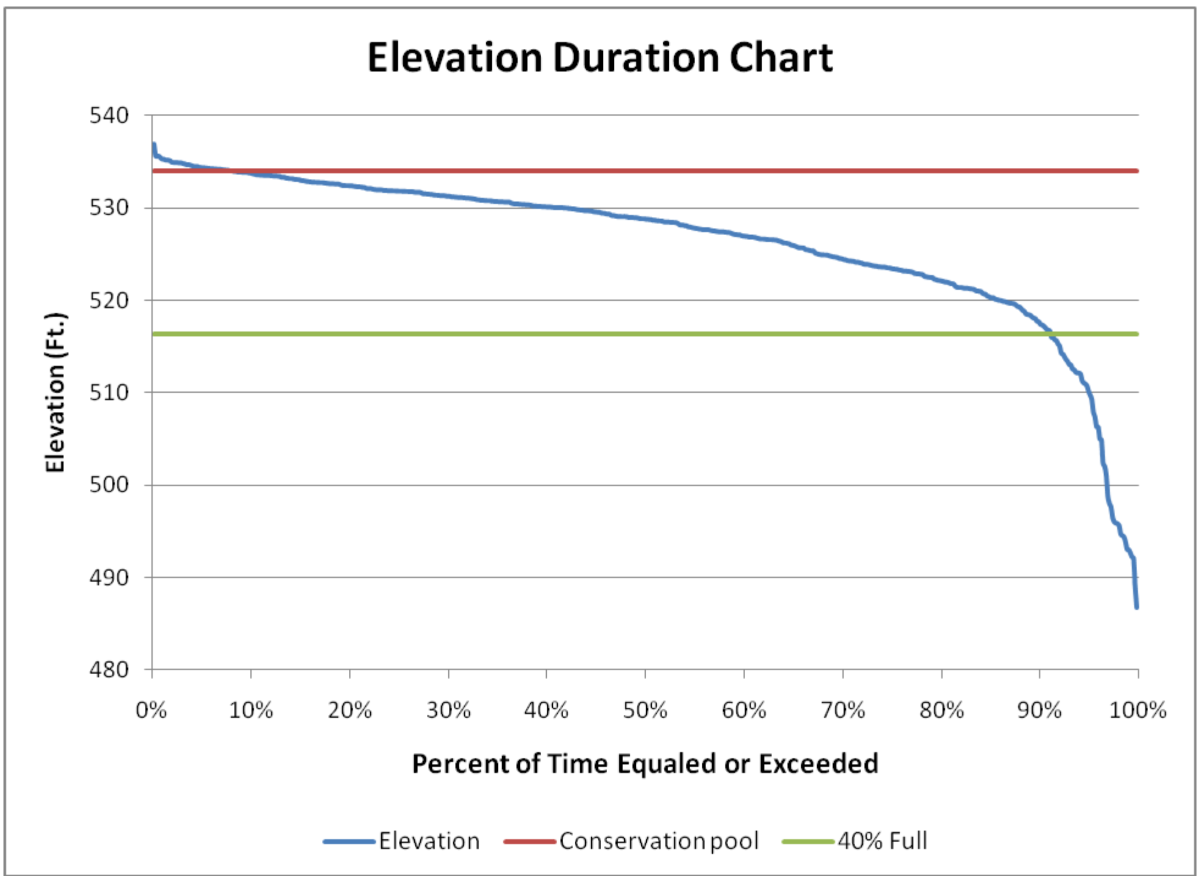


Figure 2-14. Water surface elevation duration chart for Lower Bois d'Arc Creek Reservoir

A secondary or incidental benefit of the LBCR, after water supply, is to provide lake-based recreation, such as boating, fishing, water-skiing, swimming, and perhaps other contact and non-contact 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. However, recreation is not part of the purpose and need of the proposed action. At this stage, no specific facilities, activities, designs or locations have been chosen.

Based on the instream flow needs analysis and subsequent discussions with the TCEQ, the environmental flow releases summarized in Table 2-2 have been proposed for the LBCR.

Table 2-2. Environmental flow criteria for bypassing inflows through the reservoir

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

cfs = cubic feet per second ac-ft = acre-feet

*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: Draft Operation Plan, Proposed Lower Bois d'Arc Creek Reservoir (NTMWD, 2014)

Leading up to the current (December 2014) Draft Operation Plan for LBCR, potential reservoir operation were discussed in general terms in two memoranda written by FNI for the NTMWD (Albright, 2014a; Albright and Gooch, 2008). The ability to maximize supply from LBCR is a key element in the operation of NTMWD's multiple sources of water as a water supply system. As part of a system thus, the operation of LBCR would depend on the development of other water sources for NTMWD, demands from the system, and local demands in Fannin County. The 2008 FNI memorandum examined one potential operation scenario, considering the aim to maximize supply while balancing long-term needs.

The 2008 memorandum was prepared in support of NTMWD's water rights application for LBCR. This memo describes modeling assuming that 236 MGD is diverted from the LBCR as long as its water level is less than two feet below the top of conservation storage (that is, between 534 and 532 feet msl). The maximum diversion would be 175,000 AFY. When the reservoir water level decreases to more than two feet below the top of conservation storage (below 532 feet msl), diversions would be reduced to less than the reservoir's firm yield of 126,200 AFY to prevent a shortage of supply, down to 114,930 AFY in the TCEQ Water Availability Model (WAM) and 124,800 AFY in the FNI WAM. The reduced demand is about five percent less than the firm yield in the TCEQ WAM and about one percent less than the firm yield of the FNI WAM (Albright and Gooch, 2008). Figures 2-15 and 2-16 simulate what annual diversions would have looked like if the LBCR had been in place and functioning during the 50-year period from 1948-1998 under potential operations using the TCEQ WAM and the FNI WAM.

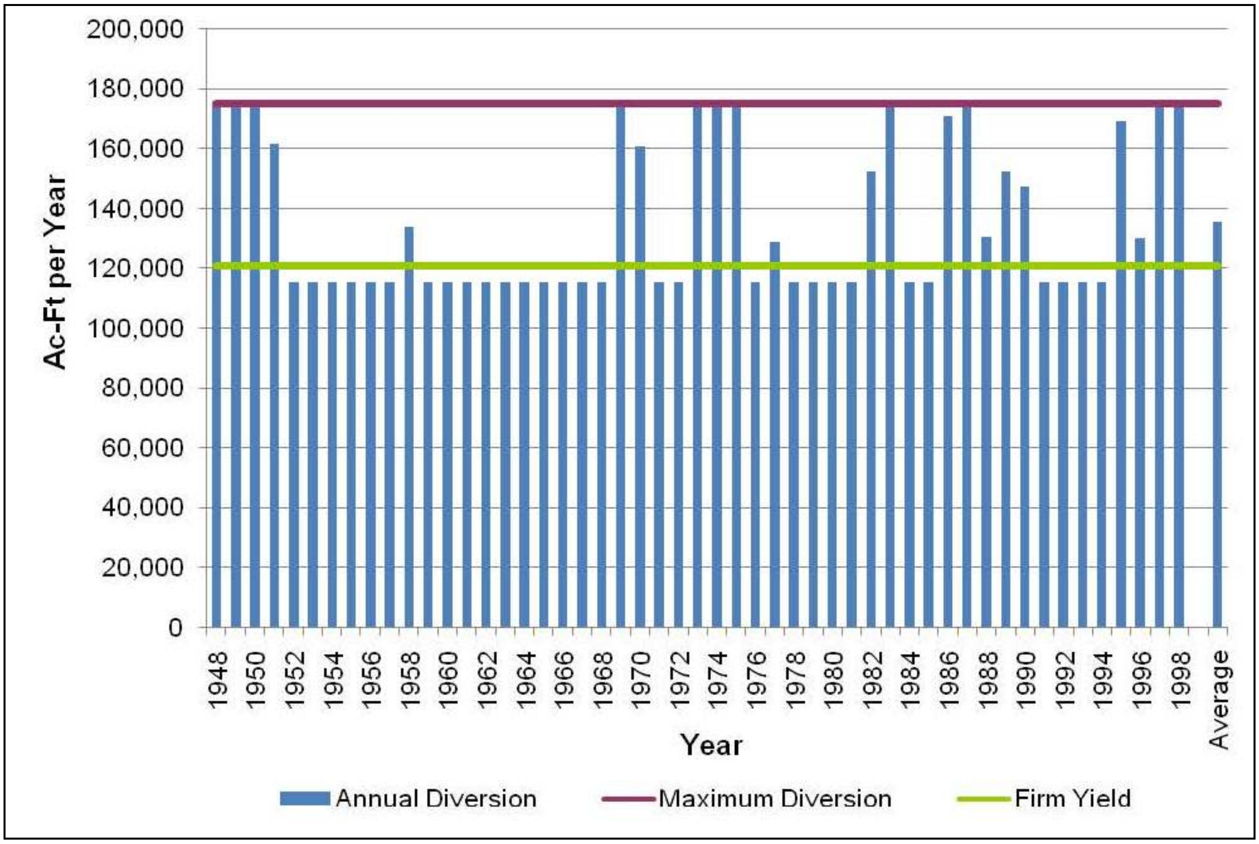


Figure 2-15. Annual diversions, 1948-1998 under potential operation using the TCEQ WAM

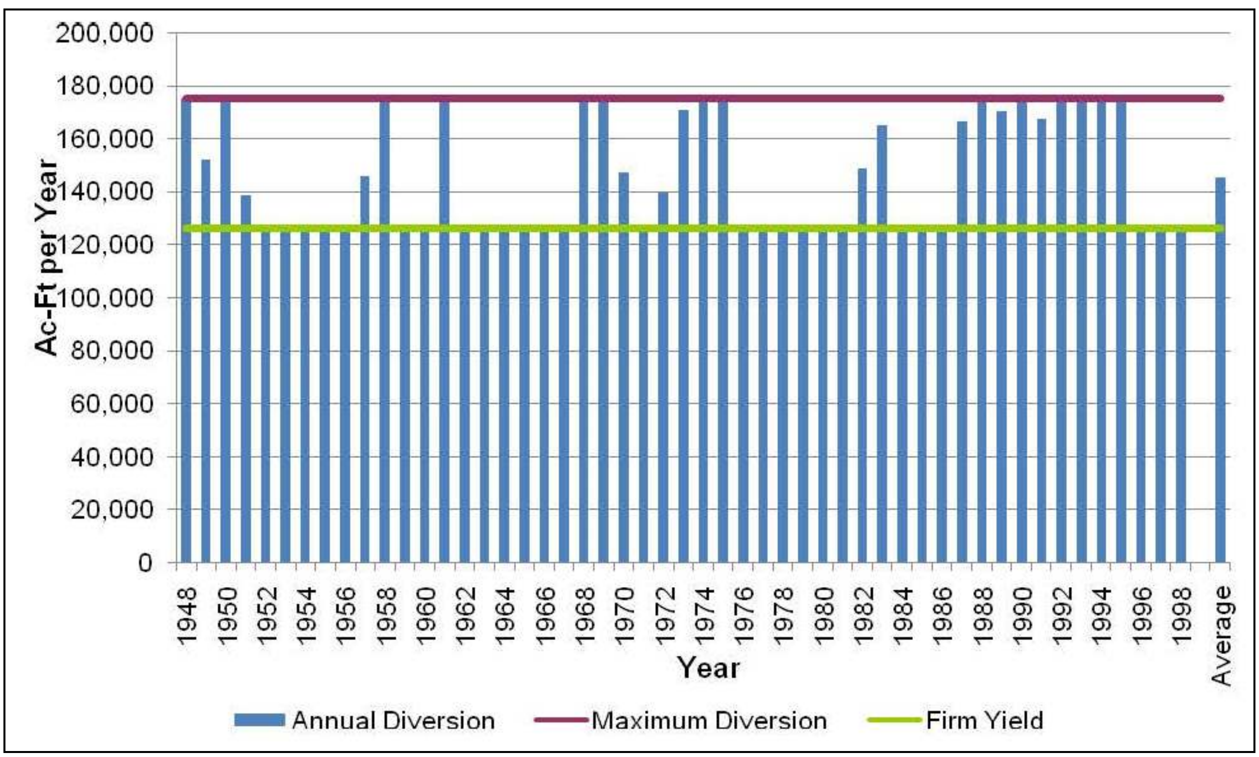


Figure 2-16. Annual diversions, 1948-1998 under potential operation using the FNI WAM

In the potential operation scenario developed in 2008, during wetter years, NTMWD would divert up to 175,000 AFY from LBCR. Alternatively, during drier times when LBCR is less than full, reservoir diversions would be reduced. The reduced level of diversion would be sufficient to provide reliable supplies for both NTMWD and local demand in Fannin County through a repeat of the drought of record (Albright and Gooch, 2008).

Under a potential operation policy of diverting 175,000 AFY during wetter years, the LBCR would be relatively full (between elevations 534 feet and 532 feet msl) with a slightly lower frequency. However, during drought conditions when the reservoir is low, there would be very little difference. Indeed, the TCEQ WAM indicates that the reservoir would have more water in storage (i.e., have a higher water level) during extremely dry periods due to the lowered demand. Some supply above the firm yield of 126,200 AFY would be available more than 40 percent of the time. During other times (i.e., 60 percent of the time), the supply from the reservoir would be slightly less than firm yield operation.

Figure 2-17 compares the flow frequency at FM 409 with the LBCR operating at its firm yield and with the overdraft operation described in the 2008 Memorandum. The flows shown from modeling runs using the daily RiverWare model that was developed to examine environmental flows for this project. The final environmental flows are included in the modeling. Flows are displayed on both a normal (top) and a log scale (bottom). The log scale graph facilitates 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 (passing water) under firm yield operation. During overdraft operation, spills 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.

As specified in the Draft Operation Plan (NTMWD, 2014), some of the factors that can affect the operation of the Lower Bois d'Arc Creek 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.

- Available infrastructure. Initially, complete use of the LBCR may be limited by treatment and distribution capacity. At times, use of the facility 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 LBCR may change to accommodate the use of those other supplies, particularly if those sources are treated at the North WTP near Leonard.

The operation policy outlined in the 2008 and 2014 memoranda and Draft Operation Plan is only one of many different potential operational policies for the LBCR. Actual operation of the reservoir will depend on the extent of development of the NMTWD system, demands from 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 below two feet if NTMWD system demands are near available supplies and if new sources are being developed that would allow reduced diversions from LBCR in later years. NTMWD currently has five major sources of water (Lakes Lavon, Texoma, Chapman and Tawakoni and reuse), and anticipates adding several more over the next few decades.

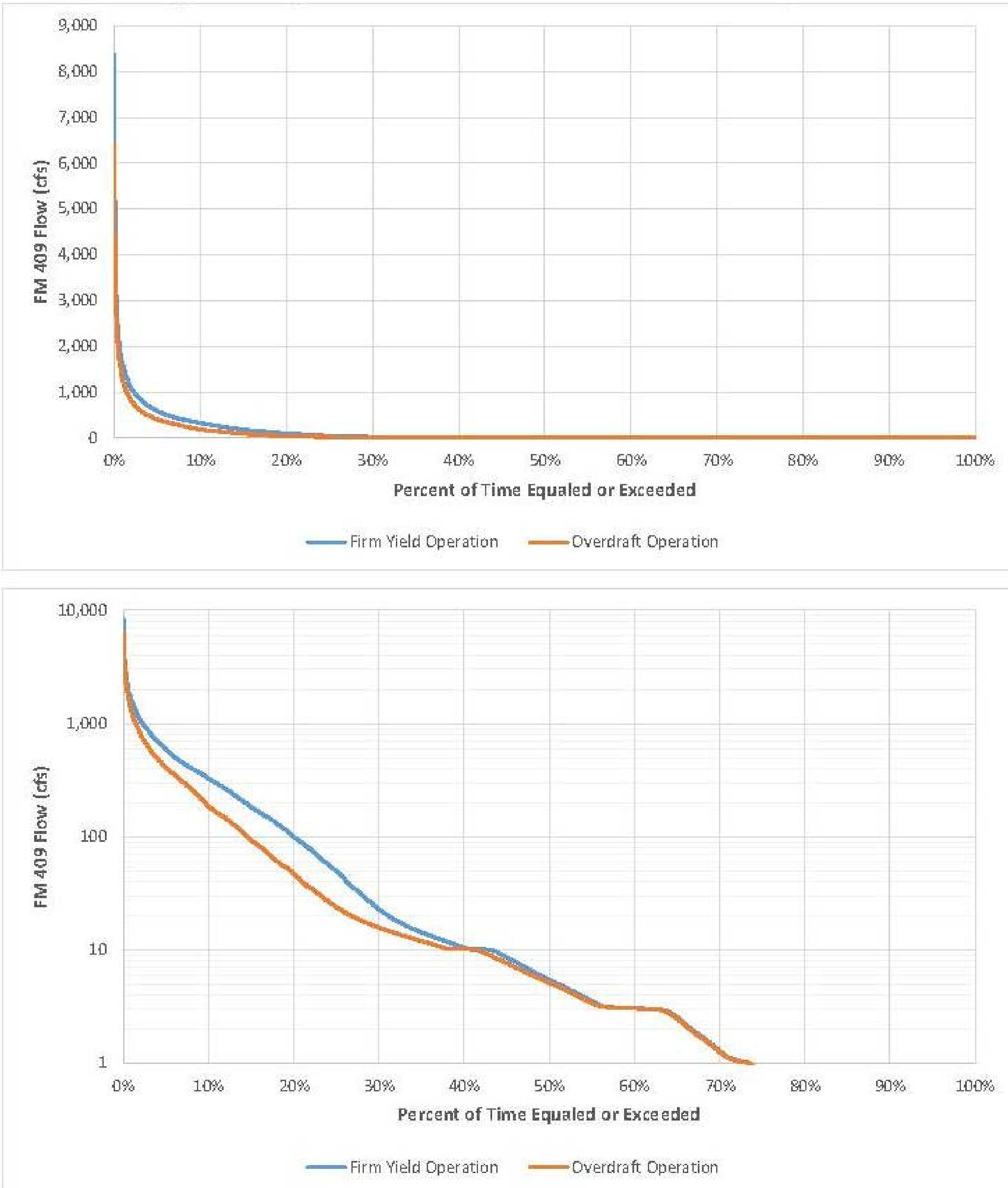


Figure 2-17. Comparison of flows at FM 409, firm yield and overdraft operation, on normal (top) and logarithmic scales (bottom)

Some of these other sources are quite far away from the NTMWD service area and it would be costly to pump their water to members and customers. As related 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 divert up to 175,000 AFY 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 utilized to a greater extent. In all cases, NTMWD will have to balance the needs for reliable water supply, costs, water quality, water rights and agreements when operating its system.

2.3.2 Developing or Acquiring Other Water Supply Sources

Potential alternatives to the Lower Bois d'Arc Creek Reservoir project can be divided into those that will be implemented prior to LBCR – and regardless of whether LBCR is approved and built – and those that are true alternatives to the proposed project. The former category includes interim water purchases, water conservation, and water reuse. The latter category includes development of new reservoirs, transporting water from existing reservoirs, development of new groundwater supplies and desalination of brackish water. The projects identified in this section were identified through the Texas water planning process and/or previous studies. For comparative purposes, the cost of water reported for the alternatives is from the 2011 Region C Water Plan unless specifically noted otherwise.

To meet its immediate needs, and until permanent solutions can be achieved, the NTMWD has contracted for interim water purchases from the Sabine River Authority (Lake Tawakoni) and Greater Texoma Utility Authority (Lake Texoma). However, neither of these water supplies, controlled by other water authorities, is available in sufficient quantity to meet NTMWD's future needs. The 49,718 AFY purchase from the SRA in 2010 decreases to 9,356 AFY by 2030 and remains at that quantity until 2060, but is subject to further reduction. The interim GTUA purchase was supposed to be 15,500 AFY in 2010 and decline to 0 by 2020. In fact, however, NTMWD was unable to withdraw and transfer water from Lake Texoma from 2009 onward, due to the discovery of zebra mussels there, and this led to the cancellation of the contract in 2012.

In general, Lake Texoma water must be mixed with fresh water due to its high content of dissolved salts. Therefore, access to Texoma water must coincide with access to another freshwater source. The presence of zebra mussels in Lake Texoma makes any such mixing very difficult and costly because of the risks of transferring this invasive species.

2.3.3 Alternatives Implemented Prior and in Addition to LBCR

Water conservation and water reuse strategies complement the Proposed Action rather than substitute for it.

2.3.3.1 <u>Water Conservation</u>

The report of the Water Conservation Implementation Task Force to the 79^{th} Texas Legislature in 2004 strongly endorsed the principle that effective and efficient water conservation, including water reuse, would be critical to meeting the water-supply needs of future generations of Texans (TWDB, 2004b). The Texas Water Code §11.002(8) defines *conservation* as "the development of water resources; and those practices, techniques, and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses." Under this definition, reuse of treated wastewater effluent would be considered a water conservation measure (Region C Water Planning Group, 2010).

Conservation is a recommended water management strategy for the NTMWD. In general, for all of Region C, the Region C Water Planning Group considered the municipal water conservation strategies suggested as best management practices (BMPs) by the Conservation Implementation Task Force and recommends a water conservation program for Region C that achieves the following:

- Including the 277,000 acre-feet per year of conservation built into the demand projections (for low-flow plumbing fixtures and efficient power plants), a total conservation and reuse supply of 1.2 million acre-feet per year by 2060, accounting for 36 percent of the region's demand without conservation.
- A reduction in dry-year per capita municipal use for the region (after crediting for reuse) from 197 GPCD in 2000 to less than 140 GPCD by 2020.

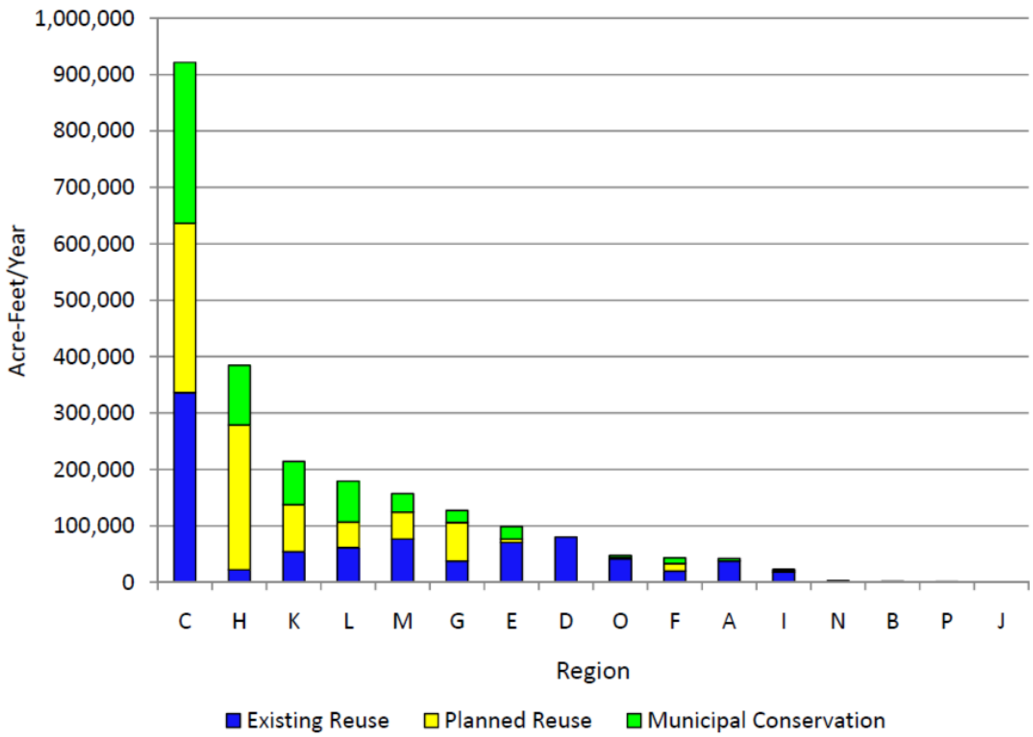


Figure 2-18. Planned 2060 reuse and municipal conservation supplies by Texas region

The 2011 Region C Water Plan includes noteworthy conservation and reuse efforts. Figure 2-18 depicts the planned supplies from reuse and municipal conservation efforts for Region C based on the 2011 Region C Water Plan and for other planning regions in the state based on the Texas Water Development Board Regional Planning Database. While Region C constitutes approximately 25 percent of the state's population, it has 40 percent of the planned water supplies from reuse and municipal conservation (Region C Water Planning Group, 2010).

In the *2006 Region C Water Plan*, the projected total water demands for Region C included water conservation savings of 11 percent of total water demand for the region by 2060. Municipal measures were categorized based on potential for water savings, opinions of probable cost, and likelihood of implementation. The basic package, recommended for every WUG in Region C, included the following measures:

- Low flow plumbing fixtures (included in water demand projections)
- Public and school education
- Water use reduction due to increasing water prices
- Water system audit, leak detection and repair, and pressure control
- Federal residential clothes washing machine standards

In addition, for 129 of the 271 WUGs in Region C, the Planning Group recommended the following extended package of measures:

- Water conservation pricing structure
- Water waste prohibition
- Coin-operated clothes washer rebate
- Residential water audit
- Industrial, commercial, and institutional (ICI) general rebate
- ICI water audit, water waste reduction, and site-specific conservation program

Non-municipal measures include estimated conservation savings from efficient new steam electric power plant savings and manufacturing and irrigation rebates. In addition, the 2006 Region C Plan called for assessing the effectiveness and applicability of specific water conservation measures in Region C during the next five years, as well as encouraging state funding for research on the effectiveness of water conservation programs and for support of education programs.

In 2007, the Texas Water Conservation Advisory Council replaced the Water Conservation Implementation Task Force. In December 2008, the Advisory Council published *A Report on Progress of Water Conservation in Texas*, which included a number of recommendations regarding water conservation and regional water planning (WCAC, 2008). In other water conservation-related developments, the TWDB has revised its water planning guidelines since the 2006 round of regional water planning. Based on updated legislation, TWDB now requires that:

- Retail public utilities with populations greater than 20,000 implement a landscape irrigation permitting, inspection and enforcement program under HB 1656;

- Retail public utilities with more than 3,300 connections submit a water conservation plan under Texas Water Code §13.146;

- The TWDB review each water conservation plan and annual report to determine compliance with minimum requirements and submission deadlines under Texas Water Code §16.402.

Furthermore, legislation enacted in 2009 requires toilets purchased after January 1, 2014 to have a maximum flush volume of 1.28 gallons per flush, replacing the existing 1.6 gallons per flush maximum rate defined in the Water Saving Performance Standards for Plumbing Act.

Region C's water providers and water users have made substantial efforts to conserve water. Regional coordination is one tool that has been utilized by wholesale water providers in the region. The NTMWD, Dallas Water Utilities and Tarrant Regional Water District jointly sponsor the annual North Texas Regional Water Conservation Symposium. Outdoor water conservation practices, such as time of day watering restrictions, have become part of local ordinances in Fort Worth, Dallas, the majority of the

NTMWD Member Cities and Customers and the majority of the other cities in the North Texas region. Cities and water utilities have begun allocating conservation staff and budgeting dollars as part of their full time water management strategies. These individual conservation efforts are part of the ongoing Region C effort to promote conservation as a permanent, valuable water management strategy (Region C Water Planning Group, 2010).

The 2011 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.

Table 2-3 summarizes the effect of recommended conservation and reuse measures on municipal water use in Region from 2010 to 2060.

Table 2-3. Projected municipal per capita water use in Region C

	Projections					
Basic Data	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Population	6,670,493	7,971,728	9,171,650	10,399,038	11,645,686	13,045,592
Municipal Demand without Low Flow Plumbing (Acre-feet)	1,568,999	1,898,716	2,162,241	2,428,587	2,735,232	3,098,539
Municipal Demand with Low Flow Plumbing (Acre-feet)	1,546,970	1,833,671	2,087,597	2,344,115	2,612,176	2,924,157
1.28 gpf plumbing savings	0	4,077	12,019	20,595	28,925	36,819
Recommended Municipal Water Conservation (Acre-feet)	46,690	106,835	151,586	192,720	235,718	284,916
Current Municipal Reuse (Acre-feet)	203,954	246,490	289,975	312,972	321,385	336,062
Recommended Municipal Reuse (Acre-feet)	1,937	257,036	275,628	276,688	292,539	300,574
Per Capita Use (Gallons per Capita per Day)						
No Conservation or Reuse	210	213	210	208	210	212
With All Plumbing Codes	207	205	202	199	198	198
With Plumbing Code and Recommended Conservation	201	193	187	183	180	178
With Recommended Conservation and Reuse	173	137	132	132	133	135
Normal-Year Use (Assumed 12 Percent Lower than Dry-Year)	155	122	118	118	119	120

Source: Table 6.8; Region C Water Planning Group, 2010

TCEQ requires water conservation plans for all large municipal, industrial, and mining water users in the state. NTMWD prepared its first Water Conservation Plan in 1997. Since that time, NTMWD has amended its Water Conservation Plan to the current *Water Conservation and Drought Contingency and Water Emergency Response Plan, March 2008(Plan)* (NTMWD, 2008). As emphasized in this Plan, "as a wholesale water supplier, NTMWD does not control the water use of its Member Cities and Customers and does not have a direct relationship with the retail customers who are the ultimate consumers of the water." Thus, to some extent, thorough and diligent implementation of conservation measures by, for example, residential water consumers, is beyond NTMWD's direct influence. However, NTMWD does control the operation of its water supply, treatment, and delivery system and can thus take direct action to maximize its efficiency.

In areas under its direct control, NTMWD has adopted the following goals for water conservation and efficiency:

- Keep the level of unaccounted water in the system below five percent.
- Maintain universal metering of customers, meter calibration, and meter replacement and repair.
- Maintain a program of leak detection and repair.
- Continue to utilize wastewater reuse as a major source of water supply. Seek TCEQ authorization for additional reuse to increase the efficiency of the NTMWD water supply system.
- Continue to recycle wash water from NTMWD water treatment plants.
- Continue to implement other in-house water conservation efforts.
- Raise public awareness of water conservation and encourage responsible public behavior by a public education program (NTMWD, 2008).

The Water Conservation and Drought Contingency and Water Emergency Response Plan also specifies that as a wholesale provider, NTMWD will continue to assist its Member Cities and Customers in the development of their own water conservation programs. NTMWD has developed a *Model Water Conservation Plan for NTMWD Member Cities and Customers*, as well as a *Model Drought Contingency and Water Emergency Response Plan for NTMWD Member Cities and Customers* that its Member Cities and Customers can use to develop their own plans. As part of the model water conservation plan, NTMWD requires its Member Cities and Customers to provide annual water conservation reports to the NTMWD. NTMWD reviews these reports and compile the information as part of its own annual conservation report, which will be used to manage NTMWD's water conservation program (NTMWD, 2008).

Section 1.5.6.2 in Chapter 1 contains an extensive, up-to-date discussion on water conservation programs, projects and measures specific to the NTMWD.

2.3.3.2 <u>Water Reuse</u>

NTMWD is also implementing water reuse strategies to help meet its water needs; indeed its reuse program is the largest of any wholesale water provider in Texas. NTMWD's East Fork Raw Water Supply Project, described in Chapter 1, began operation in 2009, diverting return flows to Lake Lavon for subsequent reuse. This project diverts return flows from the East Fork of the Trinity River to a constructed wetland for polishing treatment and ultimately returns this water to Lake Lavon. The water right for the project authorizes diversions up to 157,393 acre-feet per year, as return flows increase and become available. NTMWD is planning on using 102,000 acre-feet per year by 2060 based on available wastewater flows (Freese and Nichols, et al., 2010).

Dallas Water Utilities and NTMWD have entered into an agreement which would permit NTMWD to exchange return flows from its WWTPs discharging into Lake Ray Hubbard for Dallas return flows discharged to the main stem of the Trinity River. Under this agreement, Dallas will obtain the right to divert NTMWD return flows from Lake Ray Hubbard and will pump an equal amount of flow from the main stem of the Trinity River to the NTMWD East Fork Water Supply Project wetland for use by NTMWD. Furthermore, once water rights for Elm Fork return flows (from NTMWD WWTPs discharging to Lake Lewisville) have been secured by NTMWD, it will support Dallas Water Utilities' efforts to secure bed and banks transport, and storage and diversion rights for the Elm Fork return flows. In exchange, Dallas will pump a quantity equal to NTMWD's discharge of its future Elm Fork return flows to the East Fork Water Supply Project wetland for use by NTMWD (Freese and Nichols, et al., 2010).

Overall, by 2060, NTMWD is projected to have added 176,577 acre-feet of water per year to its supplies from implementing its own reuse projects.

In sum then, conservation provided 5,180 acre-feet of NTMWD's total water supplies in 2010, and is projected to supply 80,398 acre-feet in 2060 (Region C Water Planning Group, 2010). Combined conservation and reuse totaled 109,729 acre-feet in 2010 and is predicted to reach 257,039 acre-feet in 2060. Combined conservation and reuse would constitute approximately 31% of the projected total water demand of 789,676 acre-feet in 2060.

2.3.3.3 Combined Contribution of Conservation and Reuse

Expanded conservation and reuse are integral strategies in NTMWD's ability to meet projected water demands by 2060. However, in and of themselves, intensified conservation and reuse are insufficient to provide enough water to meet the projected demand from the doubling of population that NTMWD's service area is projected to undergo between 2010 and 2060 (see Chapter 1, Section 1.5.2). Table 1-7 shows that the projected remaining net need (projected net need minus conservation and reuse strategies recommended by the Region C Water Planning Group) as 64,498 AFY in 2020, growing to 287,809 AFY in 2060. Conservation and reuse do not obviate the need for the LBCR, but rather complement it. Conservation and reuse strategies and the LBCR are all part of the portfolio or suite of strategies recommended to meet the rapidly rising demand for municipal water supplies in the region as it continues to develop, and as outlying rural areas are gradually built up into urban and suburban land uses.

2.3.4 Alternatives Implemented Instead of LBCR

Each of the alternatives listed and described in this section is evaluated according to the following set of criteria:

- Environmental impacts – relative general impacts to water and biological resources as well as to the human environment

- Carbon footprint – Long-term energy consumption and related carbon dioxide emissions from transporting (pumping) water from the new supply source to NTMWD's service area or treatment plant

- Water quality – Key water quality parameters; lower quality raw water would entail greater treatment costs

- Purpose and Need/Adequacy of supply – relative comparison of the water supply that would be added with that which would be supplied by LBCR; does the alternative meet the fundamental purpose and need?

- Economic cost – relative cost to NTMWD and water users of developing the alternative

- Reliability and availability – whether or not the alternative is fully available or is encumbered or compromised in some manner

- Time to implementation – could the alternative be developed within the time frame in which NTMWD needs the water

- Need for partners – could NTMWD develop the water source by itself or would it need to team up with partners

2.3.4.1 Supply 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 one extent or another, 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, surface water is granted under a priority system, "first in time, first in right." 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 in the Sulphur River basin, for example, can vary depending on when they are permitted.

Downsized (Smaller) Version of LBCR Project
At the request of the USACE Tulsa District, and in the interest of investigating alternatives that might result in reduced impacts to waters of the U.S. and to the environment more generally, FNI evaluated the potential yield and impacts of a reduced size reservoir at the same location on Bois d'Arc Creek as the proposed LBCR project (Kiel, 2015).

This smaller reservoir would have a conservation pool elevation at elevation 514 ft. msl and would result in a storage capacity of 126,800 AF and a surface area of approximately 8,250 acres, roughly half the acreage of the Proposed Action. The footprint of the dam is assumed to be similar in size to the Proposed Action and at the same location. 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 the proposed LBCR project. Therefore, the limit of construction is estimated at 8,740 acres, again, approximately half that of LBCR (the Proposed Action). The firm yield of this downscaled version of the LBCR would be approximately 83,700 AFY of supply, or about 66 percent or two-thirds that of the 126,200 AFY of the Proposed Action (Kiel, 2015).

The potential impact to waters of the U.S. of this smaller project is estimated at approximately 3,600 acres. 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. Additional impacts occur to streams would occur as the prospective lake reached its capacity.

It is estimated that water could be available from this smaller Lower Bois d'Arc Creek Reservoir by 2022. This time frame would allow for design modification and amendments to the NTMWD water right application to TCEQ. The TCEQ's technical review of the smaller project and of changes to the proposed project mitigation would probably be required, and the contested case hearing currently scheduled for 2015 could be delayed by up to a year or more due to the change in project size and yield and the need to evaluate and review these (Kiel, 2015).

The cost of this downsized project would be about the same as the Proposed Action, since all of the same elements would be required, and "economies of scale" foregone. Cost savings of 10 percent would likely apply to the dam and raw water transmission infrastructure. Land acquisition costs are assumed to be about 70 percent of the land costs for the Proposed Action. NTMWD would still have to acquire sufficient lands for a 100-year flood event and flood easement for a 500-year event. Under these assumptions, the unit cost for water from a smaller-footprint dam and reservoir that would provide less water would be about 25 percent higher than for the LBCR project.

The main disadvantage of this smaller-scale alternative is the amount and reliability of water supply during drought. Because of its smaller capacity, the reservoir would fluctuate considerably and this fluctuation in storage, water level, and shoreline could impact both water quality and aquatic habitats. Storage in the smaller reservoir would be below 50,000 AF about 10 percent of the time. In contrast, the proposed LBCR is below 50,000 acre-feet of storage only three percent of the time (Kiel, 2015).

Evaluation according to listed criteria

- Environmental impacts – Overall environmental impacts and impacts to waters of the U.S. from this particular downsized Lower Bois d'Arc Creek Reservoir would be less than those from the Proposed Action – roughly half. There would be fewer impacts to bottomland hardwood forests and other valuable natural habitats, as well as generally lower agricultural and rural impacts.

- Carbon footprint – Per unit of water delivered to NTMWD's water supply system, long-term energy/electricity consumption and related carbon dioxide emissions from pumping water from a smaller reservoir to the North WTP would be the same as for the Proposed Action.

- Water quality – Water quality would be the same as for the Proposed Action.

- Purpose and Need/Adequacy of supply – The firm yield of this smaller version of the LBCR would be approximately 83,700 AFY, or about 66 percent that of the Proposed Action. This project would only partially meet the expressed Purpose and Need of the Proposed Action, necessitating one or more additional projects elsewhere to make up the difference.

- Economic cost – Because of foregone economies of scale, relative unit cost for water under this potential alternative is estimated to be 25 percent higher than for the Proposed Action.

- Reliability and availability – While this alternative is no less available or more encumbered than the Proposed Action, in times of drought it would be less reliable due to its reduced storage.

- Time to implementation – It is estimated that this project could deliver water by 2022, slightly longer than for the Proposed Action because of the need for technical re-evaluation and review by engineers, planners, biologists, and regulators.

- Need for partners – No additional partners would be needed.

In sum, taking into account the stated purpose and need of the proposed LBCR – to provide water supplies to meet the growing water needs of NTMWD beginning in 2020 and continuing on through 2030 and beyond, when increased water demands will require NTMWD to develop water supplies in addition to the proposed LBCR – this smaller, downsized version of LBCR is not a reasonable or practicable alternative to address the underlying long-term need for the project. NTMWD is predicted to need nearly 110,000 AFY of additional water supply by 2030 and nearly 288,000 AFY of supply by 2060. The smaller LBCR does not provide sufficient supplies to meet NTMWD's needs and it underutilizes a potential water resource as well. If this alternative were to be implemented, NTMWD would still be forced to develop additional water supplies now and in the future. Thus, developing a smaller-scale project was dismissed from more detailed consideration in this EIS.

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 measures to reduce flooding along Bois d'Arc Creek and in the City of Bonham. An Upper Bois d'Arc Creek reservoir site was studied by the USACE in 1968, and subsequently reviewed again by the USACE in 2000 (USACE, 1968 and USACE, 2000). The proposed Upper Bois d'Arc Creek Reservoir would be located about 3.5 miles south of the City of Bonham. It would have a controlled drainage area of 108 square miles, which is about one third of the drainage area of the proposed action. The proposed reservoir would have a total storage of 137,500 acre-feet, with 82,040 acre-feet dedicated to water supply. Based on the USACE analyses, the Upper Bois d'Arc Creek reservoir would provide flood protection for the 50-year storm event and 24 MGD of water supply (approximately 27,000 AFY).

Evaluation according to listed criteria

- Environmental impacts – Likely to be less than LBCR due to its smaller scale.
- Carbon footprint – Comparable to or slightly less than LBCR.
- Water quality – Unknown.
- Purpose and Need/Adequacy of supply – The Upper Bois d'Arc Creek Alternative would yield only about 20 percent of the water that could be diverted from LBCR, insufficient to meet NTMWD's needs.
- Economic cost – Unknown.
- Reliability and availability – Unknown.
- Time to implementation – Due to the need for detailed engineering and environmental studies, it is unlikely this alternative could be developed in time to meet NTMWD's near and mid-term needs.
- Need for partners – Probably not needed.

In sum, due to the smaller drainage area and smaller storage in the reservoir, this alternative cannot provide the amount of water supply needed for the project; it other words, it would not meet the purpose and need for the project. This project site was not considered in the state water planning process. A reservoir site located upstream (south) of the City of Bonham is thus not a practicable alternative to the proposed project.

Marvin Nichols Reservoir Alternative

Located on the Sulphur River in Red River and Titus counties, the undeveloped Marvin Nichols Reservoir site (Figure 2-19) is a recommended strategy in the *2011 Region C Water Plan* for the NTMWD, the Tarrant Regional Water District (TRWD), and the Upper Trinity Regional Water District (UTRWD). Marvin Nichols Reservoir was also a recommended project in the *2001 Region C Water Plan* and the *2006 Region C Water Plan*. According to preliminary engineering analysis, this project would provide a large source of additional supply for the North Texas region at a relatively low cost. Marvin Nichols Reservoir would also be an alternative supply source for Dallas Water Utilities and the City of Irving. The total yield of Marvin Nichols Reservoir is estimated at 612,300 AFY, assuming that Lake Ralph Hall is senior to Marvin Nichols Reservoir and that Marvin Nichols Reservoir is operated as a system with Wright Patman Lake. The division of the 489,840 AFY assumed to be available to Region C from the reservoir in the recommended strategy is:

- 280,000 AFY for TRWD
- 174,840 AFY for NTMWD
- 35,000 AFY for UTRWD

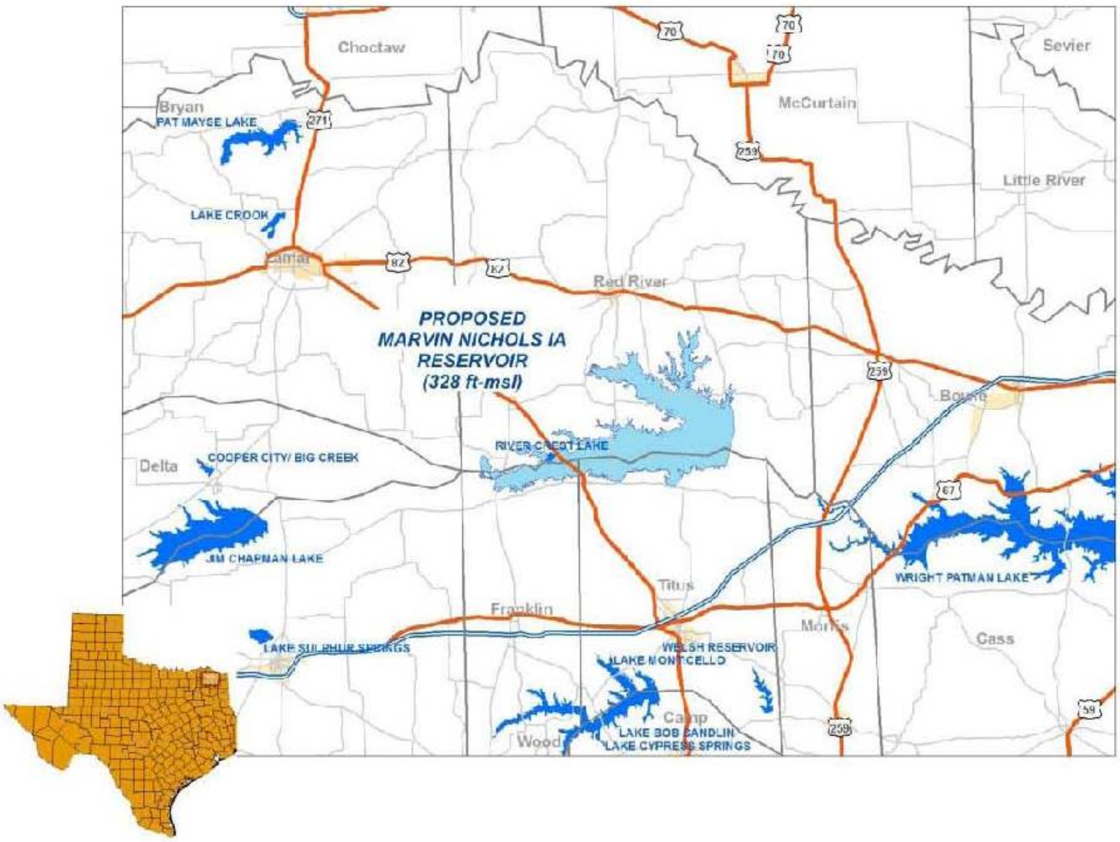


Figure 2-19. Location map of the recommended Marvin Nichols Reservoir
Source: TWDB, 2008

The delivery system from Marvin Nichols Reservoir (which accounts for three-quarters of the total cost of the project) will eventually be developed in phases. Phase 1 would be developed by 2030 and would include the reservoir and the initial pipelines and pump stations. Phase 2, planned for 2050, includes parallel pipelines and additional pump stations to deliver the remainder of the supply from the project (Region C Water Planning Group, 2010).

At the recommended conservation pool elevation of 328 feet MSL, it would inundate approximately 67,400 acres, in comparison with 16,641 acres for LBCR. The U.S. Fish and Wildlife Service has classified some of the Marvin Nichols acreage as Priority 1 bottomland hardwoods, their highest quality rating (USFWS, 1985). Approximately 39 percent of the reservoir site is classified as bottomland hardwood forest, 20 percent upland deciduous forest, 19 percent grasslands, and nine percent marsh (TWDB, 2008; Table 2-4). Additional studies would be needed to ascertain the quality and extent of these habitats (Freese and Nichols, 2008a).

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 alone, the development of this reservoir would likely entail greater 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, with comparably greater impacts on natural habitats. With regard to the two most high quality habitat types – wetlands and bottomland hardwood forests – initial estimates of impacted wetlands and bottomland hardwoods for this alternative are considerably greater than the acreage determined for the proposed action (TWDB, 2008; Freese and Nichols, 2008a).

Table 2-4. Acreage and percent landcover for recommended Marvin Nichols Reservoir

Landcover Classification	Acreage[a]	Percent
Bottomland hardwood forest	26,309	39.2%
Marsh	6,259	9.3%
Seasonally flooded shrubland	1,198	1.8%
Swamp	565	0.8%
Evergreen forest	27	0.0%
Upland deciduous forest	13,667	20.4%
Grassland	13,069	19.5%
Shrubland	1,027	1.5%
Agricultural land	3,169	4.7%
Urban/developed land	8	0.0%
Open water	1,847	2.8%
Total	**67,145**	**100.0%**

[a]Acreage based on approximate GIS coverage rather than calculated elevation-area-capacity relationship; *Source*: TWDB, 2008

Other possible adverse impacts from this large construction project with permanent effects, while not investigated specifically, would likely include impacts to threatened and endangered species, air and noise, agriculture, cultural resources, transportation, utilities, and infrastructure. Both adverse and beneficial impacts would probably occur to existing recreation resources and socioeconomics, with beneficial impacts in these two areas likely outweighing adverse effects.

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, it is highly unlikely that this reservoir site could be permitted and developed by 2020 as an alternative to the LBCR.

Evaluation according to listed criteria

- Environmental impacts – Overall environmental impacts of Marvin Nichols Reservoir would be greater than LBCR, particularly because of elimination of bottomland hardwood forests and other valuable natural habitats, as well as generally high agricultural and rural impacts.

- Carbon footprint – Long-term energy/electricity consumption and related carbon dioxide emissions from pumping water from Marvin Nichols Reservoir to the NTMWD service area would be greater than for LBCR due to the greater distance.

- Water quality – Key water quality parameters are rated as medium by the Region C Water Planning Group (2010).

- Purpose and Need/Adequacy of supply – The share of water allocated to NTMWD is expected to be 174,840 AFY, or 39 percent more than LBCR's firm yield of LBCR 126,200 AFY.

- Economic cost – The relative unit cost of Marvin Nichols Reservoir is slightly higher than LBCR, but still under $1.50 per thousand gallons (Figure 2-25).

- Reliability and availability – Reliability is rated as high by the Region C Water Planning Group (2010). According to the 2012 State Water Plan, the North East Texas Regional Water Planning Area (Region D) opposes Lake Marvin Nichols (TWDB, 2012).

- Time to implementation – Regional and state water planners see Marvin Nichols Reservoir as a long-term project, with development of Phase 1 by 2030 and Phase 2 by 2050. This would not meet NTMWD's near- and medium-term needs for water supply.

- Need for partners – NTMWD would need to partner with TRWD, UTRWD , DWU and perhaps Irvine to develop this water source; would necessitate more complex arrangements than LBCR.

In sum, taking into account these various considerations, the Marvin Nichols Reservoir would be unable to meet the NTMWD's projected water shortages over the coming 10 to 20 years. It is not a practicable or preferred alternative to the proposed action because: 1) in all probability it would generate greater environmental impacts, and 2) it cannot be implemented within the time frame required to satisfy the stated purpose and need of this project.

George Parkhouse South Lake Alternative

George Parkhouse Lake (South), also known as Parkhouse I, is a potential reservoir located on the South Sulphur River in Hopkins and Delta Counties, approximately 18 miles southeast of the City of Sulphur Springs (Figure 2-20). If constructed, it would be immediately downstream from Jim Chapman Lake and would yield 122,000 acre-feet per year, of which 80 percent would be available for NTMWD. With a conservation pool elevation of 401 ft. MSL, George Parkhouse Lake (South) would inundate approximately 29,000 acres and store 652,000 acre-feet. The reservoir would have a total drainage area of 654 square miles, of which 479 square miles are above Jim Chapman Lake (TWDB, 2008).

The yield of George Parkhouse Lake (South) would be reduced substantially by the development of Marvin Nichols Reservoir (Region C Water Planning Group, 2010). Yield studies conducted as part of the Reservoir Site Protection Studies indicate the yield of this lake would be reduced by 60 percent, to 48,400 acre-feet per year, if constructed after Marvin Nichols (HDR *et al*, 2007).

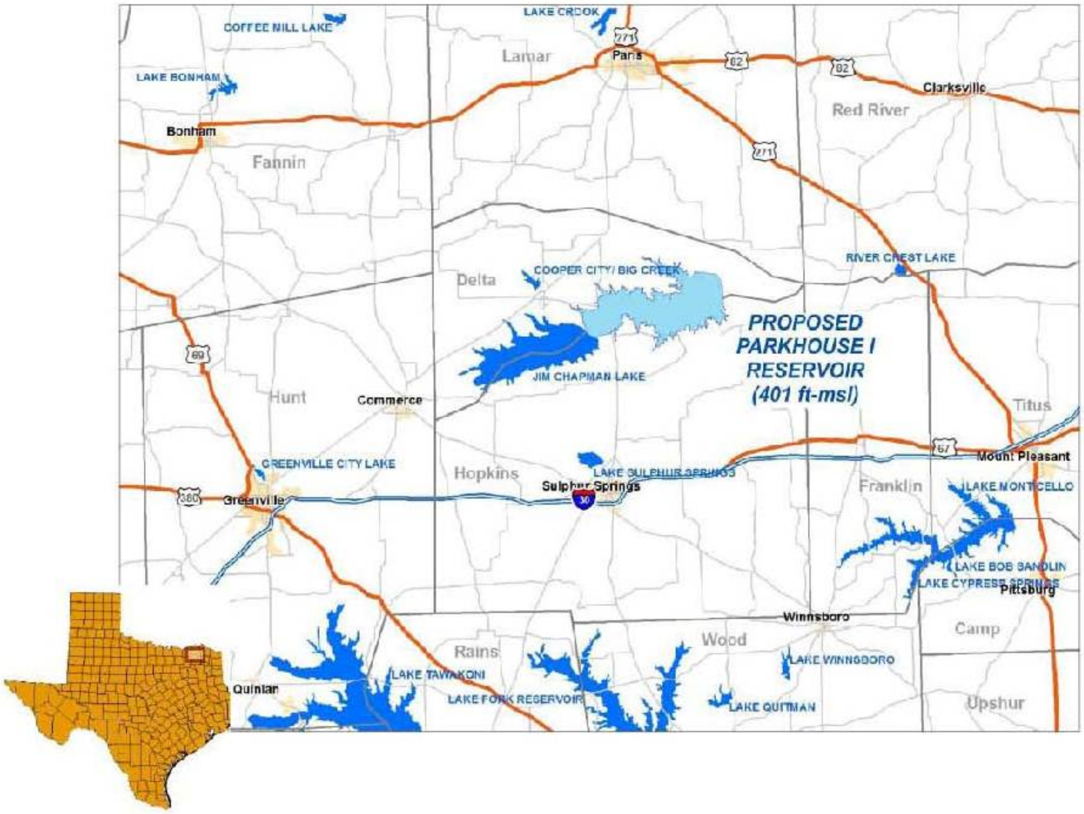


Figure 2-20. Location map of the George Parkhouse (South) Lake
Source: TWDB, 2008

The upper edge of the lake, as currently configured, would abut the dam for Jim Chapman Lake and over fifty percent of the land impacted would be bottomland hardwood forest or marsh (HDR *et al*, 2007). The reservoir site is situated some distance upstream of a Priority 1 bottomland hardwood preservation site identified as Sulphur River Bottoms West (USFWS, 1985). Table 2-5 summarizes existing landcover for the Parkhouse Lake (South) as reported in the Reservoir Site Protection Study. Landcover on the reservoir site is dominated by contiguous bottomland hardwood forest (37 percent), along with sizeable areas of grassland (16 percent), marsh (16 percent), and agricultural land (16 percent) (TWDB, 2008).

Table 2-5. Acreage and percent landcover for the George Parkhouse (South) Lake

Landcover Classification	Acreage[a]	Percent
Bottomland hardwood forest	10,379	36.8%
Marsh	4,566	16.2%
Seasonally flooded shrubland	584	2.1%
Swamp	83	0.3%
Upland deciduous forest	2,428	8.6%
Grassland	4,611	16.4%
Shrubland	211	0.7%
Agricultural land	4,470	15.9%
Urban/developed land	5	0.0%
Open water	848	3.0%
Total	**28,185**	**100.0%**

[a]Acreage based on approximate GIS coverage rather than calculated elevation-area-capacity relationship; *Source*: TWDB, 2008

Other possible adverse impacts from this large dam and reservoir construction project, while not specifically examined, would likely include impacts to both federal and state threatened and endangered species, downstream hydrology, air and noise, agriculture, cultural resources, transportation, utilities, and infrastructure. Both adverse and beneficial impacts would probably occur to existing recreation resources and socioeconomics, with beneficial impacts in these two areas likely outweighing adverse effects.

Evaluation according to listed criteria

- Environmental impacts – Overall environmental impacts of George Parkhouse Lake (South) would be somewhat greater than LBCR. This reservoir would inundate an area 70 percent larger than LBCR, consisting mostly of bottomland hardwood forest, other natural habitats, and agricultural lands. The Region C Water Planning Group (2010) rates its environmental and agricultural/rural impacts as medium high and other natural resources impacts as medium.

- Carbon footprint – Long-term energy/electricity consumption and related carbon dioxide emissions from pumping water from George Parkhouse Lake (South) to the NTMWD service area would be roughly comparable to LBCR due to similar distance.

- Water quality – Key water quality parameters are rated as low by the Region C Water Planning Group (2010).

- Purpose and Need/Adequacy of supply – Water diversions to NTMWD would be approximately 80 percent that of the LBCR. However, if the Marvin Nichols Reservoir were to be constructed first, the supply available to NTMWD would only be about 38 percent that of LBCR.

- Economic cost – The relative unit cost of George Parkhouse Lake (South) is estimated to be about 25 percent higher than LBCR (Figure 2-25).

- Reliability and availability – Reliability is rated as high by the Region C Water Planning Group (2010), but George Parkhouse Lake (South) is not a recommended water management strategy for any Region C water supplier (Region C Water Planning Group, 2010)

- Time to implementation – Due to the need for detailed engineering and environmental studies, new water rights and interbasin transfer permits (IBTs), it is unlikely this alternative could be developed in time to meet NTMWD's near and mid-term needs.

- Need for partners – George Parkhouse Lake (South) is listed as an alternative strategy for Dallas Water Utilities, NTMWD, UTRW D, and the City of Irving.

In sum, the proposed George Parkhouse Lake (South) is not a practicable alternative to the LBCR due to the uncertain reliability of supply with the development of other reservoirs in the river basin and the environmental impacts. Since the Marvin Nichols Reservoir is part of the NTMWD's long range water supply plan, it would not make sense to develop George Parkhouse (South) Lake. Furthermore, its estimated firm yield of 122,000 AFY, of which only 80% (or 98,000 AFY) would be available for NTMWD, is less than LBCR's firm yield of 126,200 AFY. This alternative would impact more land area, and larger areas of bottomland hardwood forest, marsh, and wetlands than would LBCR, as seen in Table 3-15. It also has a higher cost per thousand gallons of water yielded.

George Parkhouse North Lake Alternative

George Parkhouse Lake (North), also known as Parkhouse II, is a potential reservoir located on the North Sulphur River in Lamar and Delta Counties, about 15 miles southeast of the City of Paris (Figure 2-21). At a proposed conservation elevation of 410.0 ft MSL, the reservoir would store 330,871 acre-feet of water and inundate 14,387 acres. The firm yield would be 144,300 AFY (with 80 percent of the yield – or 115,440 AFY available for NTMWD), but its yield would be significantly reduced by the development of Lake Ralph Hall and/or Marvin Nichols Reservoir. A sensitivity study of the reservoir yield found that the yield of George Parkhouse North could range from 32,100 AFY (assuming both reservoirs are constructed prior to George Parkhouse North) to 117,400 AFY assuming only Lake Ralph Hall is constructed prior to George Parkhouse North (HDR *et al*., 2007).

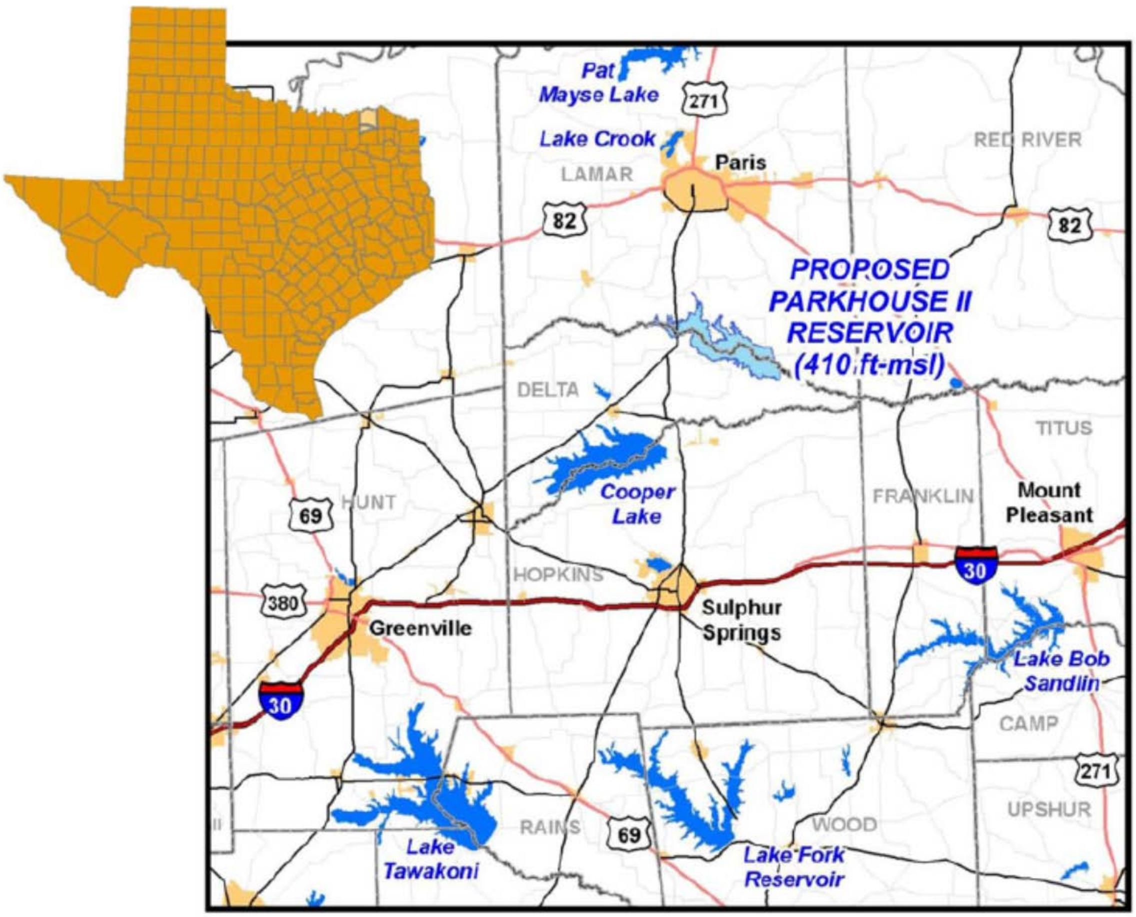


Figure 2-21. Location map of the George Parkhouse (North) Lake
Source: TWDB, 2008

This reservoir site is located upstream of a designated Priority 1 bottomland hardwood preservation site known as Sulphur River Bottoms West. It would inundate approximately 14,400 acres of land at conservation storage capacity. Table 2-6 summarizes existing landcover for the George Parkhouse North Lake site as determined by the TPWD. Landcover is dominated by grassland (49 percent), with sizeable areas of upland deciduous forest (26 percent) and agricultural land (16 percent). Only about 1.4 percent (208 acres) of this site is classified as bottomland hardwood forest (TWDB, 2008).

Table 2-6. Acreage and percent landcover for the George Parkhouse (North) Lake

Landcover Classification	Acreage[a]	Percent
Bottomland hardwood forest	208	1.4%
Seasonally flooded shrubland	170	1.1%
Swamp	31	0.2%
Evergreen forest	9	0.0%
Upland deciduous forest	4,003	26.0%
Grassland	7,605	49.5%
Shrubland	672	4.4%
Agricultural land	2,424	15.8%
Urban/developed land	45	0.3%
Open water	200	1.3%
Total	**15,367**	**100.0%**

[a]Acreage based on approximate GIS coverage rather than calculated elevation-area-capacity relationship; *Source*: TWDB, 2008

Evaluation according to listed criteria

- Environmental impacts – Overall environmental impacts of George Parkhouse Lake (North) would be less than LBCR, due to a smaller area of inundation and less bottomland hardwood forest impacted. The Region C Water Planning Group (2010) rates its environmental and agricultural/rural impacts as medium high and other natural resources impacts as medium.

- Carbon footprint – Long-term energy/electricity consumption and related carbon dioxide emissions from pumping water from George Parkhouse Lake (North) to the NTMWD service area would roughly comparable LBCR due to similar distance.

- Water quality – Key water quality parameters are rated as low by the Region C Water Planning Group (2010).

- Purpose and Need/Adequacy of supply – While the firm yield of George Parkhouse Lake (North) is greater than LBCR's firm yield, only 80 percent would be available to NTMWD, slightly less than what could be diverted from LBCR. Moreover, its yield would be greatly reduced if either Lake Ralph Hall or Marvin Nichols Reservoir, both of which have higher priority, were to be developed.

- Economic cost – The relative unit cost of George Parkhouse Lake (North) is estimated to be about the same as that of LBCR (Figure 2-25).

- Reliability and availability – Reliability is rated as high by the Region C Water Planning Group (2010), but George Parkhouse Lake (North) is not a recommended water management strategy for any Region C water supplier (Region C Water Planning Group, 2010)

- Time to implementation – Due to the need for detailed engineering and environmental studies, new water rights and IBTs, it is unlikely that George Parkhouse Lake (North) could be developed in time to meet NTMWD's near and mid-term needs.

- Need for partners – George Parkhouse Lake (North) is listed as an alternative strategy for Dallas Water Utilities, NTMWD, UTRW D, and the City of Irving.

In sum, while this alternative would likely impact less bottomland hardwood forest and wetlands than the LBCR, and its cost per acre-foot of water delivered compares favorably ($131 versus $133 for LBCR), it is not a practicable alternative to Lower Bois d'Arc Creek Reservoir due to the uncertainty of the reliable supply, given the highly probable development of other reservoirs in the river basin which would constrain its yield. For instance, Lake Ralph Hall is currently under permit evaluation so it is somewhat more likely it could be constructed in the near future.

Other New Reservoirs
Several other proposed reservoirs in the region were recommended or considered in the 2012 Texas State Water Plan, but are not considered feasible for NTMWD because of commitments 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 reservoir site because USFWS has designated a wildlife refuge within the footprint; much of the water from proposed Lake Columbia is already committed to users in the Neches River Basin; proposed Lake Tehuacana is located adjacent to Richland- Chambers Reservoir, and would be used and operated by the Tarrant Regional Water District. 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 Upper Trinity Regional Water District.

2.3.4.2 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 ones from scratch. 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, 3) reallocating a portion of a reservoir's flood storage to water supply storage.

Lake Lavon Alternative
Lake Lavon, owned and operated by the USACE, is located in the Trinity River Basin near the town of Wylie and the headquarters and main water treatment plant 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 ft. msl), there is also approximately 275,600 AF of flood storage. If the water conservation pool elevation were to be raised by five feet to elevation 497 ft. msl, there would be an estimated 115,649 AF of additional storage available for water supply (Kiel, 2014b).

To use this additional water, NTMWD would need to obtain a Texas water right. Using the Trinity River WAM, the amount of water that could be permitted for diversion from Lake Lavon under this reallocation alternative 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 senior water rights.

Adding to the complexity of this alternative, since it is a USACE project, an Act of the U.S. Congress would be required to reallocate flood storage that exceeds 50,000 AF. This scenario – at 115,649 AF – would necessitate such an action, and its approval is doubtful. Lake Lavon is located in a developed area next to Wylie. Conversion of some share 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, increasing the risk of flooding. Such a loss would need to be mitigated before an approval could be issued.

Evaluation according to listed criteria

- Environmental impacts – Fewer impacts on habitat than LBCR because it is an existing facility. There are risks to surrounding residents associated with potential diminished flood control capacity during wet periods.

- Carbon footprint –Per unit of water delivered, less than LBCR due to its proximity to the Wylie water treatment plant.

- Water quality – Adequate.

- Purpose and Need/Adequacy of supply – Reallocation of flood storage in Lake Lavon would provide only about five percent (1/20th) of the yield of the LBCR, insufficient to meet NTMWD's needs.

- Economic cost – Unknown, but much less than LBCR.

- Reliability and availability – As indicated above, any water right issued by Texas would be junior in priority, and thus vulnerable to disruption during severe droughts.

- Time to implementation –This alternative could not be implemented within the timeframe during which the water is needed by NTMWD. To receive Congressional approval, conduct the necessary engineering and environmental studies, and obtain a Texas water right could take 10-15 years, even assuming authorization is received from Congress.

- Need for partners – Not needed.

In sum, reallocating flood storage to water supply in Lake Lavon is not a viable alternative to the LCBCR. It would only provide about five percent of LBCR's yield. It cannot be implemented within the timeframe needed for the water. It entails risks associated with the reliability of this supply during drought as well as risks to residents from a potential reduction in flood control capacity during storm events.

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, City of Irving, UTRWD, and the Sulphur River Municipal Water District. At present, the reservoir is permitted for 273,000 AFY for 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, 2014b).

The flood pool of Lake Chapman is between elevations 440 and 446.2 feet NGVD (National Geodetic Vertical Datum). 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 Chapman would be almost 25,000 AFY, about one-sixth the amount that can be withdrawn under existing Texas water rights, and about one-fifth of expected average annual diversions from the LBCR.

Also, 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 even 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.

USACE partners with other agencies to manage the lands around Lake Chapman for fish and wildlife management and recreational purposes. Over 3,200 acres of bottomland hardwoods and wetlands would be inundated with the reallocation (Kiel, 2014b). Moreover, conversion of flood storage to water supply also would reduce the flood protection that the reservoir currently provides for local residents. As in the case of Lake Lavon above, Congressional action would be required to reallocate flood storage in excess of 50,000 AF.

This alternative provides less than 20% of the yield of Lower Bois d'Arc Creek Reservoir. 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, assuming Congressional approval is granted. There are risks associated with the reliability of this supply during drought and risks associated with potential diminished flood control capacity during wet periods. This is not a practicable alternative to the Lower Bois d'Arc Creek Reservoir.

Evaluation according to listed criteria

- Environmental impacts – Fewer impacts on habitat than LBCR because it is an existing facility. However, inundating 3,200 acres now used for wildlife habitat and recreation is not a trivial impact. There are risks to surrounding residents associated with potential diminished flood control capacity during wet periods.

- Carbon footprint – Per unit of water delivered, roughly comparable to LBCR.

- Water quality – Adequate.

- Purpose and Need/Adequacy of supply – Reallocation of flood storage in Lake Chapman would provide only about 20 percent or less of the yield of the LBCR, insufficient to meet NTMWD's needs.

- Economic cost – Unknown, but much less than LBCR.

- Reliability and availability – As indicated above, any water right issued by Texas would be junior in priority, and thus vulnerable to disruption during severe droughts.

- Time to implementation –This alternative could not be implemented within the timeframe during which the water is needed by NTMWD. To receive Congressional approval, conduct the necessary engineering and environmental studies, and obtain a Texas water right could take 10-15 years, even assuming authorization is received from Congress.

- Need for partners – Not needed.

In sum, reallocating flood storage to water supply in Lake Jim Chapman is not a viable alternative to the LCBCR. It would only provide about 20 percent of LBCR's expected yield. It cannot be implemented within the timeframe needed for the water. It entails risks associated with the reliability of this supply during drought as well as risks to residents from a potential reduction in flood control capacity during storm events.

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. Lakes Ray Roberts and Lewisville are owned and operated by the USACE. The City of Dallas owns and operates Lake Ray Hubbard and the Sabine River Authority owns and operates Lakes Tawakoni and Fork. All five lakes are used by the City of Dallas for water supply (Kiel, 2014b).

Three of these lakes – Hubbard, Tawakoni and Fork – are used exclusively for water supply and do not have dedicated flood storage. The two lakes owned and operated by the USACE do 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 likely reduce the flood protection that these lakes currently provide. In the case of those lakes with no flood storage – Hubbard, Tawakoni and Fork – existing homes and businesses have developed around the lakes that would be inundated were the water conservation pool to be raised. This would almost certainly generate intense political opposition to raising the conservation pool water level to increase water supply storage.

Based on the analyses for Lakes Lavon and Chapman, the anticipated increase in yield associated with increased storage for water supply at these existing lakes in the region would be relatively small. 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 practical alternative to LBCR because they can neither provide the amount of water supply needed, nor within the time period required. There would probably be strong opposition both at the local and Congressional levels. Finally, there would likely be an unacceptable increase in the flood hazard from any reallocation of storage capacity at other lakes in the region.

Lake Texoma Alternatives

As described in Chapter 1 of this EIS, Lake Texoma is a large existing USACE reservoir on the Red River bordering Texas and Oklahoma. NTMWD has a 1986 water right to divert 84,000 acre-feet per year of water from Lake Texoma, and use 77,300 of this amount through the bed and banks of Lake Lavon (after an allowance of 6,700 acre-feet per year 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. Currently, the NTMWD blends Lake Texoma water with its other sources to make it suitable for municipal use (Freese and Nichols, 2008a).

The U.S. Congress has authorized the reallocation of 150,000 acre-feet of storage in Lake Texoma from hydroelectric power generation to municipal use in Texas, with 50,000 acre-feet reserved for the Greater Texoma Utility Authority (GTUA). The NTMWD negotiated a contract with the Tulsa District for the remaining 100,000 acre-feet of storage in Lake Texoma authorized for Texas in April 2010, having been granted a state of Texas water right in November 2006 to impound and divert this water. The permit specifically states that this water cannot be placed in Lake Lavon. This water contains elevated levels of dissolved salts (mostly halite, or sodium chloride – NaCl, which is common table or "rock" salt) from natural, 230-million year old Permian Period brine deposits upstream in the Red River watershed (Wurbs, no date). Thus, use of the Lake Texoma water supply will require either, 1) the development of new fresh water supplies to blend at a treatment facility or, 2) the construction of a new desalination water treatment facility. These implementation methods are very different and should be considered two different alternatives to LBCR (Freese and Nichols, 2008a). Desalination of Lake Texoma water is discussed in Subsection 2.3.4.4.

Lake Texoma Development 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. Due to environmental concerns and additional costs associated with large desalination projects, the NTMWD's preferred use of this water source is to blend the Texoma water with a new fresh water supply. 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 potential impacts of added high concentrations of dissolved solids to existing lakes or streams (Freese and Nichols, 2008a). It is assumed that NTMWD would use one part of Lake Texoma supply for two parts of other imported water. 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).

At present, there are no readily available fresh water supplies in the amount needed to blend with the new water supply from Lake Texoma, and existing supplies are insufficient to provide a blended water of acceptable quality for municipal use. Therefore, the blended alternative cannot be implemented without also implementing another water supply to provide new fresh water to the NTMWD. NTMWD intends to eventually make use of water supplies from this source, but only after developing other adequate fresh water sources, such as LBCR (Freese and Nichols, 2008a). Blending is not a viable, practicable alternative to LBCR in the next two decades without first acquiring another water supply source.

Evaluation according to listed criteria

- Environmental impacts – No impacts on habitat at Lake Texoma because it is an existing facility. May impact habitats at site of new or modified reservoir used to provide water for blending.
- Carbon footprint – Per unit of water delivered, greater than LBCR due to longer distance.
- Water quality – Problematic because of high dissolved salt content, requiring blending.
- Purpose and Need/Adequacy of supply – Unable to meet purpose and need or provide adequate water supply for NTMWD because of insufficient supplies of lower-dissolved-salt water to use for blending with Texoma water.
- Economic cost – Potentially cheaper, provided water were available for blending.
- Reliability and availability – Both reliable and available.
- Time to implementation –Uncertain. Would require Congressional authorization, IBT, contract with USACE, and state water right.
- Need for partners – Unknown.

Toledo Bend Reservoir Alternative
Toledo Bend Reservoir extends for about 65 miles along the Sabine River on the Texas-Louisiana state line to the southeast of Dallas (Figure 2-22). 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 the

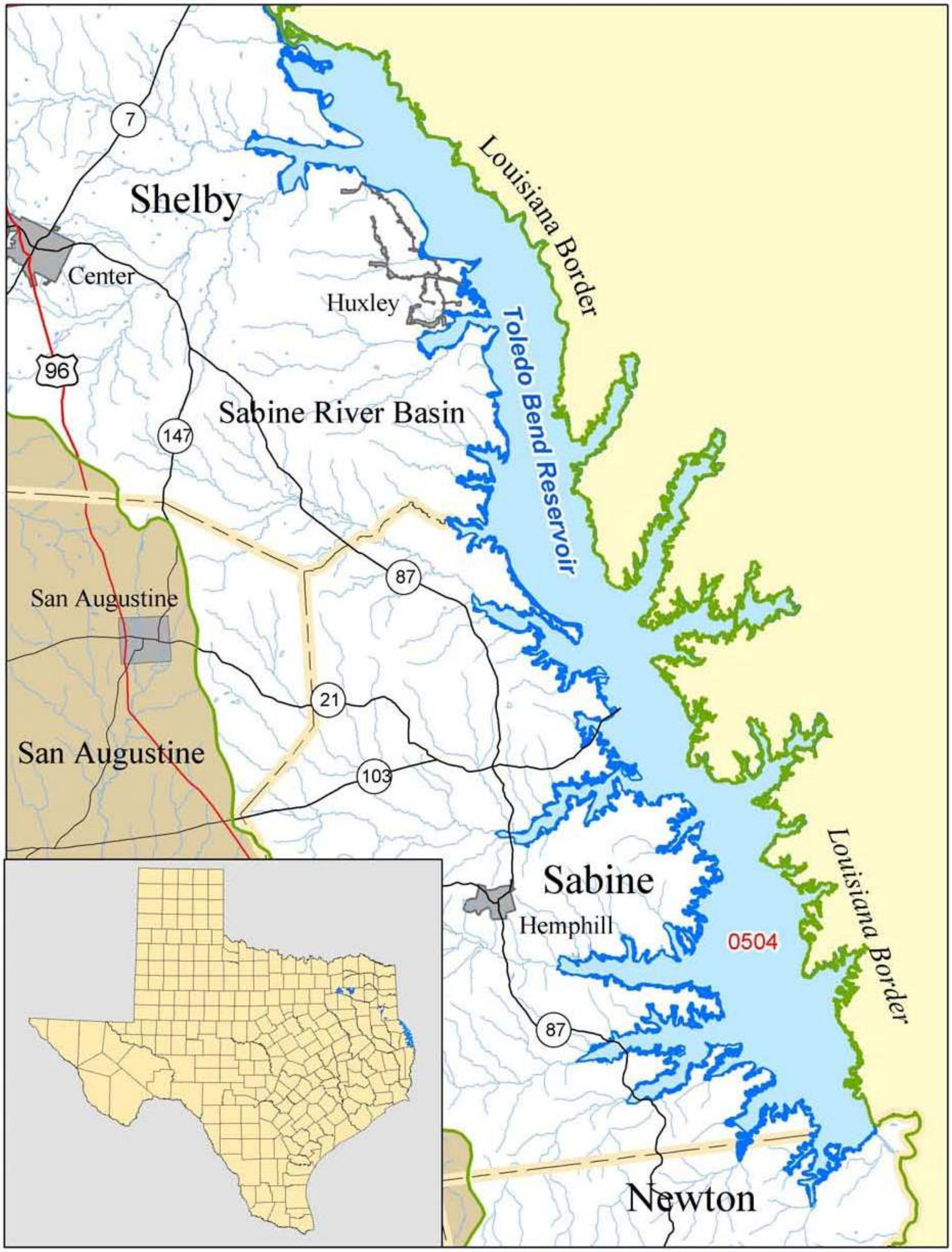


Figure 2-22. Toledo Bend Reservoir location map
Source: Region C Study Commission, 2010

South and 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 acre-feet (SRA, no date-b).

The total permitted supply from this source for Texas is 750,000 AFY. The Sabine River Authority (SRA) of Texas operates the Texas portion of this lake. In both the 2012 Texas State Water Plan and the 2011 Region C Water Plan transport of water from Toledo Bend Reservoir to the North Texas area is a recommended joint strategy for the NTMWD, Tarrant Regional Water District, and the SRA. This project, as presented in the *2012 Texas State Water Plan*, would provide 200,000 AFY for NTMWD (Region C Water Planning Group, 2010; Region C Study Commission, 2010).

This alternative would require multiple transmission pipelines to transport the water approximately 200 miles to North Texas. The current concept for this project includes the use and storage of existing reservoirs as part of the transmission system. This transfer of water is anticipated to have a low to medium low impact to the receiving reservoirs. A long series of interconnected pipelines would have linear impacts on lands they would traverse. Most of these direct impacts would be temporary, while the pipeline is being laid; a few would be permanent. Impacts to habitat would be minor to at most moderate; most of the habitats traversed are already altered or agricultural, although there is a chance that the Sabine National Forest would have to be crossed. Where natural habitats do occur (e.g., woodlands, grasslands, wetlands) the main potential permanent impact would be habitat fragmentation, which degrades but does not destroy natural habitats and their values for wildlife and wild flora. A number of pump stations would be required, each of which would have a modest direct footprint. In addition, pumping substantial quantities of water such a long distance requires significant amounts of electrical energy, the production of which may contribute incidentally to air pollution or greenhouse gas emissions, if fossil fuels (natural gas or coal) are used to generate this electricity.

While this strategy would likely have fewer initial environmental impacts than the construction of a new reservoir, it would have greater capital costs and energy usage associated with the long transmission pipelines. The unit cost (capital cost per thousand gallons delivered) of this alternative is estimated to be more than twice that of LBCR (Region C Water Planning Group, 2010). NTMWD's share of the estimated pumping costs for this alternative is nearly $38 million per year for 200,000 AFY. For a comparable quantity of water supply from the LBCR (126,200 AFY), the estimated pumping costs for water from Toledo Bend Reservoir would be approximately $24 million as compared to $4.6 million from LBCR, more than five times as much. (These costs assume electricity priced at $0.09 per kilowatt-hour.) As energy costs continue to increase, the operating costs for water from Toledo Bend Reservoir would increase by a larger amount than estimated for the LBCR. The higher energy usage also places additional burdens on existing and future electrical generating facilities, which creates additional environmental impacts to those directly associated with this project (Freese and Nichols, 2008a). For example, a comparison of long-term (100-year) carbon-equivalent emissions (including carbon dioxide, methane, and nitrous oxide) between the Toledo Bend pipeline, LBCR, and other alternatives showed that Toledo Bend had by far the highest cumulative emissions due to its greater energy requirements (Kirksey et al., 2011).

Evaluation according to listed criteria

- Environmental impacts – In spite of the long pipeline and need to pass through Sabine National Forest, overall permanent impacts on valuable habitats would be less for the Toledo Bend Reservoir Alternative than for LBCR.

- Carbon footprint – Per unit of water delivered, would be much higher than LBCR due to the much longer distance water would have to be pumped.

- Water quality – Key water quality parameters are rated as low by the Region C Water Planning Group (2010).

- Purpose and Need/Adequacy of supply – The Toledo Bend Reservoir Alternative could meet the purpose and need because it can supply more than enough water for NTMWD's mid-term needs (200,000 AFY).

- Economic cost – Cost per thousand gallons would be approximately double that of LBCR.

- Reliability and availability – Reliability rated as high by the Region C Water Planning Group (2010).

- Time to implementation –Likely longer than for LBCR due to length of pipeline and complexity of institutional arrangements. It would require an IBT and agreements with multiple users.

- Need for partners – NTMWD would likely need to partner with TRWD and Sabine River Authority.

In sum, the Toledo Bend project is not a practicable alternative to the Proposed Action because it has significantly higher capital costs, greater energy usage and associated carbon dioxide (greenhouse gas) emissions, and higher long-term operating costs than the costs for the LBCR.

Water from Oklahoma Alternative

Yet another potential alternative is transport and use of water from Oklahoma. The *2011 Region C Water Plan* estimates that it is comparable in cost with the LBCR (Region C Water Planning Group, 2010). In 2002, however, 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. Assuming the Legislature was to approve water sales to Texas in the future, both the 2012 Texas State Water Plan and 2011 Region C Water Plan recommend that the NTMWD, the TRWD, and the UTRWD jointly develop a project to use water from Oklahoma. The recommended project is planned for 2060 and includes 50,000 AFY each for TRWD and NTMWD and 15,000 acre-feet per year for UTRWD (Freese and Nichols, 2008a).

The TRWD, UTRWD and NTMWD have each submitted water rights applications for water in Oklahoma. NTMWD has applied for water from the Kiamichi River, Muddy Boggy Creek and stored water in Lake Hugo. At this time, the state cannot act upon these permits without further direction from the Oklahoma Legislature or the judicial system.

If the Oklahoma Water Resources Board were to grant an Oklahoma water rights permit, the NTMWD would also need to obtain a Section 401 water quality certification if Oklahoma water were to be discharged to a Texas stream or lake, and a Section 404 permit for the diversion structure. Depending upon the source of water and its diversion location, a transmission system would be needed to the NTMWD's service area.

Due to the uncertainty regarding the Oklahoma moratorium on export of water to Texas and the uncertain status of the Oklahoma water rights permit, this strategy would likely not be able deliver water in a timely manner to meet the NTMWD's near-term (10-20 year) water needs.

Lake O' the Pines Alternative

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 (Figure 2-23). Authorized in 1946, the reservoir was created as part of the overall plan for flood control in the Red River Basin below Denison Dam. Outdoor recreation and water supply were added as purposes during construction (USACE, 2007). Its Texas water rights are held by the Northeast Texas Municipal Water District (NETMWD). The NTMWD has investigated the possibility of purchasing supplies in excess of local needs from the Cypress Basin. According to the 2012 Texas State Water Plan and the 2011 Region C Water Plan there could be as much as 89,600 AFY available for export from the basin. However, there are competing interests for this supply, including increased demands for steam electric power in the vicinity of this lake (northeast Texas). The 2011 Region C plan does not recommend it for any Region C supplier.

Figure 2-23. Ferrell's Bridge Dam at Lake O' the Pines
USACE photo

Development of this source would require contracts with the NETMWD and other Cypress River Basin suppliers with excess water supplies. Presently, the NETMWD and other suppliers have not committed to selling this amount of water. The NETMWD has recently entered into an agreement with the Caddo Lake Institute to provide water downstream of the dam, potentially reducing the available supply for export.

Evaluation according to listed criteria

- <u>Environmental impacts</u> – According to the Region C Water Planning Group (2010), environmental, natural resources, and rural/agricultural impacts would all be low, in good part because the dam and reservoir are pre-existing.

- <u>Carbon footprint</u> – Per unit of water delivered, would be much higher (about double) than LBCR due to the much longer distance water would have to be pumped.

- <u>Water quality</u> – Key water quality parameters are rated as low to medium-low by the Region C Water Planning Group (2010).

- Purpose and Need/Adequacy of supply – The Lake O' the Pines Alternative could supply about ¾ of the water (89,600 AFY) that LBCR could, partially meeting the purpose and need.

- Economic cost – Cost per thousand gallons of water would be almost one dollar greater that of LBCR (about 70 percent higher).

- Reliability and availability – Reliability rated as high by the Region C Water Planning Group (2010).

- Time to implementation –Likely longer than for LBCR due to length of pipeline and complexity of institutional arrangements. It would require an IBT and agreements with multiple users, renegotiating existing contracts, and a contract with NETMWD. All of these steps are time-consuming and potentially obstacles to this project being brought to fruition.

- Need for partners – NTMWD may need to partner with DWU and/or TRWD.

Lake O' the Pines is about 120 miles from the North Texas region, and this distance, the limited supply it would provide, and uncertainty concerning the need to reach agreements with existing water rights holders, all make this supply uncertain and impractical as an alternative to LBCR.

Wright Patman Lake Alternatives

Wright Patman Lake is an existing reservoir in the Sulphur River Basin, owned and operated by the USACE. It is about 150 miles from the NTMWD. The City of Texarkana has contracted with the USACE for storage in the lake and a supply of 13 MGD (14,568 AFY). Texarkana holds a state of Texas water right permit to use up to 180,000 AFY from the reservoir. However, to obtain a reliable supply of this amount, Texarkana would have to activate a contract with the USACE to increase the conservation storage in the lake. Implementation of this contract would require an environmental evaluation of the change in operation of the reservoir as required by NEPA. The USACE contract specifies that the maximum supply from this operational change is 84 MGD, or about 94,132 AFY, resulting in a total supply of 108,800 AFY (Freese and Nichols, 2008a).

Accessing the full 180,000 acre-feet per year in the Texas water right would require additional modifications to the USACE contract. There are three different strategies by which water could be made available from Wright Patman Lake to NTMWD:

- Water could be purchased from the City of Texarkana under its existing water right.

- Flood storage in Wright Patman Lake could be converted to conservation storage, and the NTMWD could use the increased yield.

- Wright Patman Lake could be operated as a system with Jim Chapman Lake (aka Cooper Lake) upstream to further increase yield.

The cost for each of these options is more than the estimated costs for LBCR (Region C Water Planning Group, 2010). Other difficulties and considerations impede the implementation and viability of each of these options. For these reasons, the Region C Water Planning Group (2010) did not list the Wright Patman Lake alternatives as recommended strategies but as alternative ones.

Purchase Water from Texarkana
Of the 180,000 acre-feet per year for which Texarkana currently has a water right, it could sell 100,000 acre-feet per year and still have sufficient supplies to meet its projected needs. Development of this supply would require activating the contract between Texarkana and the USACE for additional conservation storage, which would require environmental studies and mitigation. This option would require Texarkana to be willing to sell water to NTMWD, which to date, it has not committed to doing (Freese and Nichols, 2008a).

Raise Flood Pool of Lake Wright Patman
Increasing the conservation storage in Wright Patman Lake to elevation 228.6 feet MSL and allowing for diversions to as low as elevation 215.3 feet MSL would increase the yield of the project to about 364,000 AFY (Freese and Nichols, 2003; Region C Water Planning Group, 2010). 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. 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 elevation 230 feet MSL, and about 3,800 acres are below elevation 240 feet MSL.) This strategy would require changes to the USACE operation of Wright Patman. Also, this strategy is recommended for Dallas in the City's long-range water supply plan and 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.

Purchase from Texarkana, Raise Flood Pool, and System Operation
System operation of Wright Patman Lake and Jim Chapman Lake could increase the joint yield from the two projects by about 108,000 acre-feet per year (Freese and Nichols, 2008a). The combination of purchasing water from Texarkana, converting flood storage to conservation storage, and system operation with Jim Chapman Lake could make 390,000 acre-feet per year available from Wright Patman Lake. The 2012 State Water Plan and the 2011 Region C Water Plan assumed 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 acre-feet per year. 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 (Freese and Nichols, 2008a).

Evaluation according to listed criteria

- Environmental impacts – According to the Region C Water Planning Group (2010), environmental and natural resources impacts of the Wright Patman Lake alternatives would be medium to medium-low, while rural/agricultural impacts would be low, in good part because the dam and reservoir are already in place, though some potential modifications could impact habitats.

- Carbon footprint – Per unit of water delivered, would be much higher (roughly double) than LBCR due to the much longer distance water would have to be pumped.

- Water quality – Key water quality parameters are rated as medium-low by the Region C Water Planning Group (2010).

- Purpose and Need/Adequacy of supply – More than enough water could possibly be made available from the Wright Patman alternatives to meet NTMWD's needs.

- Economic cost – Cost per thousand gallons of water for the three options considered range from $1.67 to $2.49, compared to $1.33 for LBCR.

- Reliability and availability – Reliability is rated as high by the Region C Water Planning Group (2010). However, availability is in question, due to the need to cooperate with multiple partners and to reach an agreement with the existing water rights holders.

- Time to implementation –Likely longer than for LBCR due to length of pipeline and complexity of institutional arrangements. It would require an IBT and agreements with multiple users. It would require an IBT, a contract with USACE, a contract with Texarkana, and a new or amended water right permit.

- Need for partners – NTMWD may need to partner with DWU , TRWD, and/or Texarkana.

In sum, due to the uncertainty of reaching contractual agreements with existing water rights holders, the environmental impacts to the White Oak Mitigation Area and surrounding area of raising the flood pool, potential conflicts with other water suppliers, and the higher operational costs, water supply from Wright Patman Lake is not considered a practicable alternative to LBCR within the specified near-to mid-term time frame.

Lake Livingston Alternative
Lake Livingston is an existing reservoir on the Trinity River in Region H. The larger portion 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 acre-feet per year of its water might be available to water suppliers in Region C from the lake (Region C Water Planning Group, 2010). Because it is an existing supply from an existing reservoir, the on-site environmental impacts of utilizing this water management strategy would be relatively low (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 Region C Water Planning Group (2010) does list it as an alternative strategy for NTMD.

Lake Livingston is located about 180 miles from the North Texas service area. Due to the distance to NTMWD, and the need to build and operate a long raw water pipeline, this alternative would cost more than twice as much as LBCR (Region C Water Planning Group, 2010). It would also entail greater energy use (for pumping) and greenhouse gas emissions. The higher costs of this alternative and the competition with other users for the supply it could provide make it much less desirable than the proposed action to meet NTMWD's purpose and need.

Evaluation according to listed criteria

- Environmental impacts – According to the Region C Water Planning Group (2010), environmental, natural resources, and agricultural/rural impacts of the Lake Livingstone Alternative would all be low, primarily because the dam and reservoir are already in place; most impacts would be due to the construction and maintenance of a long pipeline.

- Carbon footprint – Per unit of water delivered, would be much higher than LBCR due to the much longer distance water would have to be pumped, equal or greater to the distance to Toledo Bend Reservoir.

- Water quality – Key water quality parameters are rated as low by the Region C Water Planning Group (2010).

- Purpose and Need/Adequacy of supply – Hypothetically, more than enough water could possibly be made available from the Lake Livingston Alternative (200,000 AFY) to meet NTMWD's needs.

- Economic cost – Unit cost (per thousand gallons of water) would be much higher for this alternative than for LBCR: $3.38 versus $1.33 (with debt service), and $1.03 versus $0.21 (after debt service).

- Reliability and availability – Reliability is rated as high by the Region C Water Planning Group (2010). However, availability is questionable, due to growing water needs to the south (greater Houston are) closer to this reservoir.

- Time to implementation –Likely longer than for LBCR due to length of pipeline and complexity of institutional arrangements. It would require a contract with TRA.

- Need for partners – NTMWD may need to partner with DWU and/or TRWD.

In sum, this alternative is impractical because of the much greater distance, unit cost, greenhouse gas emissions, and uncertain future availability.

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 acre-feet per year might be available to water suppliers in North Texas. So as to preserve hydropower generation from Sam Rayburn Reservoir, 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. Because of the long distance, this is a relatively expensive source of supply for NTMWD. There also has been recent interest in supplies from Sam Rayburn Reservoir/ Lake B.A. Steinhagen from other users (Freese and Nichols, 2008a).

This particular strategy was considered in the 2007 Texas State Water Plan but was not even listed in the 2011 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.

Other Existing Lakes

Other existing lakes in the vicinity of NTMWD service area include Lake Ray Hubbard, Ray Roberts Lake, Lewisville Lake, Lake Grapevine, Lake Fork, Cedar Creek Reservoir, Richland-Chambers Reservoir and Lake Palestine. However, each of these sources is fully committed to its existing customers. Lakes Ray Hubbard, Ray Roberts, Lewisville, Grapevine, Fork and Palestine are water supply sources for the City of Dallas, and these sources are needed to meet the demands of the City, 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 meet the water demands of the TRWD (Freese and Nichols, 2008a). Thus, none of these existing lakes is able to meet the purpose and need of the proposed action.

2.3.4.3 New Groundwater Supplies

The TWDB created 16 Groundwater Management Areas (GMAs) in Texas. 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 or "achieve" the DFC established by the GMA for that particular aquifer.

Figure 2-24 show the major aquifers of Texas, three of which are discussed below: Ogallala, Carrizo-Wilcox, and Trinity.

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

Carrizo-Wilcox Aquifer Groundwater Alternative
The Carrizo-Wilcox Aquifer covers a large area of east, central, and south Texas (Figure 2-21). Organizations and individuals have been studying the development and export potential of water supplies in Brazos County and surrounding counties. 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 practicable alternative to the Proposed Action.

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 aforementioned Carrizo-Wilcox. The four minor aquifers are the Woodbine, Queen City, Nacatoch, and locally undifferentiated formations referred to collectively as "other aquifer."

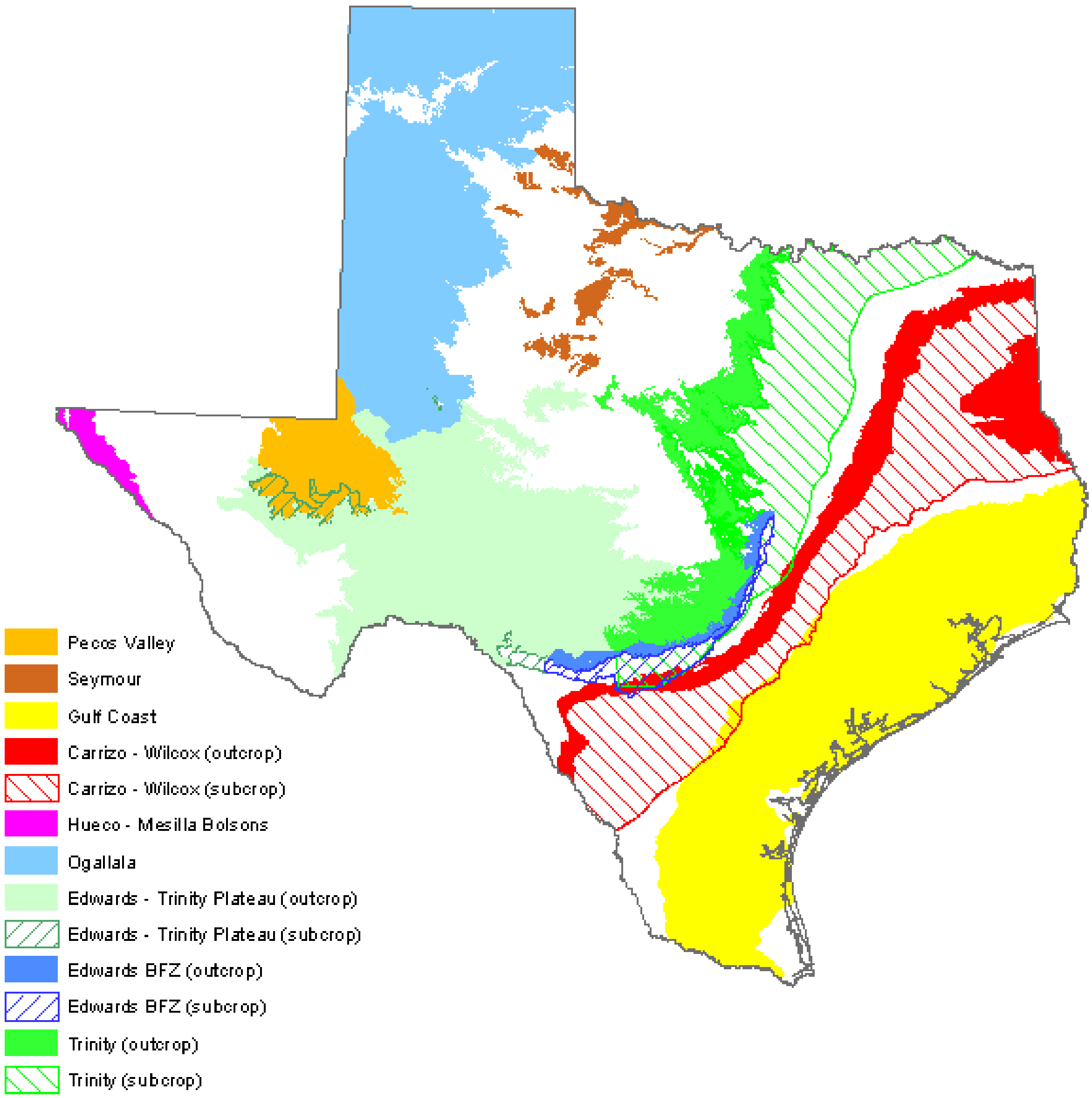


Figure 2-24. Major aquifers of Texas
Source: TWDB, no date-b

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 126,200 AFY for the LBCR. However, many providers and users compete for this water already, 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 in the region. The Region C Water Planning Group (2010) does not even list Region C aquifers among the scores of "Potentially Feasible Water Management Strategies for Wholesale Water Providers" in Table O.1 of Appendix O of the *2011 Region C Water Plan.* Thus, this is not a feasible alternative for NTMWD.

2.3.4.4 Desalination of Brackish Water

Desalination of Lake Texoma Water

As discussed above in Section 2.3.4.2, water from Lake Texoma is relatively high in dissolved salts. One option that would allow use of this water for municipal purposes is to desalinate the water 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 require disposal of over 30 MGD 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. The cost is over $3.00 per thousand gallons of treated water, over twice as expensive as LBCR (Region C Water Planning Group, 2010). However, these costs are more uncertain than other cost estimates developed for the potential alternatives for the following reasons:

- There is not an established track record of success in the development of large brackish water desalination facilities.

- Most of the large desalination facilities built to date are located on or near the coast.

- If a 100-million-gallon-per-day or larger plant were to be developed for Lake Texoma water, it would be the largest inland desalination facility in the world. To date, large-scale inland desalination facilities (greater than 50 MGD) have not been permitted or constructed anywhere in Texas. The Fort Bliss/ El Paso Water Utilities desalination facility, which is the largest inland desalination plant in Texas, produces 27.5 MGD.

- The method, cost and regulatory requirements of brine disposal for such a facility are uncertain. Due to this uncertainty, brine disposal has the potential to significantly increase the estimated cost for desalination. 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 quite difficult to permit. Building a pipeline for disposal in the ocean would be prohibitively expensive and still entail environmental impacts. Detailed studies to better quantify the cost estimates and feasibilities would be required if a large scale desalination strategy is pursued.

Further, the desalination alternative will only provide the equivalent of about 60 percent of reliable treated water supply from the LBCR if 100 percent is desalinated. The *2011 Region C Water Plan* assumes part of the total supply is desalinated and blended with the raw water from Lake Texoma. This alternative assumes a 70 MGD desalination facility, which would still be the largest inland desalination facility in Texas. There are also environmental, cost and permitting issues associated with the brine disposal for a large-scale inland desalination facility. Estimated costs for desalination of Lake Texoma water would be about twice that of treated water from LBCR. As noted above, desalination is also a much more energy-intensive process than conventional water treatment. As energy costs are expected to continue to increase, these differences would also be expected to increase commensurately. Thus, large-scale desalination of Lake Texoma water is not a practicable alternative to the proposed action due to the cost uncertainty, smaller water supply and the potential environmental impacts associated with large-scale brine disposal.

While large scale desalination of Texoma water is currently not practicable, there are some potential options to use a portion of the Texoma water either through desalination or blending, but the quantity available would be smaller than the amount of water developed from Lower Bois d'Arc Creek Reservoir. As such, a smaller scale project would not be an alternative to the LBCR (Freese and Nichols, 2008a).

Gulf of Mexico Seawater Desalination Alternative

The State of Texas has sponsored initial studies of potential seawater desalination projects. These may be a potential 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 such criteria pollutants as particulates, sulfur dioxide, nitrogen oxides, and volatile organic compounds, and possibly the toxic heavy metal mercury; and 3) emit carbon dioxide, 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 supply for NTMWD. While the water supply from seawater desalination is essentially unlimited, this is a high energy use strategy and the cost is much higher than the cost of other water management strategies for NTMWD – almost six times as expensive (Region C Water Planning Group, 2010). Thus, this is not a practicable alternative to the proposed action.

2.3.5 Comparison of Alternatives

Figure 2-25 compares the costs of the alternatives discussed above, as estimated by the Region C Water Planning Group (2010).

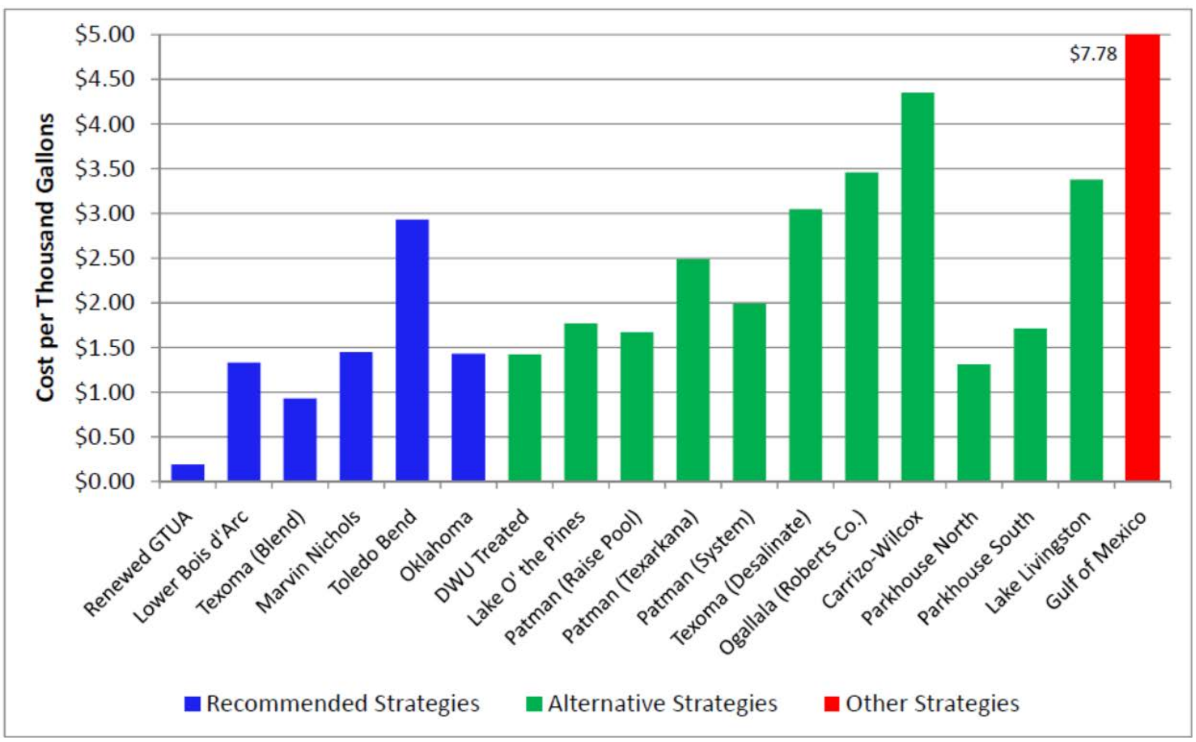


Figure 2-25. Unit costs of potentially feasible strategies for NTMWD according to the Region C Water Planning Group

Source: 2011 Region C Water Plan, Figure 4E.7

Table 2-7 summarizes those alternatives considered but found to be not practicable and dismissed from detailed consideration.

Table 2-7. Alternatives considered but dismissed from detailed consideration

Alternative	Comments/reason for dismissal
Water conservation and reuse	• Insufficient in and of itself to meet projected 2060 demand • Integral part of portfolio of strategies to meet projected demand
Marvin Nichols	• Due to its size alone, building this reservoir would likely entail greater environmental impacts than the proposed LBCR, especially on bottomland hardwood forest habitat • Cost of delivered water only slightly more than LBCR • Unable to be implemented within the time frame required to satisfy the stated purpose and need of this project
George Parkhouse South (Parkhouse I)	• Larger size would probably entail greater environmental impacts • Larger areas of bottomland hardwoods, marsh and wetlands would be impacted • Uncertain reliability of supply due to possible construction of other reservoirs in basin • Cost of delivered water somewhat greater than LBCR • Lower firm yield than LBCR • Unlikely this alternative could be developed in time to meet NTMWD's near and mid-term needs
George Parkhouse North (Parkhouse II)	• Would likely impact less bottomland hardwood forest and wetlands than LBCR • Cost per acre-foot of water delivered compares favorably • Uncertainty of reliable supply, given probable development of other reservoirs in basin which would constrain yield •), it is unlikely this alternative could be developed in time to meet NTMWD's near and mid-term needs.
Upper Bois d'Arc Creek	• Due to smaller drainage area and less storage in reservoir, could not provide the amount of water supply needed • Due to the need for detailed engineering and environmental studies, unlikely it could be developed in time to meet NTMWD's near and mid-term needs
Lake Fastrill	• No longer a viable reservoir site because USFWS has designated a wildlife refuge within the reservoir footprint
Lake Columbia	• Much of water from proposed reservoir already committed to users in Neches River Basin
Lake Tehuacana	• Unavailable to NTMWD because it would be operated by the Tarrant Regional Water District
Lake Ralph Hall	• Unavailable to NTMWD because it would be developed and used by the Upper Trinity Regional Water District • EIS now under preparation
Lake Lavon reallocation of flood storage to water supply	• Would only provide about five percent of LBCR's yield • Cannot be implemented within the timeframe needed for the water • Entails risks associated with the reliability of this supply during drought as well as risks to residents from a potential reduction in flood control capacity during storm events

Alternative	Comments/reason for dismissal
Lake Jim Chapman reallocation of flood storage to water supply	• Would only provide about 20 percent of LBCR's expected yield. • Cannot be implemented within the timeframe needed for the water • Entails risks associated with the reliability of this supply during drought as well as risks to residents from a potential reduction in flood control capacity during storm events
Reallocation of Storage at Other Reservoirs in the Region (Lakes Ray Hubbard, Ray Roberts, Lewisville, Tawakoni and Fork)	• Anticipated increase in yield associated with increased storage for water supply at these existing lakes in the region would be relatively small • Can neither provide the amount of water supply needed, nor within the time period required • Probably be strong opposition both at the local and Congressional levels • Likely be an unacceptable increase in the flood hazard from any reallocation of storage capacity at other lakes in the region
Lake Texoma Development with New Fresh Water Supplies	• Elevated dissolved salts in Lake Texoma entails certain environmental impacts whether water is used by blending or by desalination • Existing water supplies in northern Texas are insufficient to provide a blended water of acceptable quality for municipal use • Time to implement is uncertain – would require Congressional authorization, IBT, contract with USACE, and state water right
Toledo Bend Reservoir Phase 2	• Would require multiple transmission pipelines to transport the water from existing reservoir 200 miles to North Texas • Impacts to habitat would not be large in that most of the habitats traversed are already altered or agricultural • Unit cost (capital cost per thousand gallons delivered) more than twice that of LBCR • Not a practicable alternative to the proposed action because it has significantly higher capital costs, greater energy usage and associated carbon dioxide (greenhouse gas) emissions, and greater long-term operating costs than the costs for the LBCR • Time to implement likely longer than for LBCR due to length of pipeline and complexity of institutional arrangements; would require an IBT and agreements with multiple users
Water from Oklahoma	• Due to uncertainty regarding the official Oklahoma position on export of water to Texas and the uncertain status of the Oklahoma water rights permit, this strategy would likely not be able deliver water in a timely manner
Lake O' the Pines	• Located about 120 miles from the North Texas region – this distance, limited supply (<100,000 AFY), and uncertainty of being able to reach agreements with existing water rights holders render this inferior as an alternative to LBCR • Time to implement likely longer than for LBCR due to length of pipeline and complexity of institutional arrangements; would require an IBT and agreements with multiple users; would also require an IBT, renegotiating existing contracts, and a contract with NETMWD

Alternative	Comments/reason for dismissal
Purchase Wright Patman Lake water from City of Texarkana	• Would require Texarkana to be willing to sell water to NTMWD, to which it has not committed
Raise Flood Pool of Lake Wright Patman	• Raising flood pool would inundate portions of the White Oak Creek Mitigation Area • Would require changes to the USACE operation of lake • Recommended for Dallas in the City's long-range water supply plan and *2011 Region C Water Plan*. Unlikely that there is sufficient water for both NTMWD and Dallas to pursue this strategy
Purchase from Texarkana, Raise Flood Pool, and System Operation of Lake Wright Patman	• System operation of Wright Patman Lake and Jim Chapman Lake could increase the joint yield from the two projects by about 108,000 acre-feet per year • Uncertainty of reaching contractual agreements with existing water rights holders, environmental impacts to the White Oak Mitigation Area and surrounding area, conflicts with other water suppliers, and higher operational costs are all obstacles that make this alternative impractical within the needed time-frame
Lake Livingston	• Located about 180 miles from the North Texas region • Due to the need to build and operate a long raw water pipeline, this alternative would cost more than twice as much as LBCR • NTMWD also faces competition with other users for this supply • Would cost more than twice as much as LBCR and would also entail greater energy use (pumping) and greenhouse gas emissions
Sam Rayburn Reservoir/Lake B.A. Steinhagen	• Because of the 200-mile distance, this would be a relatively expensive source of supply for NTMWD • Not considered as a strategy for NTMWD in the *2011 Region C Water Plan* due to excessive cost and uncertain availability • Need to construct and operate long water pipelines with attendant pumping stations; entails more greenhouse gas emissions
Other Existing Lakes	• All other existing lakes in the vicinity of NTMWD service area are fully committed to existing users
Ogallala Aquifer Groundwater	• This alternative is no longer available to the NTMWD because rights holder Mesa Water recently entered into an purchase agreement with the Canadian River Municipal Water Authority
Carrizo-Wilcox Aquifer Groundwater	• This aquifer covers a large area of east, central, and south Texas • Relatively expensive source of water supply for the NTMWD due to long distances that pipeline would need to be constructed and operated • Due to cost considerations and competition for this water source, not a practicable alternative
Other Groundwater Supplies in Region C	• Many providers and users compete for this water already; little additional water supply is actually available from Region C aquifers • TCEQ has designated a ten-county area within Region C as a priority groundwater management area due to excessive declines in groundwater (e.g., dropping water tables)

Alternative	Comments/reason for dismissal
Desalination of Lake Texoma Water	• Desalination is both costly and energy-intensive, and its high greenhouse gas emissions are a drawback • No established track record of success in the development of large brackish water desalination facilities • Most large desalination facilities built located on or near coast • If a 100-MGD plant were built, it would be the largest inland desalination facility in the world • Brine disposal a serious cost and environmental issue
Gulf of Mexico Seawater Desalination	• Desalination is both costly and energy-intensive, and its high greenhouse gas emissions are a drawback • 300 mile distance is a major disadvantage • While water supply from seawater desalination is essentially unlimited, this is a high energy use strategy and the cost is much higher (6X) than the cost of other water management strategies

Table 2-8 also lists the water supply alternatives considered but rejected from more detailed consideration in this EIS because they failed to meet the declared Purpose and Need of the Proposed Action, specifically because of either inadequate water supply or insufficient timeliness, or both criteria. By way of comparison, LBCR (the Proposed Action) would have a firm yield of 126,200 AFY and be available in 2020. Three other proposed reservoirs – Lakes Columbia, Ralph Hall, and Tehuacana – are also included in this table.

Table 2-8. Alternatives considered but deemed inadequate on grounds of either insufficient water or timeliness, or both

Alternative	Potential quantity of water (AFY) available to NTMWD	Expected year available[1]
Supply from new (undeveloped) reservoirs		
Smaller-scale LBCR	83,700	2022
Upper Bois d'Arc Creek Reservoir	26,900	2035
Marvin Nichols Reservoir	174,840	2040
George Parkhouse South Lake	97,600 (38,700, after Marvin Nichols)	2035 2060
George Parkhouse North Lake	93,920 (after Ralph Hall) 25,680 (after MN)	2035 2060
Lake Columbia	50,000	2030
Lake Ralph Hall	0	NA
Lake Tehuacana	0	NA
Transporting water from existing reservoirs		
Lake Texoma	0 (no new supply) 40,000 (LBCR) 113,000 (339,000 AF available for blending)	NA 2030 2060

Alternative	Potential quantity of water (AFY) available to NTMWD	Expected year available[1]
Toledo Bend Reservoir	200,000	2030
Water from Oklahoma	0 - 50,000 (unknown if OK will grant permit)	Unknown. If acted within 5 years, earliest online date would be 2030.
Lake O' the Pines	0 - 30,000 (quantity unknown; competing interests)	
Wright Patman Lake: Purchase from Texarkana	0	NA
Wright Patman Lake: Raise Flood Pool	0 - 180,000	2035
Wright Patman Lake - System Operation with Jim Chapman	0 - 130,000	2040
Lake Livingston	0 - 100,000	2030
Sam Rayburn Reservoir/Lake B.A. Steinhagen	0	NA
Lake Lavon Reallocation	0 - 7,200	2030
Lake Jim Chapman Reallocation	0 - 24,950	2030
Lakes Ray Roberts and Lewisville Reallocation	0	NA
Lakes Ray Hubbard, Tawakoni, Fork	0	NA
New groundwater supplies		
Ogallala Aquifer groundwater in Roberts County	N/A	NA
Carrizo-Wilcox Aquifer Groundwater in Brazos County	0 - 10,000	2060
Other Groundwater Supplies in Region C and nearby counties	0	NA
Desalination of Brackish Water		
Desalination of Lake Texoma Water	20,000 80,000	2022 2035
Gulf of Mexico Seawater Desalination	200,000	2040
[1]Expected year available and supply available may differ from the year and amount reported in the 2011 Region C Water Plan due to developments since the plan was published.		

No single alternative or combination of alternatives in the above tables would meet the Purpose and Need while substantially reducing LBCR's impacts on waters of the U.S. and the general environment.

Table 2-9 is an impact comparison matrix, which compares and contrasts the impacts of the two alternatives that are analyzed in detail in Chapter 4 of the EIS.

Table 2-9. Impact comparison matrix

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Topography, Geology and Soils	**Section 4.3.1 (page 4-12)** • Over short term, topographic features, geological formations, and soils on the reservoir site, along the proposed pipeline, and at the water treatment plant site would all remain essentially in their present condition. • Over long term, if these lands continued to be used for agriculture or grazing, rather than being restored to a more natural and thicker vegetative cover, soil erosion would be expected to occur on the steeper sites, gradually reducing soil depth. • 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. • Bank erosion 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. • No short- or long-term effects on geology. • Adverse but less than significant impacts from ongoing erosion would be long-term, localized, and minor to moderate in magnitude. • Due to continuing 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 due to the conversion of rural land soils to urbanized or developed lands. Impacts would thus be adverse, long-term, and moderate to major.	**Section 4.3.2 (page 4-13 to page 4-17)** • Topography would be altered by dam construction, though these impacts would be localized. • Impacts to subsurface geology not expected, as deep excavation would not occur during dam construction. • Impacts of dam and reservoir construction to soils moderate in magnitude, both short-term and long-term, medium or localized in extent, probable, and slight in precedence and uniqueness. • Overall effects on topography, geology, and soils of constructing the LBCR would be adverse but less than significant. • Operating the LBCR would have a long-term adverse, but less than significant, impact on Prime Farmland Soils by eliminating these soils from potential use in agriculture. • Overall effects on topography, geology, and soils of operations at the LBCR would be adverse but less than significant. • Impacts from laying raw water pipeline would be adverse, short-term, minor in magnitude, short-term, of medium extent and slight precedence, and less than significant overall. • Impacts from WTP and TSR on soils would be adverse but less than significant, of minor to moderate magnitude, long-term duration, small to medium extent, probable likelihood, and slight precedence. • Effects on soils from FM 1396 relocation and new bridge construction would be adverse, long-term, minor, localized and of slight precedence. • Cumulative impacts on soils in Fannin County from all past, present, and reasonably foreseeable future actions are expected to constitute an adverse, long-term (permanent), moderate to major impact covering a large area. These impacts would mostly occur due to growth and development of Fannin County and the DFW Metroplex, leading to conversion/loss of agricultural soils.

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Water Resources	**Section 4.4.1 (page 4-17 to page 4-18)** • Continuing evolution of channelized segment of Bois d'Arc Creek and tributaries towards a state of dynamic equilibrium. • Increased runoff from development and urbanization, particularly in the nearby City of Bonham. • Potential for flooding caused by the development of new roads and bridges. • Increases in turbidity could result from development and/or increased erosion and downcutting of channel. • Overall, direct, indirect, and cumulative impacts on surface water resources would be of minor magnitude, long term duration, medium or localized extent, probable likelihood, and slight precedence – adverse but insignificant. • Moderate impact on local aquifers because of potential for increased pumping of groundwater, decreased production rates, shortages, and potentially lower water quality from deeper wells. • While direct impacts to streams of the Proposed Action would be avoided, most of the cumulative impacts on streams associated with growth of the DFW Metroplex would likely still occur under the No Action Alternative. These effects would be adverse, moderate, long-term, of large extent, probable likelihood, and slight precedence. • Little or no contribution to cumulative adverse impacts on waters and wetlands in Fannin County or Texas as a whole is anticipated. • By not meeting projected water needs, could possibly lead to an increase in well drilling and pressure on already stressed groundwater resources	**Section 4.4.2 (page 4-18 to page 4-37)** • Proposed Action would permanently impact up to 5,876.76 acres of wetlands, 225 acres of streams, and 113 acres of open waters. • Due to erosion within the watershed, and sediment transport upstream in Bois d'Arc Creek, the LBCR would probably lose on the order of several percent of its water storage capacity by 2060, typical of reservoirs in the region. • No adverse water supply impacts are predicted to occur downstream on the Red River, even under low flow conditions. • The proposed reservoir would neither cause nor be harmed by adverse water quality conditions. • As at other reservoirs in the region, authorities would have to actively monitor for the presence of toxic golden algae, which can cause fish kills and other problems, proactively reduce the risk of outbreaks, and actively control outbreaks. • Building the LBCR would not increase flooding upstream of Highway 82, including at Highway 56. • Lake Bonham Dam would be adversely affected by the LBCR, but these impacts can be mitigated to an acceptable level. • LBCR would not adversely impact existing water rights within the basin or the inter-basin transfer to water rights in the Trinity or Sabine River Basins. • Not expected to have any significant adverse impact on local groundwater resources and may even have a beneficial impact. • Net impacts on waters of the United States would be adverse in the short and medium term and beneficial over the long term. • Significant impacts of the project on waters of the U.S. would be substantially mitigated following implementation of the proposed mitigation plan at Riverby Ranch. • Due to proposed water release regime from LBCR, impacts on the existing downstream aquatic environment would likely be beneficial, of moderate magnitude, long-term duration, medium extent, probable likelihood, and moderate precedence.

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Water Resources (cont.)	within the county and wider region. • Would not contribute to cumulative downstream water supply impacts.	• There would be temporarily adverse but no permanent impacts to waters and wetlands from constructing a 35-mile raw water transmission line from LBCR to the proposed North WTP near Leonard, TX, as well as the WTP, a TSR, FM 1396 relocation, bridge construction, and related activities and appurtenant facilities. • By 2060, the cumulative effect of all reasonably foreseeable changes on streams in Fannin County would be adverse, moderate, long-term, of large extent, probable likelihood, and slight precedence. • Little or no contribution to cumulative adverse impacts on waters and wetlands in Fannin County or Texas as a whole is anticipated. • Not expected to exacerbate adverse cumulative impacts on local groundwater resources and may even have a beneficial impact. • Would reduce cumulative downstream flows in Bois d'Arc Creek, although no existing water rights would be affected. • Would result in minor reductions of flows and water supply in the Red River downstream of the Bois d'Arc Creek confluence, though this would not represent a significant cumulative adverse impact. • Cumulative impacts from all actions in the Red River Basin, including hydraulic fracturing for shale-gas production, are not likely to cause water supply shortages.
Air Quality and Climate	**Section 4.5.1 (page 4-52)** • No impacts to air quality or climate because no installation of dam, water treatment facility, or pipeline would occur. • Air quality would remain unchanged when compared to existing conditions, discussed under the Affected Environment. • Would have no direct impact on the climate, and would not contribute to global warming. • Nonetheless, long-term moderate adverse effects would be expected under No Action Alternative due	**Section 4.5.2 & 4.5.3 (page 4-52 to page 4-58)** • Short-term minor adverse and long-term minor beneficial impacts to air quality would be expected with the implementation of the Proposed Action. • Short-term emissions would be limited to fugitive dust and diesel emissions from construction equipment during dam, water treatment facility, and pipeline development. • Direct and indirect air emissions would not be expected to exceed applicability thresholds or contribute to a violation of any federal, state, or local air regulation. • Long-term effects would be primarily due to the elimination of

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Air Quality and Climate (cont.)	to anticipated climate change in region. • Would constitute a less conservative approach to water management under future drier, hotter conditions associated with climate change when compared to the Proposed Action. • Would not contribute at all to cumulative air quality impacts in the ROI.	existing sources of air emissions within the project area. • Would have a relatively small carbon footprint, and would have an incremental, but overall negligible, contribution to global warming. • 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 less available precipitation. • Would contribute directly to cumulative air quality impacts in the ROI only to a negligible to minor degree.
Acoustic Environment (Noise)	**Section 4.6.1 (page 4-58)** • Would have no impacts to noise because there would be no installation of the dam, water treatment facility, or pipeline. • Noise levels would remain unchanged when compared to existing conditions. • Would not contribute at all to the expected cumulative increase in future ambient noise levels in Fannin County as it becomes more populous and developed.	**Section 4.6.2 (page 4-58 to page 4-60)** • Would have short-term minor adverse and long-term minor beneficial effects on the noise environment. • Short-term minor increases in noise would result from the temporary use of heavy equipment during land clearing and construction. • Long-term effects would likely be mixed. • While most existing sources of noise within the reservoir footprint such as agricultural activities, automobile traffic, and lawn maintenance equipment would end, there is likely to be noise associated with long-term recreational and real estate development at and in the vicinity of the reservoir. • Increases in noise would not create areas of incompatible land use or violate any Federal, state, or local noise ordinance. • Would contribute both directly and indirectly to a cumulative increase in noise levels within Fannin County, however, these impacts and noise levels would not be significantly adverse.
Biological Resources	**Section 4.7.1 (page 4-61 to page 4-62)** • Effects to vegetation communities would likely be a mixture of minor adverse and minor beneficial; it is not possible to foresee which of these might predominate, and thus whether the net effect would be adverse or beneficial.	**Section 4.7.2 (page 4-62 to page 4-80)** • Effects of reservoir construction to vegetation would be adverse, moderate in magnitude, short-term and long-term in duration, medium in extent, probable, and moderate in precedence and uniqueness. • Approximately 6,330 acres of bottomland vegetation would be

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Biological Resources (cont.)	• None of the direct effects to vegetation that would occur at the proposed reservoir, dam, pipeline, and the water treatment facility sites due to the Proposed Action would take place under the No Action Alternative. • Adverse effects to wildlife within the LBCR footprint would likely be minor and adverse, although, as in the case of vegetation, there could possibly be a net increase in wildlife abundance and diversity in the area associated with broader regional trends. • Any substantive change to wildlife abundance or diversity in the area would come from projects such as additional rural houses, an increase or intensification of agriculture practices, and reversion of agricultural fields to old fields, grass fields, or eventually, woody habitat. • Overall effects to aquatic wildlife would be minor to moderate, adverse, and long term because the degraded condition and modified hydrology of this creek would continue for the indefinite future. Existing conditions, which include both very high, erosive flows during storm events, as well as long periods of little or no flow, are not conducive to maintaining an abundant and diverse stream fauna. • Effects to threatened and endangered species under the no action alternative would likely be no more than minor adverse. • Would not contribute to any cumulative change in either wetland or upland vegetation, but under this scenario, there would still be a net decrease in natural vegetation in Fannin County, especially upland vegetation, associated with anticipated population growth and development in the coming	removed. • Effects of constructing raw water transmission and treatment facilities on vegetation would be adverse, minor in magnitude, short-term and long-term in duration, small in extent, probable, and slight in precedence and uniqueness. • Effects of reservoir operation to vegetation would be adverse, minor in magnitude, long-term in duration, small to medium in extent, probable, and slight in precedence and uniqueness. • Net impacts of the Proposed Action on upland or terrestrial vegetation would be moderately adverse in the short and medium term and minor adverse over the long term. With mitigation measures implemented, these impacts would be less than significant. • Taking into account the proposed mitigation plan, overall impacts to terrestrial wildlife from the Proposed Action would be both adverse and beneficial as well as short-term and long-term. • Once reservoir habitats become established, 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 of Proposed Action. • Impacts of Proposed Action on aquatic wildlife within the reservoir footprint would be both adverse and beneficial, short-term and long-term, of medium extent, probable likelihood, and moderate precedence. • Downstream of reservoir, likely effects of the Proposed Action on aquatic wildlife would be largely beneficial, due to the ability of water managers to control flows throughout the year. • Effects on federally-listed T&E species are unlikely due to their probable absence from the site. • Adverse impacts are possible, though considered unlikely, to five state-threatened fish species and one reptile, because their preferred habitat is found at the LBCR site, though none of these species were documented during surveys.

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Biological Resources (cont.)	decades. • Would not contribute to adverse cumulative impacts on wildlife associated with growth and development, but nor would it prevent this growth and development from occurring. • Would avoid direct adverse and beneficial cumulative impacts resulting from the Proposed Action, but it would not avoid adverse impacts on aquatic life in Bois d'Arc Creek from the anticipated increase in development within the watershed. • Would not contribute to cumulative adverse impacts on either federal or state threatened and endangered species in Fannin County. However, cumulative adverse impacts might still occur on these species due to expected growth and development.	• Would not contribute to the growing cumulative pressure on wetlands-associated vegetation, but would contribute to a minor extent to the cumulative decline in upland vegetation associated with woodlands, ranching, and agriculture as a result of expected population growth and development in Fannin County in coming decades. • Over the long term, the immediate adverse effects of the Proposed Action on wildlife in Fannin County would be offset by wildlife habitat restoration and improvement at the Riverby Ranch mitigation site. Thus, the long-term net cumulative effect of the Proposed Action 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 diversity) in Fannin County than at present due to the need to develop existing wildlife-supporting habitats to support another 48,000 human residents within the county. • 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 the segment that would be downstream of the proposed dam; on balance, 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 of the draft water right permit. • 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 48,000 new residents by 2060, would tend to have adverse implications cumulatively for the diversity and abundance of aquatic life, both fish and benthic macroinvertebrates in Bois d'Arc Creek. • Would not contribute to cumulative adverse impacts on federally threatened and endangered species in Fannin County; however, might adversely affect four state-listed species that could

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Biological Resources (cont.)		potentially be present in the project vicinity. . • Overall expected cumulative impacts on state-listed species documented within Fannin County would be adverse and long-term, due to anticipated development within the country to meet the needs of 48,000 new residents by 2060.
Recreation	**Section 4.8.1 (page 4-80)** • Little to no direct impacts on existing recreation facilities, opportunities, types and levels. • Overall impacts on recreation would be minor, slight, medium in extent, long-term and possible. Therefore, these impacts would not be significant. • No changes would occur to existing public or private recreation areas in this region. Increased pressure on recreation areas due to a larger population may impact the quality of or access to existing recreation areas in the future. • Would experience neither the adverse nor the beneficial, long-term and cumulative effects of the Proposed Action.	**Section 4.8.2 (page 4-80 to page 4-84)** • Would cause a variety of different actions on recreation in the vicinity. It is probable that construction of the reservoir would have minor to moderate, short-term adverse impacts. These impacts would be limited to a small extent. • Recreational opportunities at the project site are likely to be moderately beneficial, long term and medium in extent. • Impact on recreational opportunities at the site would probably be moderately significant and beneficial. • Infrequent minor to moderate adverse impacts may occur to the Legacy Ridge Country Club golf course. • Impacts on other public recreational areas are unlikely, but could be minor, long term, of medium extent and slight to moderate precedence. Thus, adverse impacts to other recreational areas are likely to not be significant. • Overall cumulative effects related to recreation are generally beneficial, and the LBCR would contribute to these. • A potential downside is that with 48,000 projected additional residents in Fannin County, and similar demographic trends in ROI generally, some outdoor recreation sites and facilities could face overcrowding, which would diminish the visitor experience.
Visual Resources	**Section 4.9.1 (page 4-85 to page 4-86)** • Visual aesthetics 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 affect visual resources in the vicinity. However, if population	**Section 4.9.2 (page 4-86 to page 4-89)** • Due to its size and salience, the proposed dam and reservoir would have a major, long-term impact on visual resources, but 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 in question. • Some individuals would regard the permanent elimination of gently rolling pastoral scenery along Lower Bois d'Arc Creek as a

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Visual Resources (cont.)	grows and development proceeds in tandem, the Bois d'Arc Valley may lose some of its existing rural appearance, in which open space is dominant. • Cumulatively, over the long run, by not developing a lake with a protected green perimeter, this alternative would deny future residents a positive visual element in a county that would be both more populous and more developed.	loss outweighing any gain provided by a lake setting. • Other individuals would regard the permanent addition of a lake on the landscape as an aesthetic asset to the community. Many members of the public would 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.
Land Use	**Section 4.10.1 (page 4-89)** • Present trends in land use change 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 Metroplex and Fannin County increase over the decades. • Would not contribute to any cumulative changes in county land use over the long term but the country would become more urbanized in any case.	**Section 4.10.2 (page 4-89 to page 4-91)** • Impacts are expected to be major in magnitude, long term, direct, medium in extent, probable, and moderate in precedence and uniqueness. • Whether or not these long-term, indeed permanent, changes in land use of major magnitude are considered adverse or beneficial – or both – depends on the particular interests and values of the observer. • Similar or greater population growth as in the No Action Alternative would likely occur, leading to an increase in the percentage of land dedicated to residential and commercial uses and a corresponding decrease in rural farmland and open space.
Utilities	**Section 4.11.1 (page 4-91)** • Does not provide the needed water supply for NTMWD members and customers. • Thus, would be expected to be adverse, major in magnitude, long-term, direct, medium in extent, probable, and slight in precedence and uniqueness to the NTMWD service area. • Existing power lines would remain in place with no impacts or need for relocation. Their use would continue at current levels.	**Section 4.11.2 (page 4-91 to page 4-93)** • 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. • Impact of construction on utilities would be adverse, minor to moderate in magnitude, short term, direct, small to medium in extent, possible, and slight in precedence and uniqueness to the power supply in Fannin County. • Expected to be beneficial, indirect, long-term in duration, medium to large in extent, possible in likelihood, and moderate in precedence and uniqueness. • Construction of the Lower Bois d'Arc Reservoir would help ensure that future water needs of the NTMWD region are met.

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Utilities (cont.)		• New water supply capable of meeting the demands of the new population growth directly and indirectly related to the creation of the LBCR. However, over time, new electric supply (generation, transmission, distribution) to meet population growth would also be necessary.
Transportation	**Section 4.12.1 (page 4-93)** • No impacts to transportation resources would occur as there would be no change in traffic on the roadways, no road closures or reconfigurations. • Anticipated growth and development in Fannin County would bring about significant cumulative effects in the county's road transportation network and traffic situation.	**Section 4.12.2 (page 4-93 to page 4-99)** • Short-term adverse effects on transportation and traffic, would be of major magnitude, due to the number and length of roads requiring temporary or permanent closure and relocation. • These impacts would be of medium to large extent, probable likelihood, and moderate precedence. These short-term effects would be significant. • Short-term and long-term effects to road network would be mixed. After completing the proposed dam, the reservoir would effectively close the secondary roadways, and motorists would be rerouted in some fashion. • Although these effects would be adverse, there would be an overall net benefit to roadway infrastructure for roads not closed by the proposed action. • Effects would be of minor magnitude, medium to large extent, probable likelihood, and slight precedence. Given the mitigation measures proposed to ameliorate these impacts, the long-term effects of the Proposed Action on transportation would be less than significant. • Anticipated growth and development in Fannin County would bring about significant cumulative effects in the county's road transportation network and traffic situation. • The reservoirs' contribution to these cumulative effects related to transportation would be minimal.
Environmental Contaminants and Toxic Waste	**Section 4.13.1 (page 4-99)** • No impacts are expected.	**Section 4.13.2 (page 4-99)** • No adverse effects expected from the Proposed Action with regard to environmental contaminants and toxic waste. • If the proposed reservoir is built, NTMWD, TCEQ, and perhaps other state or federal agencies would be conducting periodic

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Environmental Contaminants and Toxic Waste (cont.)		assessments of water quality, so that if a source of contaminants were to become evident, it would be addressed in the appropriate manner.
Socioeconomics	**Section 4.14.1 (page 4-100 to page 4-101)** • In the absence of the proposed project, the population projections for the six counties may not materialize to the fullest. • Could affect counties in ROI in the form of foregone indirect economic benefits. Neither water supply nor projected population growth would be directly affected under this alternative. • Job and income creation associated with the construction and operation of the dam & reservoir would not take place. • Real estate and business development around the reservoir would not occur. • Over the long term, would have adverse socioeconomic impacts of major magnitude, large (multi-county) extent, probable likelihood, and moderate to severe precedence. • Adverse socioeconomic impacts would be significant.	**Section 4.14.2 (page 4-101 to page 4-118)** • Overall impacts 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 adverse and beneficial economic impacts would be considered significant, although magnitude of long-term of beneficial effects is much greater than magnitude of long-term adverse effects. Adverse impacts can be mitigated to below the threshold of significance by offering fair market value to willing sellers of homes and properties. • Adverse fiscal and social impacts are more weighted toward the short-term; at the same time, there would also be a major short-term economic stimulus associated with construction of the reservoir and related facilities. • Over time, socioeconomic impacts associated with the Proposed Action would become more and more positive or beneficial. On net, over the life of the proposed facility (50-100 years or more), socioeconomic effects would be positive for Fannin County. • 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).
Environmental Justice and Protection of Children	**Section 4.15.1 (page 4-119)** • No impacts related to environmental justice and protection of children. • Would not result in any cumulative impacts on environmental justice.	**Section 4.15.2 (page 4-119 to page 4-124)** • Does not entail long-term environmental justice impacts. • Would neither benefit nor disadvantage minorities disproportionately either during construction or operation. • Adverse, short-term, negligible to minor magnitude impacts could occur during the construction phase. These impacts would not be significant. • Long-term impacts of the Proposed Action on children would be

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Environmental Justice and Protection of Children (cont.)		primarily beneficial. • Any long-term cumulative effects from the LBCR and LRH on environmental justice would be slight but likely beneficial, from increased economic and recreational opportunities.
Cultural Resources	**Section 4.16.1 (page 4-124)** • There would be no impacts to cultural resources from the Proposed Action, as it would not be built or operated. • However, over the long term, any cultural resources within the reservoir footprint and mitigation sites would be largely unprotected by federal law, since they are on private properties. Thus, cumulatively and over the long term, impacts to cultural resources from the No Action alternative are unknown.	**Section 4.16.2 (page 4-124 to page 4-126)** • No effect on properties currently listed on the National Register of Historic Places. • No effect on State of Texas historical markers. • Would adversely affect the Wilks Cemetery within the reservoir footprint. • Regardless of 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. • Measures to mitigate adverse effects to two cemeteries outside the reservoir footprint, but within the flowage easement, 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. • 34 structures and/or buildings are within the APE, none of which are eligible for the NRHP. Thus, the Proposed Action would have no effect on significant historic buildings or structures. • No effect on buildings or structures outside the APE and above the 541 foot MSL elevation. • Impacts to at least 5 and as many as 24 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.

Impact Topic	No Action Alternative	Proposed Action (LBCR, raw water pipeline, water treatment plant, terminal storage reservoir)
Cultural Resources (cont.)		• In sum, without mitigation, the Proposed Action's impacts on cultural resources, primarily archeological sites, would be considered significant under NEPA. • Impacts can 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.

3.0 AFFECTED ENVIRONMENT

This chapter of the EIS describes the "affected environment" of the proposed action. It is not an encyclopedia of the natural and human environment of North Texas or Fannin County, rather, it emphasizes those aspects of the environment that could potentially affect, or be affected by, the proposed Lower Bois d'Arc Creek Reservoir and dam, and connected actions such as the raw water pipeline, new water treatment plant, terminal storage reservoir, and road relocations.

3.1 TOPOGRAPHY, GEOLOGY, AND SOILS

For topography, geology and soils, the Region of Influence (ROI) is the project footprint itself, including connected actions such as the raw water pipeline, terminal storage reservoir, and new treatment plant.

3.1.1 Topography and Geology

The proposed Lower Bois d'Arc Creek Reservoir as well as its connected actions are located primarily in Fannin County, Texas. Fannin County is 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 Action in the Blackland Prairies subprovince (Figure 3-1). 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.

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 about 86 feet and the elevation of the valley floor at the dam site is approximately 476 feet MSL. The confluence of tributary Honey Grove Creek, entering from the southeast, with Bois d'Arc Creek is located about 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 (Freese and Nichols, 2006).

The study area is located in the Gulf Coastal Plain physiographic province as mentioned above and is also within the Red River Basin. 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 late-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). The study area would not exceed the depth of the Ozan formation listed on Table 3-1.

In support of NTMWD's application to the TCEQ for a Texas Water Right, Freese and Nichols conducted preliminary subsurface investigations in 2006 and 2008 at the lower Bois d'Arc Creek reservoir site that consisted of six borings to depths of approximately 50-70 feet along the proposed dam alignment (Freese and Nichols, 2006; Bosecker, 2008) (Figure 3-2). Samples of rock and soils obtained in the field investigation were subjected to laboratory tests to help 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 run to help evaluate the strength of the bedrock.

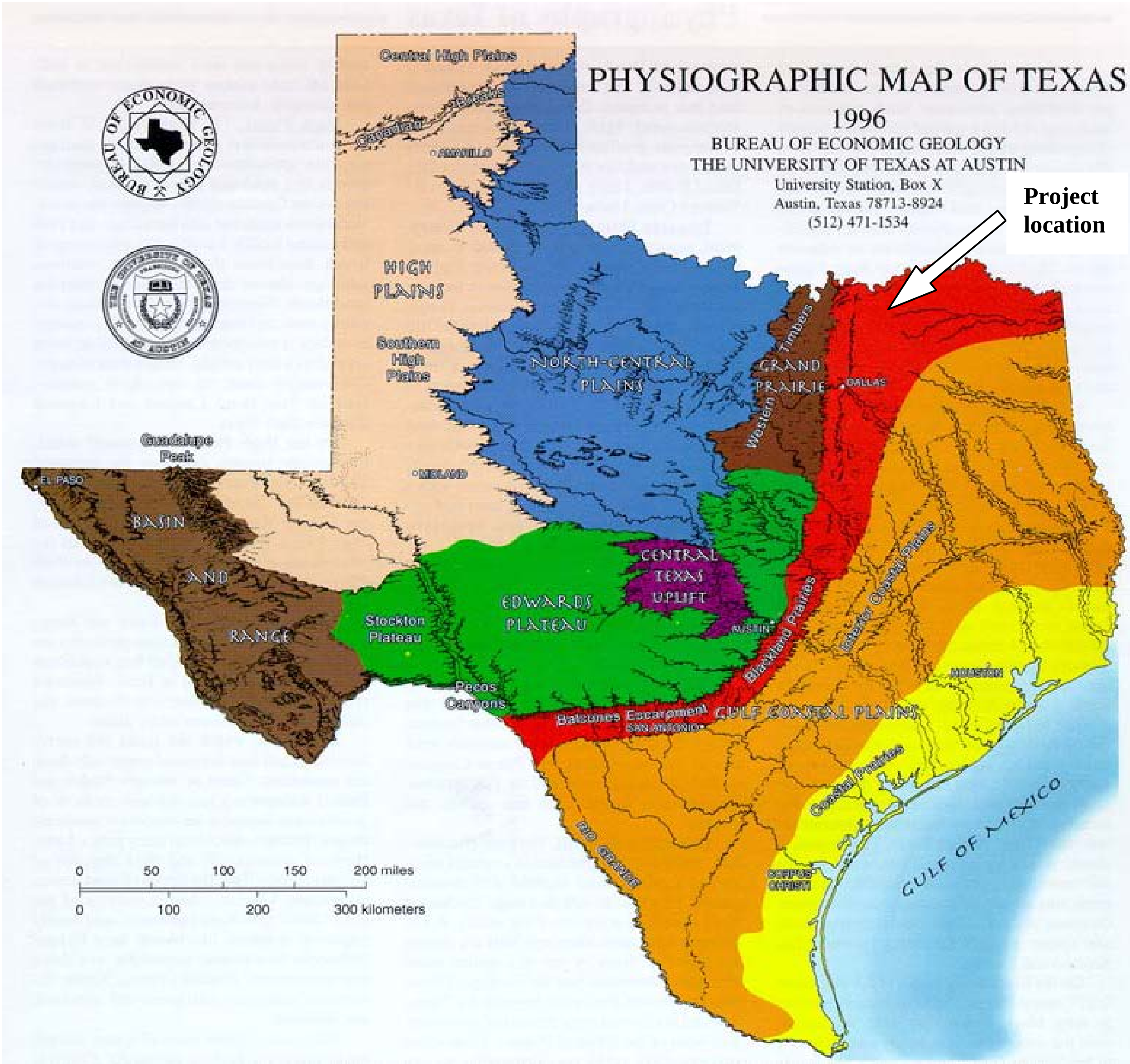


Figure 3-1. Physiographic map of Texas

According to the Texarkana Sheet of the *Geological Atlas of Texas*, the east abutment of the dam is underlain by Pleistocene-age Qt (Quaternary – a geologic period) 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.

They 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. Their maximum thickness is 30 feet, with their top surface about 11 feet above the floodplain (Figure 3-3).

Table 3-1. Geologic units at the Lower Bois d'Arc Creek Reservoir site

Age	Unit	Thickness (ft)	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

The Fluviatile terrace deposits are underlain by the Bonham Formation (Ozan Formation in Table 3-1) 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. It is waxy, greenish gray and weathers yellowish gray. It has a clay bed near the middle, is calcareous, and abundantly glauconitic. Marine megafossils (large fossils) are common. Its thickness ranges from 375 to 530 feet (Bosecker, 2008).

Borings associated with the preliminary subsurface investigation indicated that the west abutment of the proposed dam site consists of 50-60 feet of very stiff to hard plastic clays underlain by about 10 feet of clayey sands and sands. Beneath the sands lies unweathered shale of low permeability. The lower slope of the west 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 appears that medium plastic clays to highly plastic clays for the dam core may be available in sufficient quantities from the reservoir areas within the floodplain and at the west abutment. Additional 2008 boring in the floodplain (Boring D-5) 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 dam core and

Figure 3-2. Location of geotechnical borings at proposed LBCR dam site

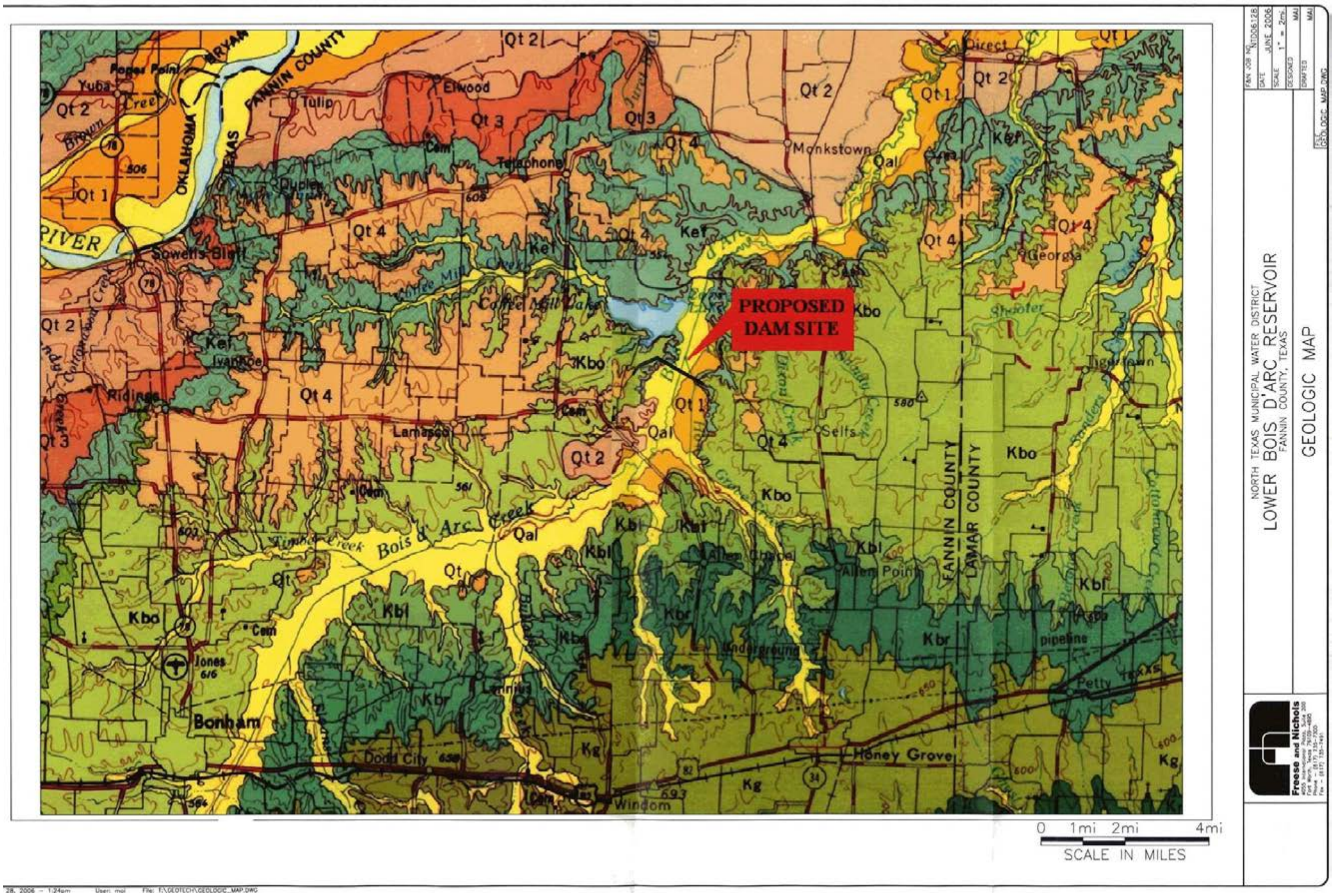


Figure 3-3. Geologic map depicting surficial geology of the LBCR site

Source: Geotechnical Investigation, Appendix C, Texas Water Rights Application (Freese and Nichols, 2006) outer zones of the dam from the reservoir areas within the floodplain and the abutments. However, further engineering tests would be necessary to confirm that the clays present are indeed suitable for use in the dam's core. Silty sand may be available in the lower slope of the west abutment for soil cement to protect the upstream slope of the dam. Additional borings and test pits will be required in the reservoir areas to identify potential borrow areas.

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 (Freese and Nichols, 2006; Bosecker, 2008).

In 2014 the final geotechnical study was conducted in support of the 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 (Miller and Bosecker, 2015).

The 2014 final geotechnical study confirmed that the dam site is covered with alluvial/fluvial terrace deposits that overlie bedrock of the Ector Chalk and Bonham Clay formations (both of the Austin Group). The alluvial/fluvial deposits are primarily fat clays, with some lean clays and clayey sands, while the rocks 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 developed for the 2006 preliminary study. The 2014 study has not unearthed any geotechnical issues that would impede the proposed reservoir development (Miller and Bosecker, 2015).

3.1.2 Soils

3.1.2.1 <u>Proposed Lower Bois d'Arc Creek Reservoir Site</u>

Soil texture is determined by the proportions of different-sized particles – sand, silt, and clay – found in a particular soil sample (Figure 3-4). The soils in the study area include many clays and various loam combinations (Figure 3-5). 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 lower Bois d'Arc Creek on the south side of the proposed reservoir is a long strip of the Frioton silty clay loam. This profile, 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 Lower Bois d'Arc 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 commonly is 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).

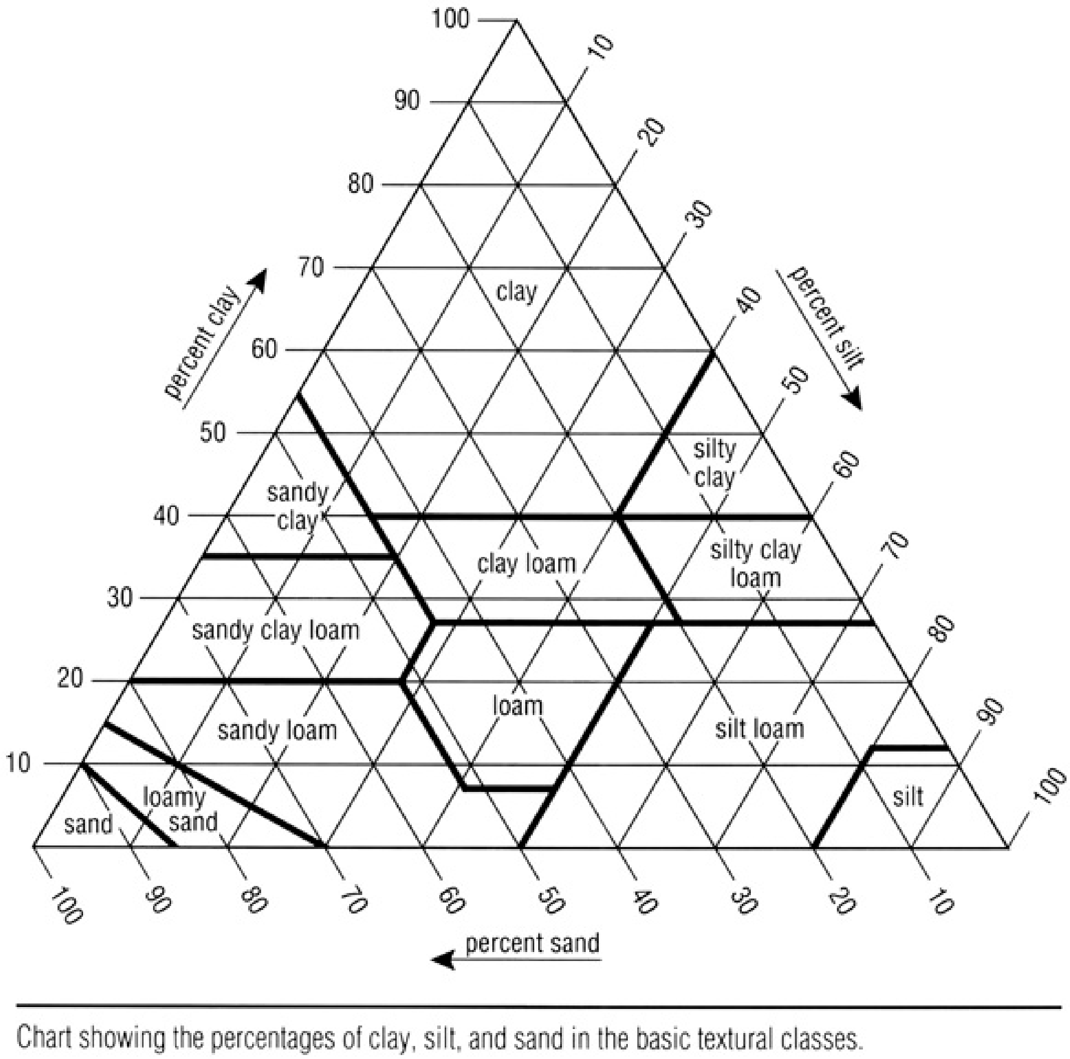


Figure 3-4. Diagram depicting soil textural classes
Source: NRCS, no date

In the preliminary geotechnical investigation, Borings D-5, D-6, and D-7 encountered the 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).

Borings D-5 and D-6 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 and 24.2 feet below ground surface (bgs), and were underlain by weathered shale. Boring D-7 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 (Bosecker, 2008).

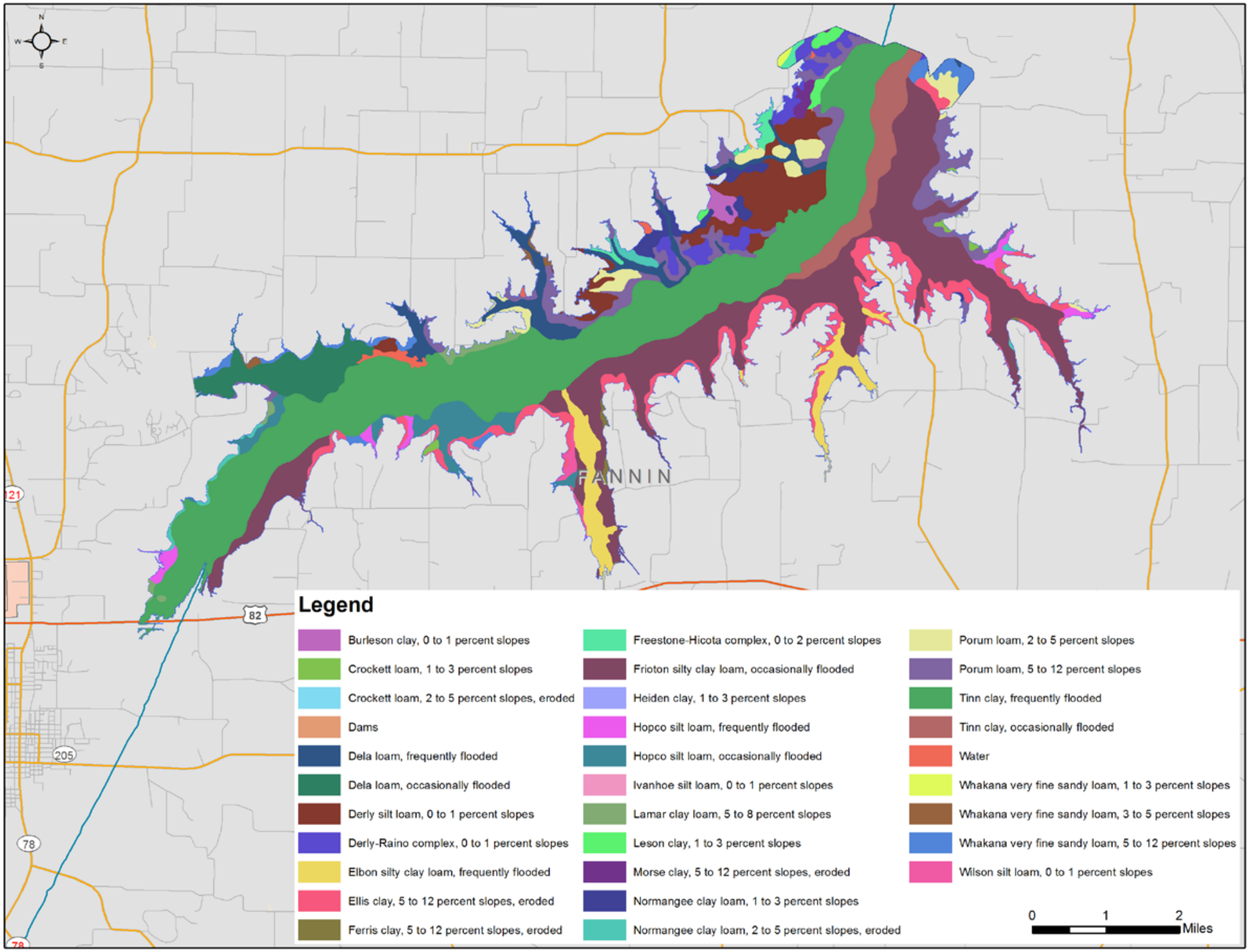


Figure 3-5. Soil types within proposed reservoir footprint

Moisture contents for the sandy soils ranged from 3 to 19 percent with the lower moisture contents encountered near the ground surface. Moisture contents 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 east abutment 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 available for use in the embankment (Freese and Nichols, 2006).

3.1.2.2 Proposed Raw Water Pipeline Route, WTP, and TSR

The soils found along the proposed raw water pipeline route from the LBCR to the proposed new water treatment plant near Leonard, as well as at the site of proposed WTP itself, and the adjacent TSR, mainly fall 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

These units are shown in 35 detailed maps included in a supplemental report by Freese and Nichols (2013). The major soil groups along the pipeline route and at the site of the WTP and TSR include the Fairlie-Delco complex (FdB), Houston Black clay (HoB), Howe-Whitewright complex (HwC).

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 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% (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% (NRCS, 2001).

The Howe-Whitewright complex soils are shallower than the previous two soil types discussed. Their depths 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%. 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 3-6, 3-7, and 3-8 illustrate the variety of soils found at this location.

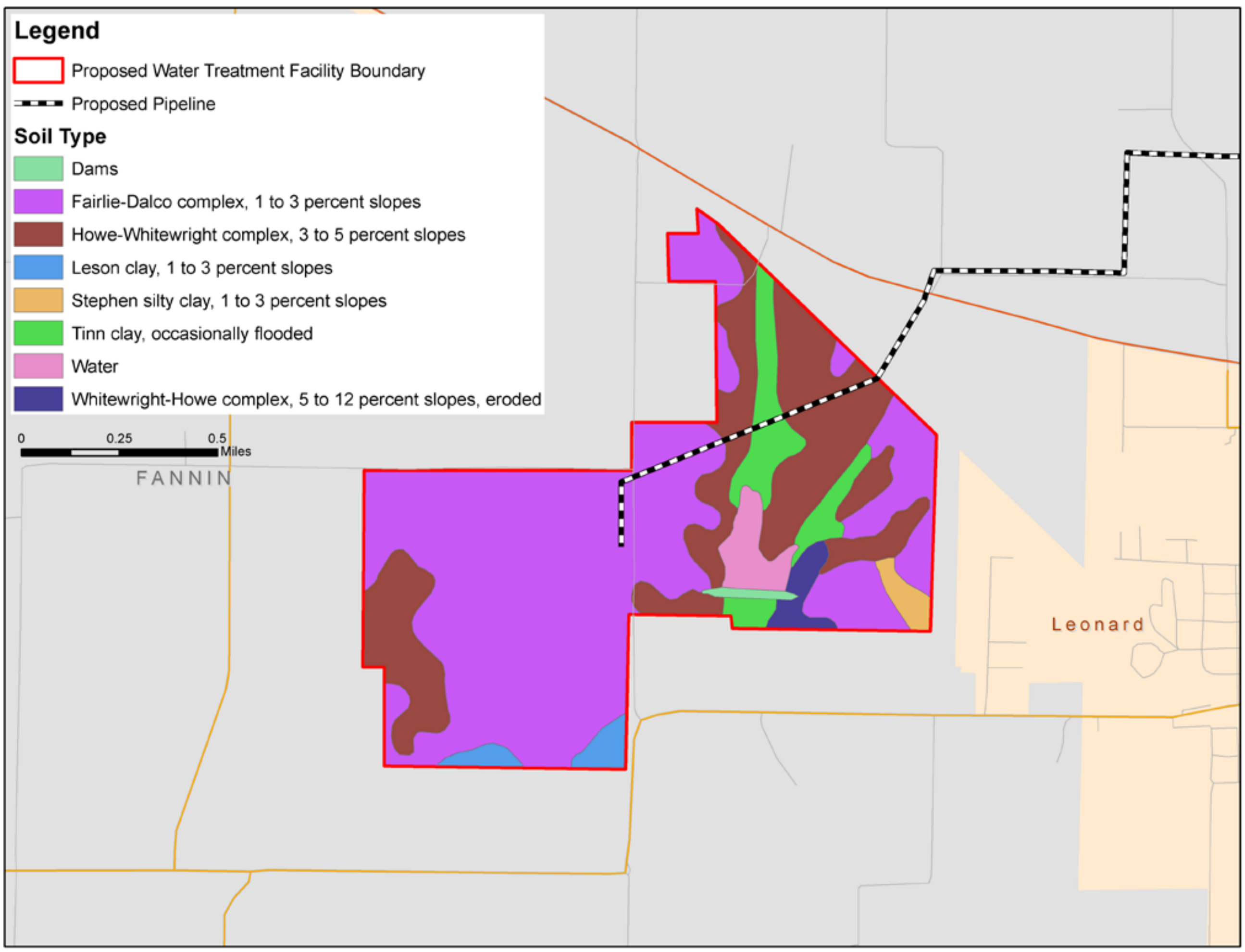


Figure 3-6. Location map of soils found at the proposed site of the new WTP and TSR

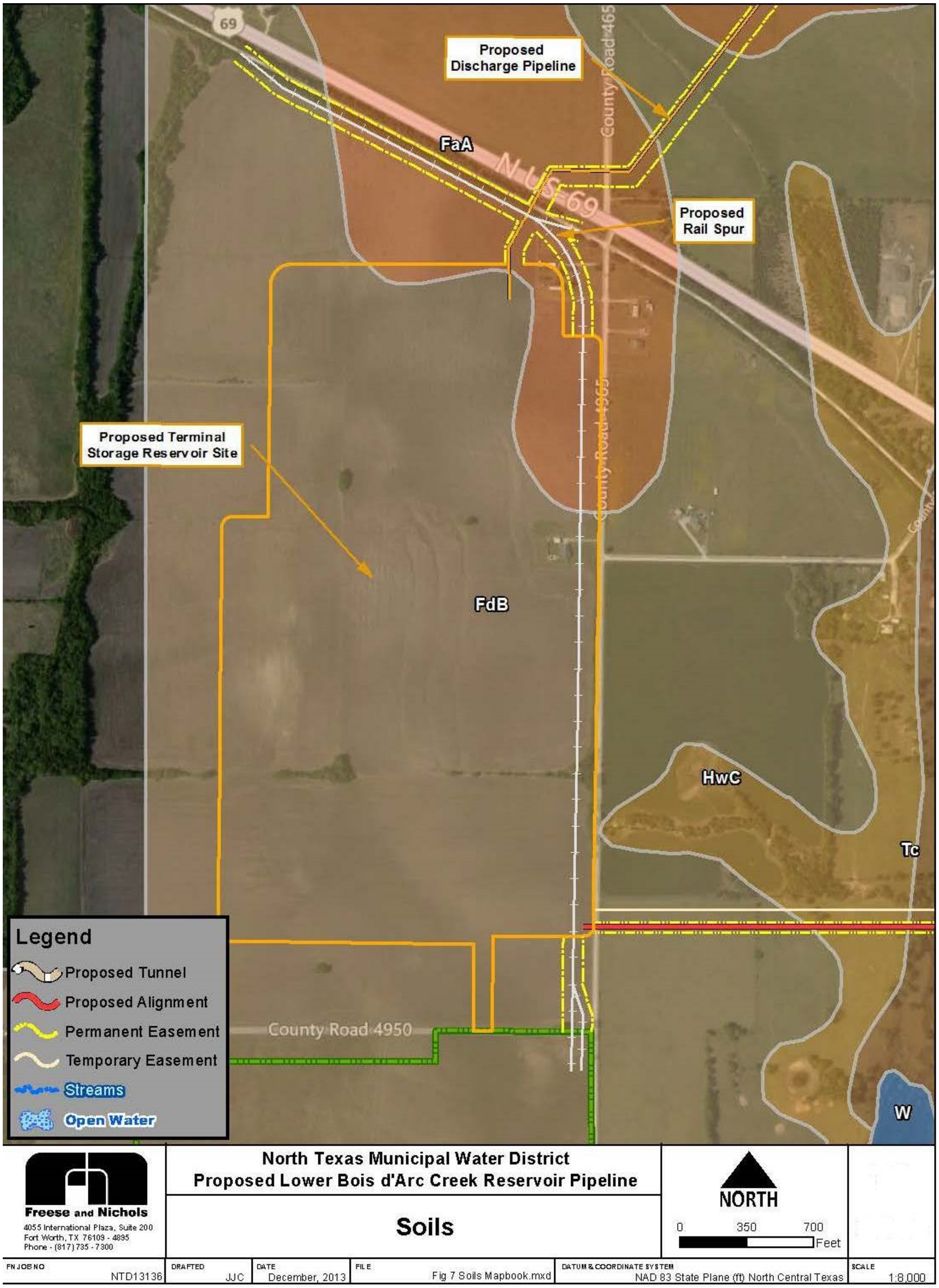


Figure 3-7. Vicinity map of soils found at the site of the proposed TSR site

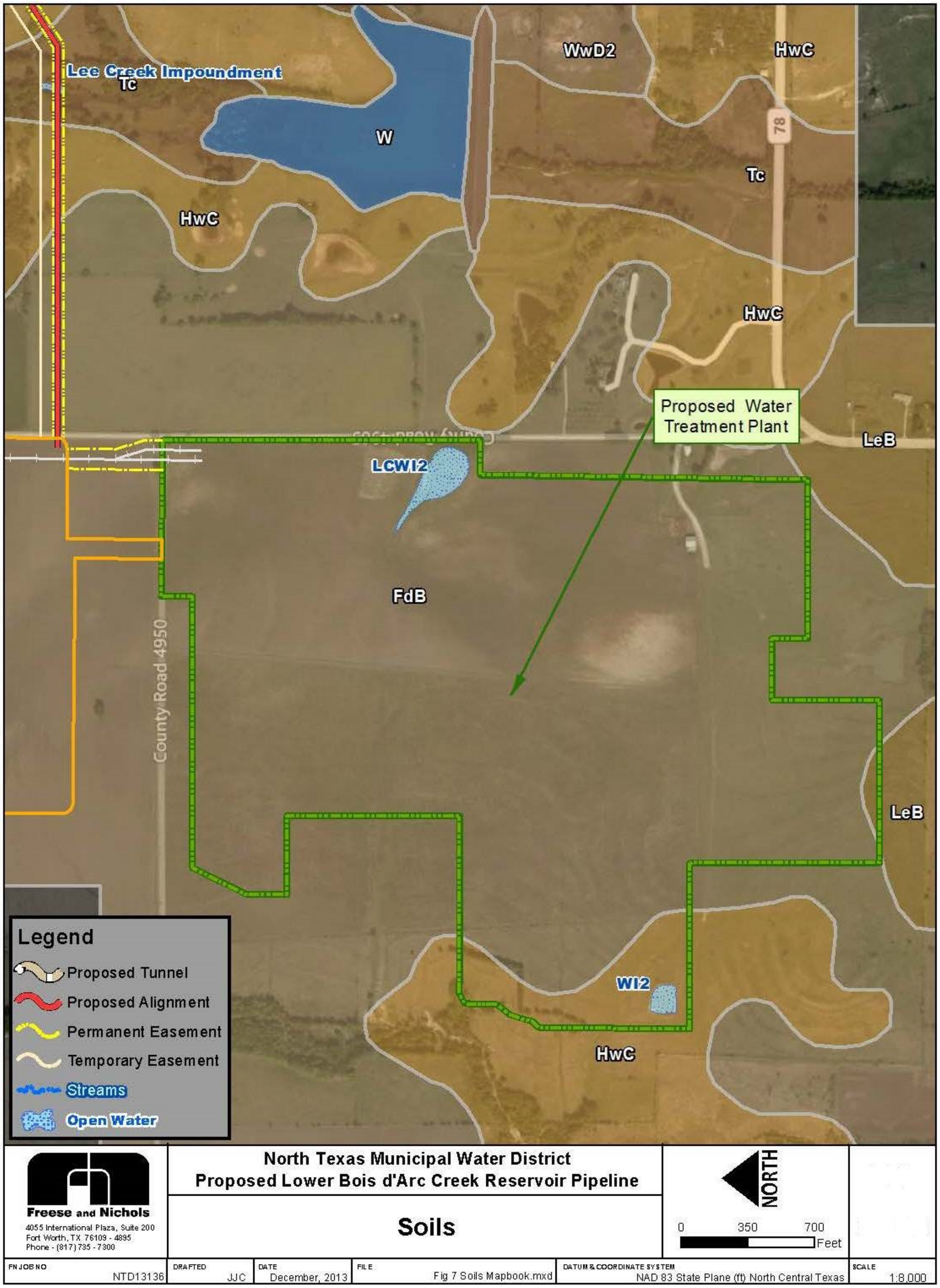


Figure 3-8. Vicinity map of soils found at the site of the proposed new WTP site

3.1.3 Prime Farmland

Within the proposed reservoir, pipeline, and water treatment facility sites, there are 13 soils listed as Prime Farmland. Prime Farmland is defined by the United States Department of Agriculture (USDA) in section 622.04 of the National Cooperative Soil Survey (NCSS) Standards publication as:

"… land that has the best combination of physical and chemical characteristics for producing food, feed forage, fiber, and oilseed crops and that is available for these uses" (NRCS, 2001).

Important characteristics of Prime Farmland include the right combination of soil properties, growing season, and water supply. The soils should be permeable to both air and water and should not be flooded during the growing season. In addition to soil properties, these additional criteria are necessary for designation as Prime Farmland (NRCS, no date):

- Land use
- Frequency of flooding
- Irrigation
- Water table
- Wind erodibility

The 13 soils at the site of the Proposed Action 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.

Consultation was conducted with the Fannin County Office of the USDA Natural Resources Conservation Service concerning application of the standard nationwide Farmland Conversion Impact Rating Form to the LBCR site. The results are shown in Chapter 4, Figure 4-2.

3.2 WATER RESOURCES

This section summarizes the hydrologic setting and examines the existing water resources and wetlands that may potentially be affected by the construction and operation of the proposed Lower Bois d'Arc Creek Reservoir. The water resources and wetlands located in the study area are described according to their type, condition, human use, and function. This section is further subdivided into discussions of surface water supply and quality, including waters of the U.S. and wetlands, fluvial geomorphology, and groundwater. The primary ROI for water resources is the Bois d'Arc Creek watershed.

Freese and Nichols has prepared multiple LBCR planning documents, including a Report Supporting an Application for a Texas Water Right for the proposed reservoir (Freese and Nichols, 2006), Environmental Report Supporting an Application for a USACE 404 Permit (Freese and Nichols, 2008a) and the associated 404 Permit Application (Freese and Nichols, 2008b), and the Bois d'Arc Creek Reservoir Instream Flow Study (Freese and Nichols, 2010a).

The Report Supporting the Application for a Texas Water Right includes in-depth surface water data statistical analyses for the Bois d'Arc Creek and nearby watersheds. The Environmental Report Supporting the 404 Permit Application includes discussions of the proposed action, alternatives, and potential impacts. The Instream Flow Study characterized baseline stream conditions within the proposed project area as well as downstream using USGS stream gage data and new data (Freese and Nichols, 2010a). The discussion that follows heavily relies upon the information provided in these reports.

3.2.1 Surface Water

Bois d'Arc Creek is a tributary of the Red River, and the proposed reservoir has a drainage area of 327 square miles (Freese and Nichols, 2008a). The Bois d'Arc Creek watershed has three existing reservoirs: Lake Bonham (which provides the water supply for the City of Bonham), Lake Crockett and Coffee Mill Lake (both recreation lakes) as shown in Figure 3-9. Figure 3-9 also shows the location of Bois d'Arc Creek and the USGS stream gages that are discussed below. Existing NTMWD surface water supplies are discussed in Section 1.5.4.

Bois d'Arc 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 (Freese and Nichols, 2008a). The creek is channelized within about 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 (Freese and Nichols, 2010a). This "flashiness" is evident in the historical flow data for Bois d'Arc Creek seen in Figure 3-10. 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.

During its preliminary studies related to the proposed action, FNI developed a more accurate delineation of the actual 100-year floodplain along Bois d'Arc Creek. The 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 then used to develop more than 100 cross-sections along 22 miles of Bois d'Arc Creek for the HEC-RAS model. FNI then conducted analyses of the 2-, 10-, 50-, 100-, and 500-year flood events. The 2-year and 100-year floodplains at the project site are shown on Figure 3-11. The 2-year floodplain covers approximately 43 percent of the proposed reservoir footprint, while the 100-year flood plain extends over 55 percent of the site (Freese and Nichols, 2008a).

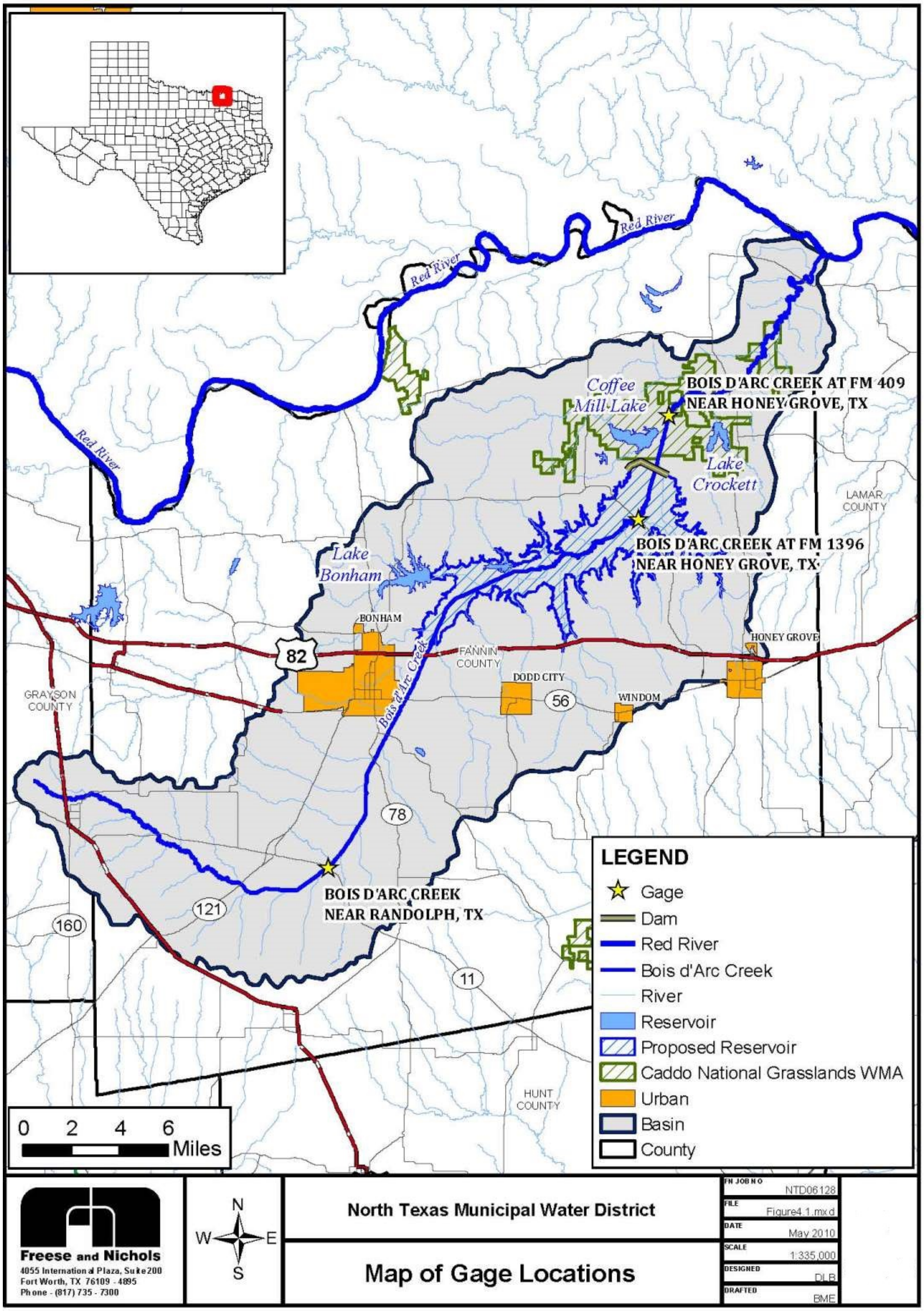


Figure 3-9. Stream gages within the Bois d'Arc Creek watershed

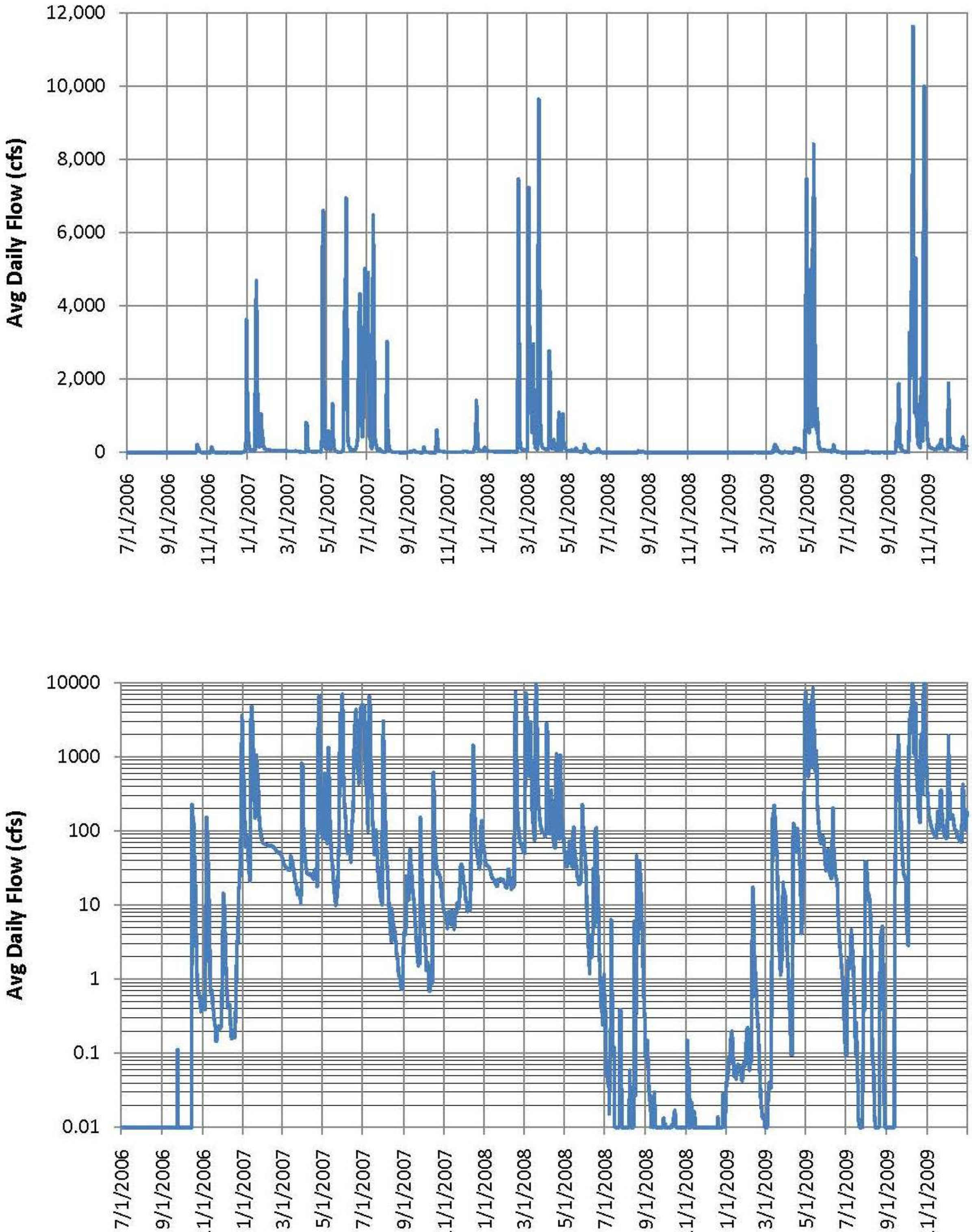


Figure 3-10. Historical flow data for USGS Gage 07332620 Bois d'Arc Creek at FM 1396
Source: Appendix B, Instream Flow Study, 2010

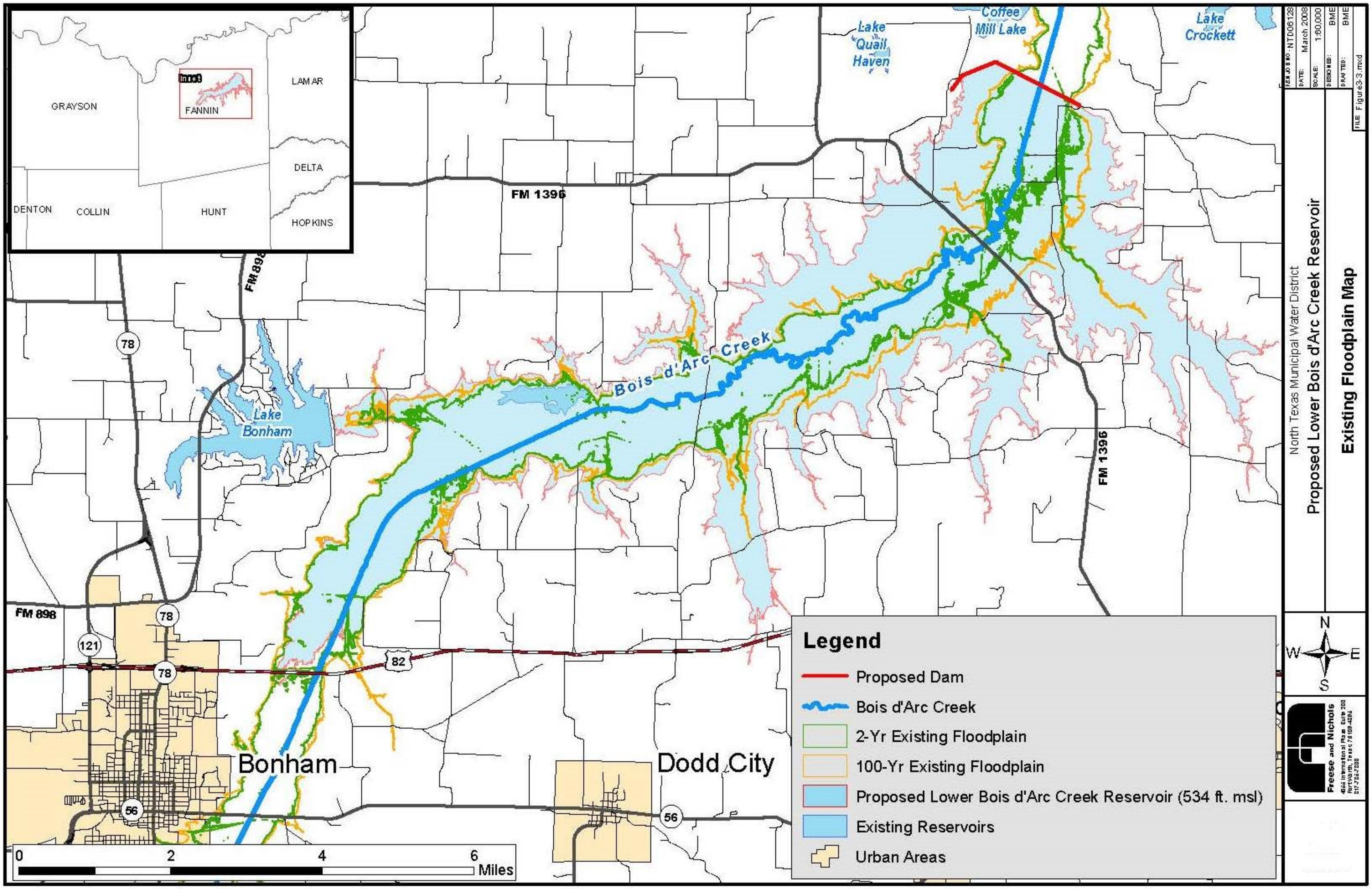


Figure 3-11. Existing floodplain along Bois d'Arc Creek in the project vicinity

There are three USGS stream gages located within the Bois d'Arc Creek watershed: (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 (Figure 3-9). All data that were available on the USGS web site for the three Bois d'Arc Creek gages were downloaded for tabulation and review and the analysis of the available Bois d'Arc Creek surface water gage data follows.

Bois d'Arc Creek near Randolph, Texas Data Analysis
Historical surface water flow data for the Bois d'Arc Creek watershed are available from the USGS Bois d'Arc near Randolph gage for December 1962 to September 1985, which recorded flows for a drainage area of 72 square miles (Freese and Nichols, 2008a). 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 since there are no water rights or significant return flows above this gage. Naturalized datasets are derived by backing out any human impacts to a watershed, such as surface water diversions and return flows. (Diversions are left in and return flows are left out of the naturalized dataset.)

Daily mean discharge data statistics were tabulated for the period of record for the Bois d'Arc Creek near Randolph, Texas gage, and are shown on Table 3-2. Flows of 0.12 cfs or less occurred at the Randolph gage about 25 percent of the time during the period of record.

Table 3-2. Bois d'Arc Creek near Randolph, Texas gage

Daily Mean Discharge Data Statistics December 1, 1962 to September 30, 1985										
	Daily Mean Discharge (cfs)					Percentile Flows (cfs)				
Month	Minimum	Median	Average	Maximum	Standard Deviation	Q_{10} [a]	Q_{25} [b]	Q_{50} [c]	Q_{75} [d]	Q_{90} [e]
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 [f]	0	4.6	55	10,600	328	0	0.12	4.6	19	55

Source: USGS, 2012
Note: Available flow data for 2012 is provisional and was not included in this analysis.
[a] Streamflow was below this value 10 percent of the time.
[b] Streamflow was below this value 25 percent of the time.
[c] Streamflow was below this value 50 percent of the time (same as median).
[d] Streamflow was below this value 75 percent of the time.
[e] Streamflow was below this value 90 percent of the time.
[f] Annual Statistics for January 1, 2007 to December 31, 2011.

Bois d'Arc Creek at FM 1396 near Honey Grove, Texas Data Analysis
The Bois d'Arc Creek at FM 1396 gage is located just above the proposed dam site and measures flow for a drainage area of 270 square miles, or approximately 83 percent of the proposed reservoir's watershed (Freese and Nichols, 2008a). The Instream Flow Study report includes data from July 2006 through September 2009 for the Bois d'Arc Creek at FM 1396 gage, as well as provisional data through December 2009 (Freese and Nichols, 2010a). The USGS has adjusted the rating curve for this gage (FM 1396) 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 data statistics have been tabulated for the Bois d'Arc Creek at FM 1396 gage for its period of record, as shown on Table 3-3. Flows of 0.07 cfs or less occurred at the FM1396 gage about 25 percent of the time during the past five years.

Table 3-3. Bois d'Arc Creek at FM 1396 near Honey Grove, Texas gage

Daily Mean Discharge Data Statistics July 1, 2006 to December 31, 2011										
	Daily Mean Discharge (cfs)					Percentile Flows (cfs)				
Month	Minimum	Median	Average	Maximum	Standard Deviation	Q_{10} [a]	Q_{25} [b]	Q_{50} [c]	Q_{75} [d]	Q_{90} [e]
January	0.04	23	238	7,030	875	0.06	11	23	84	230
February	0.01	33	320	8,240	1,108	0.10	8.2	33	79	536
March	0	35	383	9,640	1,253	1.1	4.6	35	148	576
April	0.10	43	259	6,600	904	1.0	24	43	94	306
May	4.4	69	688	8,420	1,615	13	27	69	259	2,684
June	0	4.8	269	5,030	897	0.06	0.52	4.8	48	374
July	0	0.07	171	6,480	786	0	0	0.07	5.0	92
August	0	0	27	3,030	233	0	0	0	1.7	14
September	0	0.01	47	1,880	198	0	0	0.01	11	50
October	0	0.10	441	11,600	1,526	0	0	0.10	14	719
November	0	0.40	26	321	55	0	0	0.40	21	93
December	0	8.4	99	3,630	372	0	0.47	8.4	66	145
Annual [f]	0	11	257	11,600	995	0	0.07	11	69	308

Source: USGS, 2012
Note: Available flow data for 2012 is provisional and was not included in this analysis.
[a] Streamflow was below this value 10 percent of the time.
[b] Streamflow was below this value 25 percent of the time.
[c] Streamflow was below this value 50 percent of the time (same as median).
[d] Streamflow was below this value 75 percent of the time.
[e] Streamflow was below this value 90 percent of the time.
[f] Annual Statistics for January 1, 2007 to December 31, 2011.

Bois d'Arc Creek at FM 409 near Honey Grove, Texas Data Analysis
The Bois d'Arc Creek at FM 409 gage is located just downstream of the proposed dam site, and measures a drainage area of 370 square miles (Freese and Nichols, 2010a). Provisional data for the FM 409 gage are included in the Instream Flow Study report for September through December 2009. The USGS has

adjusted the rating curve for this gage (FM 409) several times due to horizontal and vertical changes in the channel bed since its installation, just as it has with the gage at FM 1396, which once again, is an indicator of the dynamic nature of the stream channel at this site, namely that it is undergoing rapid erosion and deposition.

Daily mean discharge data statistics have been tabulated for the Bois d'Arc Creek at FM 409 gage for its period of record, as shown on Table 3-4. Flows of 0.14 cfs or less occurred at the FM 409 gage about 25 percent of the time during the past 2 years.

Table 3-4. Bois d'Arc Creek at FM 409 near Honey Grove, Texas gage

Daily Mean Discharge Data Statistics
June 4, 2009 to December 31, 2011

	Daily Mean Discharge (cfs)					Percentile Flows (cfs)				
Month	Minimum	Median	Average	Maximum	Standard Deviation	Q_{10}[a]	Q_{25}[b]	Q_{50}[c]	Q_{75}[d]	Q_{90}[e]
January	6.6	67	284	6,440	1,051	9.8	12	67	109	158
February	7.2	108	600	8,170	1,378	10	13	108	514	1,165
March	1.6	61	155	943	225	3.7	6.1	61	193	382
April	2.2	57	69	618	93	3.3	8.8	57	83	104
May	14	63	562	7,410	1,431	23	35	63	222	976
June	0.25	2.5	12	329	37	0.54	1.1	2.5	14	25
July	0	0.53	6.3	142	20	0.05	0.13	0.53	2.7	7.9
August	0	0	1.7	56	7.0	0	0	0	0.16	1.7
September	0	0.02	110	2,270	358	0	0	0.02	12	196
October	0	0.11	859	12,400	2,041	0	0	0.11	266	3,488
November	0	3.4	48	358	73	0	0.68	3.4	84	124
December	0.70	34	97	1,620	202	1.8	2.1	34	98	229
Annual[f]	0	4.2	143	8,170	676	0	0.14	4.2	51	186

Source: USGS, 2012
Note: Available flow data for 2012 is provisional and was not included in this analysis.
[a] Streamflow was below this value 10 percent of the time.
[b] Streamflow was below this value 25 percent of the time.
[c] Streamflow was below this value 50 percent of the time (same as median).
[d] Streamflow was below this value 75 percent of the time.
[e] Streamflow was below this value 90 percent of the time.
[f] Annual Statistics for January 1, 2010 to December 31, 2011.

Instream Flow Study Measurements

As part of the Instream Flow 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 (CADSWES), a division of the University of Colorado at Boulder (Freese and Nichols, 2010a). The Bois d'Arc Creek model was used to characterize the existing baseline conditions of the watershed as well as to assess future conditions with the 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 TCEQ Red River Basin Water Availability Model (TCEQ WAM). 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 collected data in May, June, and July 2009 from locations along the mainstem of the Bois d'Arc Creek, above and below the proposed reservoir site at Highway 82, CR 2645, FM 1396, FM 409, and on USFS property located downstream of FM 100 (Freese and Nichols, 2010a). 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 sampling sites. Table 3-5 presents the field stream measurements collected at FM 1306 and FM 409 during the 2009 sampling events.

Table 3-5. Instream flow study measured streamflows

FM 1396 gage location				FM 409 gage location			
Date	Transect	Discharge (cfs)	Elevation (feet)	Date	Transect	Discharge (cfs)	Elevation (feet)
5/05/2009	1	530	474.2	5/05/2009	1	756	464
5/12/2009	1	7,595	488.25	5/12/2009	1	6,072	477.8
5/15/2009	1	848	476.6	5/15/2009	3	902	465.5
5/15/2009	6	755	476.1	5/15/2009	1	953	468.8
5/21/2009	6	114	472.85	5/21/2009	no data collected		
6/09/2009	2	21.51	471.3	6/09/2009	1	23.44	456.2
7/07/2009	2	1.7	470.3	7/07/2009	1	2.19	454.6

Source: Freese and Nichols, 2010a

For the Bois d'Arc Creek at FM 1396 gage, the maximum, average, and median daily mean discharge values measured by the USGS gage for May over the period of record were 8,420, 688, and 69 cfs, respectively. The May transect measurements measured one high flow event and four discharge measurements that were between the 50th and 90th percentile of daily mean flow for the May period of record. The average and median daily mean discharge value measured by the USGS gage for June over the period of record were 269 and 4.8 cfs, respectively. The June transect measurement falls in between these values. The median daily mean discharge value measured by the USGS gage for July over the period of record was 0.07 cfs, which is slightly below the July transect measurement. The daily mean discharge statistics for this gage are shown in Table 3-3.

For the Bois d'Arc Creek at FM 409 gage, the four May transect measurements are between the average and maximum daily mean discharge values for May (562 and 7,410 cfs, respectively), and are likely all high flow events. The June transect measurement is similar to the 90th percentile daily mean discharge value for June (25 cfs), and the July transect measurement is a little less than the 75th percentile daily mean discharge value for July (2.7 cfs). The daily mean discharge statistics for this gage are shown in Table 3-4, although it should be noted that the period of record for this gage is only a few years and these statistics may not capture an accurate flow range over a longer time period.

3.2.1.1 Surface Water Quality

Bois d'Arc Creek is categorized as a perennial stream with a high aquatic life use designation from its confluence with the Red River upstream to its confluence with Sandy Creek, which is located within the proposed reservoir site. The creek is categorized as perennial with an intermediate aquatic life use designation from the Sandy Creek confluence upstream to the confluence with Pace Creek, which is located upstream of the reservoir site (Freese and Nichols, 2010a).

TCEQ has adopted Texas Surface Water Quality Standards in order to protect the quality of the State's water, and these standards outline both general and site-specific criteria (TCEQ, 2010). The Bois d'Arc Creek is not a classified stream segment as defined in Appendix A of the 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, located upstream of the proposed reservoir site (TCEQ, 2010). In the absence of site specific standards, water quality standards for the segment downstream from where the stream is located apply; the site specific criteria outlined in Appendix A for the Red River below Lake Texoma segment apply to Bois d'Arc Creek (TCEQ, 2010). 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, 2010).

TCEQ surface water quality standards that are applicable to Bois d'Arc Creek are summarized in Table 3-6. 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, 2010). Criteria for specific toxic materials for the protection of aquatic life and human health have not been included in this table, but are listed within Tables 1 and 2 of the full water quality standards (TCEQ, 2010).

Table 3-6. Applicable water quality standards for Bois d'Arc Creek

Site-specific uses and criteria for classified segments (mg/L) [a, b]	
Chloride	375
Sulfate	250
Total dissolved solids	1,100
Dissolved oxygen	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 (mg/L) [c]	
Dissolved oxygen	4.0

Source: TCEQ, 2010
[a] = Applicable site-specific criteria are for the Red River below Lake Texoma segment
[b] = Units are mg/L unless otherwise specified
[c] = Applicable unclassified water body standard is for lower Bois d'Arc Creek between the Sandy Creek and Pace Creek confluences (located upstream of the proposed reservoir)

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 NTMWD's report supporting an application for a Texas water right for the Lower Bois d'Arc Creek Reservoir (Freese and Nichols, 2006). A summary of these data is provided in Table 3-7. Average concentrations ranged 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 in these samples (Freese and Nichols, 2006).

Water quality samples have been collected at a total of seven sites on Bois d'Arc Creek, 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). The seven sites sampled for water quality on Bois d'Arc Creek include: FM 78, FM 1396, FM 409, U.S. 82, FM 100, CR 2645, and USFS. These water quality sampling sites are shown on Figure 3-12.

Table 3-7. Red River Basin water quality data, 1996-2006

Sampling Location	Average concentration (mg/L)		
	Chloride (375)[a]	Sulfate (250)[a]	Total dissolved solids (1,100)[a]
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
Lake Crook (1977-1994)	7	15	150

Source: Freese and Nichols, 2006; NA = no data available
[a] Water quality criteria for the Red River below Lake Texoma segment

To date, Bois d'Arc Creek water quality sampling has included:

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

Table 3-8 provides a summary of the water quality data collected for the proposed reservoir project along with the applicable water quality criteria. Water quality data collected during the Instream Flow Study and from other sources (i.e., USGS, TCEQ, RRA) indicates both that Bois d'Arc Creek meets its High Aquatic Use classification and that water quality is not a limiting factor for aquatic life (Freese and Nichols, 2010a).

3.2.1.2 Fluvial Geomorphology

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 (Freese and Nichols, 2010a). 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 stream, and found 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 (Freese and Nichols, 2010a).

Bois d'Arc Creek has been identified as a highly channelized stream system (about 62 percent of the stream channel), which has contributed to sudden high flow events and reduced base flow, erosion of the stream bed and bank areas, and a deficiency in habitat diversity. The Instream Flow Study (Freese and Nichols, 2010a) found that flows of less than 1 cfs could transport fine sediments and that gravel would be transported starting at 25 cfs. The hydrologic and geomorphic analyses conducted in that study also

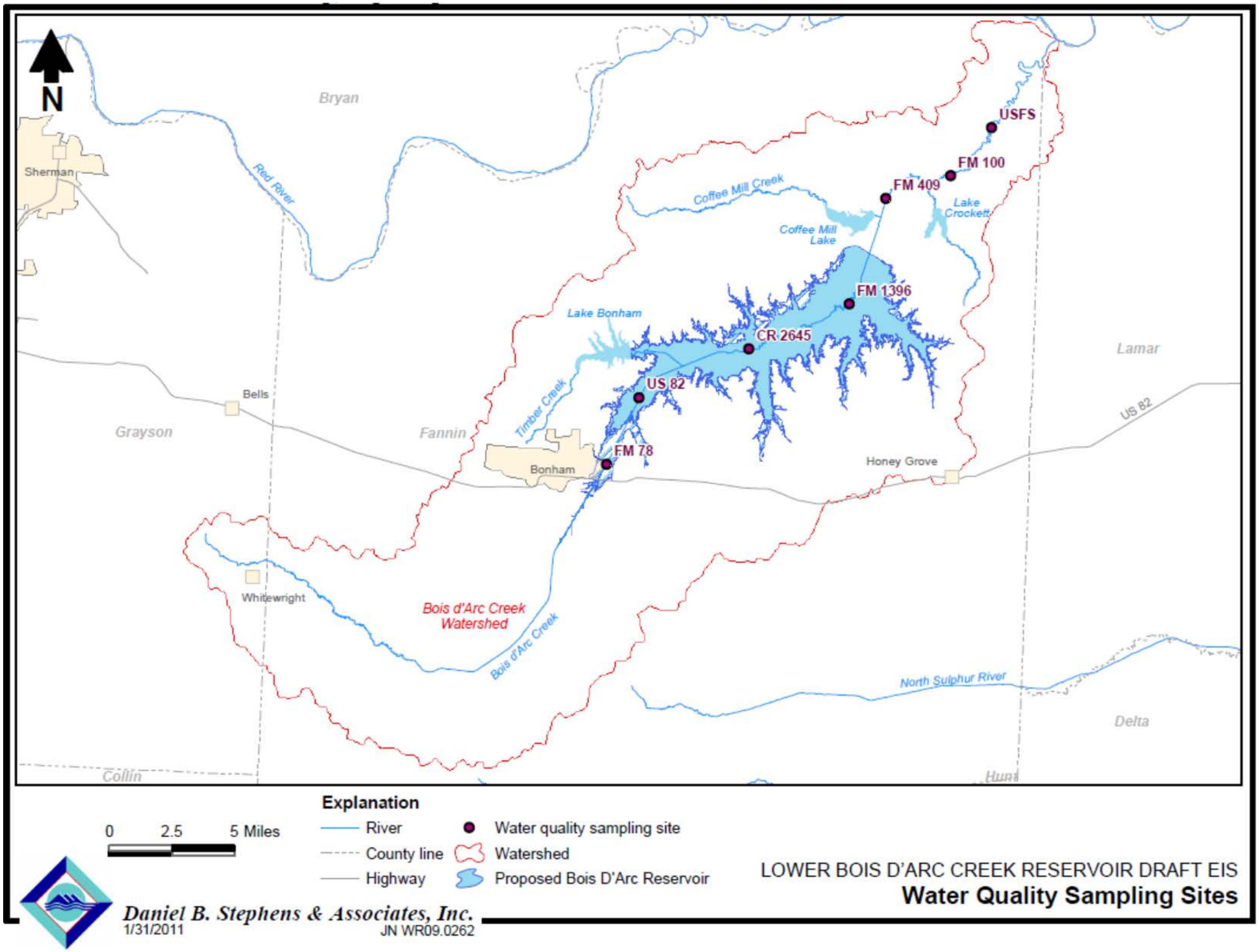


Figure 3-12. Water quality sampling sites along lower Bois d'Arc Creek

demonstrated that Bois d'Arc Creek was in disequilibrium with increased downcutting and erosion and decreased lateral migration or meandering, and stream conditions were considered generally poor (Freese and Nichols, 2010b).

Table 3-8. 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
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 total dissolved solids (mg/L)	1,100	---	142 to 390	---	150 to 346	158 to 526	343	---

Sources: Freese and Nichols, 2006 and 2010a; TCEQ, 2010.
NS = No criterion
[a] Flow for 7/2009 water quality data only

In 2008, FNI conducted a Rapid Geomorphic Assessment (RGA) 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 (Freese and Nichols, 2008d). An RGA is similar to Step 1 of a Texas Instream Flow Study. The 2008 RGA is included in the Administrative Record of this EIS.

Alterations of the natural stream channel on Bois d'Arc Creek began prior to 1915, and over the past century, substantial portions of it have been channelized. Archival aerial photographs show that channelization within the Bois d'Arc Creek system continued all the way into the 1970's. 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 a function of determining if the channel is in dynamic equilibrium or if the sediment supply and stream power are still 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 (Freese and Nichols, 2008d). 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.

A five-stage Incised Channel Evolution Model (ICEM) describes the evolution of a channelized stream or river and was used in the RGA to describe the conditions of the Bois d'Arc Creek system. The changes in channel geometry resulting from channelization extend upstream and downstream from the modified reach as the stream system works to re-establish dynamic equilibrium. Channelization can also impact tributaries of the channelized watercourse that are forced to adjust through down cutting and erosion to re-acquire equilibrium (Freese and Nichols, 2008d).

Figure 3-13 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 (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 (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 (Freese and Nichols, 2008d). 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 RGA classified each stream segment as "good," "fair," or "poor" pending 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, meanwhile, indicates a moderately stable channel reach, in which the sediment transport capacity is not in balance with the sediment supply.

The 2008 RGA classified 54 percent of Bois d'Arc Creek within the inundation pool of the proposed reservoir as "poor" with the remainder 46 percent being classified as "fair." Eighty-six percent of Honey Grove Creek within the inundation pool was classified as "fair" with the remainder being classified as "good" (8%) or "poor" (6%). Ward Creek was classified mostly as "fair" (84%) with the remaining 16 percent being classified as "poor." Majorities of Bullard Creek (82%) and Sandy Creek (83%) were classified as "poor" with the remainder of 18 and 17 percent as "fair," respectively.

The Instream Flow Study looked at planform stability and inferred lateral migration rates by analyzing historical photographs of Bois d'Arc Creek and found that the banks of Bois d'Arc Creek were actively eroding and channel widening was occurring as a result, with limited meander development

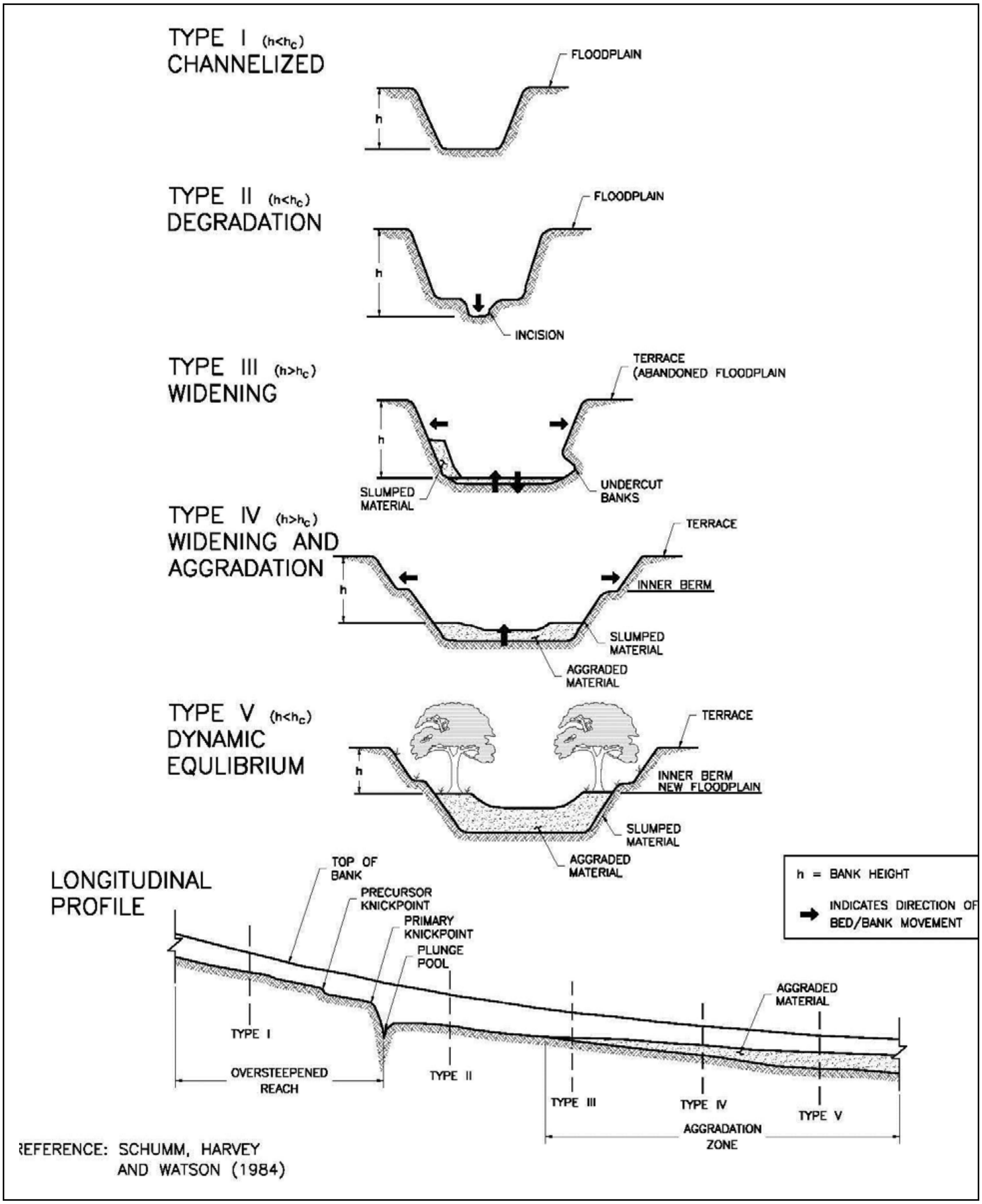


Figure 3-13. Incised channel evolution process
Source: Figure 3-1 in Freese and Nichols, 2008d

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 (Freese and Nichols, 2010b). Abandoned channels or artificial oxbows have been created from the channel straightening and bank loss was estimated at 0.5 feet 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 (Freese and Nichols, 2010a).

3.2.1.3 Waters of the United States, Including Wetlands, on the LBCR Site

A Section 404 jurisdictional determination was performed for the proposed project area, in order to identify the waters of the United States that would be impacted by the proposed Lower Bois d'Arc Creek Reservoir project. The site visits that the jurisdictional determination was based on were conducted between February 2007 and January 2008 (Freese and Nichols, 2008a). Freese and Nichols used the USACE *1987 Wetlands Delineation Manual* procedures using baselines that were located along the southern end of the project area at the proposed normal pool elevation of 534 feet MSL, mapping transects perpendicular to the baselines spaced approximately 0.5 mile apart. A total of 30 transects were mapped, and data were also collected at stream crossings (Freese and Nichols, 2008a).

FNI's wetland delineations and waters delineations were reviewed in the field by the USACE on October 21 and 22, 2008. USACE spot checked but did not confirm 100 percent of sites, and was mainly focused on FNI's practices and conclusions. Delineations and jurisdictional determination were confirmed as correct procedurally and had appropriate conclusions.

Additional information including USGS 7.5 minute topographic maps, two foot contour aerial light detection and ranging (LiDAR) survey maps, USFWS National Wetlands Inventory maps, USGS National Hydrography Datasets, NRCS Soil Survey Geographic Database (SSURGO) information, and 2007 digital color infrared imagery was used (Freese and Nichols, 2008a).

The jurisdictional determination concluded that potential waters of the United States do exist within the proposed project area, including 5,874 acres of wetlands, 219 acres of streams, and 87 acres of open water, and that these waters of the United States are subject to USACE jurisdiction under Section 404 of the Clean Water Act (Freese and Nichols, 2008a). Figure 3-14 depicts the boundary of jurisdictional wetlands as well as streams and open waters within the reservoir footprint.

On December 24, 2002, the U.S. Army Corps of Engineers issued Regulatory Guidance Letter (RGL) No. 02-2. This RGL clarified and supported the national policy for "no overall net loss" of wetlands and it reinforced USACE's commitment to protect waters of the U.S., including wetlands. Section 404 permittees must provide appropriate and practicable mitigation for authorized impacts to aquatic resources in accordance with relevant laws and regulations (USACE, 2002).

Texas State Law also has a goal to achieve "no net loss" of wetland functions and values with the development of any project that proposes to store, take, or divert state water in excess of 5,000 acre-feet per year, and defines wetland functions to include aquatic and wildlife habitat, water quality protection, storage for flood control, erosion control, and groundwater recharge. For any project with unavoidable wetlands loss, the impacts to wetlands must be mitigated with suitable mitigation habitat located within the same watershed and ecoregion, and replacement must be of equal or greater value to the affected

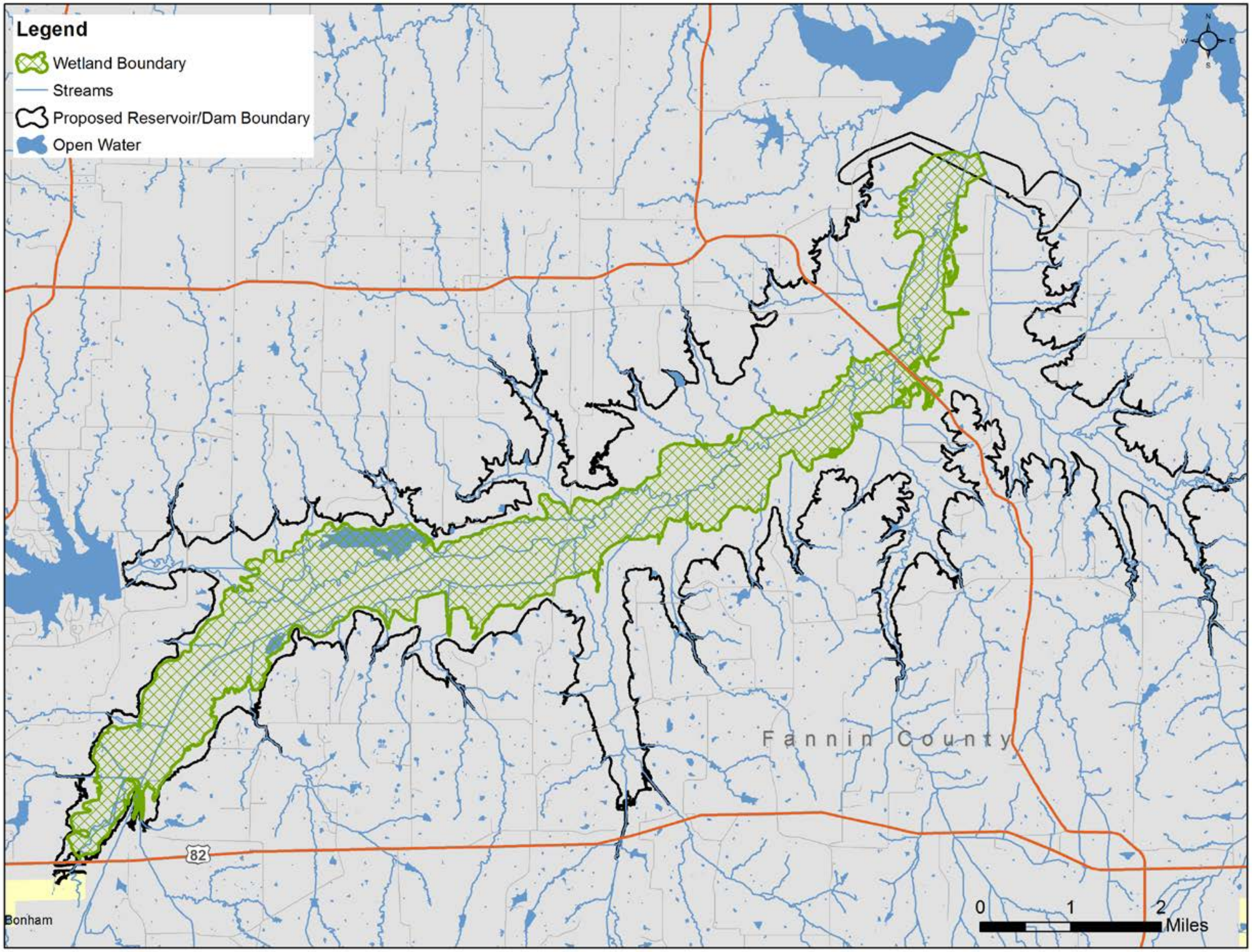


Figure 3-14. Existing jurisdictional waters and wetlands at LBCR site

habitat. Habitat mitigation plans and agreements must be ensured through binding legal contracts, and managed in perpetuity (Texas Administrative Code, Title 30, Chapter 297, Subchapter E, Rule §297.53).

Responding to a Congressional mandate, on April 10, 2008, EPA and USACE jointly issued the first federal regulation governing compensatory mitigation for impacts to wetlands and other aquatic resources. Although the 2008 Compensatory Mitigation Rule is largely focused on codifying requirements for compensatory mitigation, it also reiterates and codifies the sequencing steps of avoidance and minimization explained in the §404(b)(1) Guidelines and the 1990 Mitigation Memorandum of Agreement (MOA). The Rule is intended to improve the planning, management, and implementation of compensatory mitigation by creating higher standards for compensatory mitigation; it requires, to the extent practicable and appropriate, that all mitigation decisions be made within the context of a watershed approach (ELI, 2015). However, NTMWD's Section 404 permit application to the Tulsa District was submitted prior to the implementation of the 2008 Compensatory Mitigation Rule. Thus, it is not applicable to this evaluation.

Within the footprint of the proposed LBCR there are a total of 5,874 acres of jurisdictional wetlands and 87 acres of open water. In addition, there are approximately 123.3 miles of streams (Freese and Nichols, 2008a). The Lower Bois d'Arc Creek Reservoir Project Section 404 Permit Application lists the areas of the types of wetlands and waters, including stream areas and lengths, within the proposed reservoir's footprint. These are shown in Table 3-9.

Table 3-9. Wetlands and Waters of the United States within the LBCR footprint

Perennial streams	120 acres; 49.8 miles
Intermittent streams	99 acres; 73.5 miles
Open waters	87 acres
Forested wetlands	4,602 acres
Herbaceous wetlands	1,223 acres
Shrub wetlands	49 acres

An interagency functional valuation of the site's wetlands was conducted using the HEP methodology, mentioned in Chapter1 and described below under the Biological Resources section. The Tulsa District of the USACE supported the use of HEP in cooperation with other agency experts, and participated as a member of the interagency team that cooperatively carried out this study. Other federal and Texas state agency participants in the HEP study were EPA, USFS, USFWS, TCEQ, TPWD, and TWDB.

3.2.1.4 Waters of the U.S., Including Wetlands – Pipeline Route, WTP, and TSR

The proposed LBCR pipeline and associated transmission and treatment facilities would be located within three different river basins, including the Red, Sulphur, and Trinity Rivers. At the request of the USACE Tulsa District, in 2013 NTMWD instructed Freese and Nichols (FNI) to conduct surveys and a Preliminary Jurisdictional Determination (PJD) along the proposed raw water pipeline route connecting the proposed LBCR with the proposed North WTP near Leonard. The fieldwork and PJD were carried out in the summer and fall of 2013. Surveys and the PJD were also conducted at the proposed intake pump station near the proposed reservoir dam, the proposed electrical substation next to the pump station, the proposed 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 (Freese and Nichols, 2013).

A combined total of 875 acres were located within the PJD's limits of investigation (LOI) for all of the above-mentioned proposed facilities. For the purposes of the PJD, the LOI was limited to the footprint, including any temporary easements and grading limits needed for construction, of each project feature.

Following routine procedures outlined within the Corps of Engineers *1987 Wetlands Delineation Manual*, the 2010 *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (Version 2.0)*, and the *U.S. Army Corps of Engineers Jurisdictional Determination Form Instructional Guidebook*, the survey team identified streams within the LOI of the proposed actions by the presence or absence of an ordinary high water mark (OHWM). Streams were then classified as perennial, intermittent, or ephemeral based on observations made during the pedestrian surveys. The acreages of streams within the LOI were calculated by multiplying the OHWM width by their respective lengths within the LOI. Streams identified within the LOI of the proposed actions include one perennial relatively permanent water (RPW), seven intermittent RPW's, and 28 ephemeral RPW's .

Three streams identified within the LOI, including Honey Grove Creek, Fox Creek, and a tributary of Fox Creek were determined to be located within the footprint of the proposed LBCR. As such, these streams had already been accounted for within the individual Section 404 permit application (and related documents) for the proposed reservoir site. Further, during the design process for the proposed pipeline, it was determined that Ward, Bullard (Figure 3-15), and Honey Grove Creeks would be crossed by tunneling (Freese and Nichols, 2013).

Named streams within the LOI that would be crossed by the proposed pipeline include the South Sulphur River, Mustang Creek, Loring Creek (Figure 3-16), Allen Creek, Pot Creek, Bullard Creek, Burnett Creek, Spring Branch, Cottonwood Creek, Ward Creek, Allens Creek, Honey Grove Creek, and Fox Creek. No named streams were identified within the LOI of the WTP, rail spur, or TSR site. All streams identified within the LOI were considered to be ephemeral, intermittent, or perennial RPW's with an eventual downstream connection to a traditional navigable water (TNW), and thus all appear to be subject to USACE jurisdiction under Section 404 of the Clean Water Act.

In sum, the proposed raw water pipeline (Figure 2-8) would cross 39 waters of the U.S., including 36 streams (one perennial, seven intermittent, and 28 ephemeral), one on-channel impoundment, and two upland/off-channel stock ponds (Figure 3-17). No jurisdictional wetlands would be crossed by the proposed pipeline. All stream and open waters crossing would be carried out by open trench construction methods, except for the crossings of Ward, Bullard, and Honey Grove Creeks, which would be tunneled (Freese and Nichols, 2013).

No waters of the U.S. are located within the footprints of the proposed TSR, WTP, and railroad spur. These sites were selected because of their proximity to each other and because they are situated entirely on uplands, thus avoiding waters of the U.S., including wetlands. Likewise, the associated drainage pipeline and outfall structure at Valley Creek avoid impacts to waters of the U.S. including wetlands.

Overall then, the results of the PJD for the sum of the proposed facilities associated with the LBCR – including the raw water pipeline, terminal storage reservoir, north water treatment plant, railroad spur, discharge pipeline and outfall structure in the headwaters of Valley Creek – indicate that the following water-related features occur within the LOI:

- Potential waters of the U.S. include 127 linear feet of perennial streams, 860 linear feet of intermittent streams, and 4,191 linear feet of ephemeral streams.
- 1.91 acres of upland, off-channel open waters (ponds, stock tanks, etc.).
- 0.10 acres of on-channel open waters are located within the LOI.
- No wetlands occur within the LOI of the proposed LBCR-associated facilities.

Figure 3-15. View looking upstream (towards southeast) of Bullard Creek

Figure 3-16. Downstream view (east) of an unnamed ephemeral tributary of Loring Creek

Figure 3-17. View looking east of an off-channel stock tank (PD1) that would be crossed by the proposed raw water pipeline

3.2.2 Groundwater

The main ROI for groundwater resources is Fannin County.

The site of the proposed Lower Bois d'Arc Reservoir is underlain by several aquifers. Some of the aquifers, such as 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 may be produced from locally to meet a variety of types 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. The major aquifers in Texas are shown in Figure 2-24. A generalized stratigraphic section of all the major geologic formations that are present in Fannin County is shown in Table 3-10, and a generalized cross-section through the region is shown in Figure 3-18.

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). 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. **Confined aquifers** are blocked from upward movement by a layer of low hydraulic-conductivity (or relatively impermeable) rock above them.

Table 3-10. Stratigraphic units and their water-bearing characteristics

<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*</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>

*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 and Nordstrom, 1982

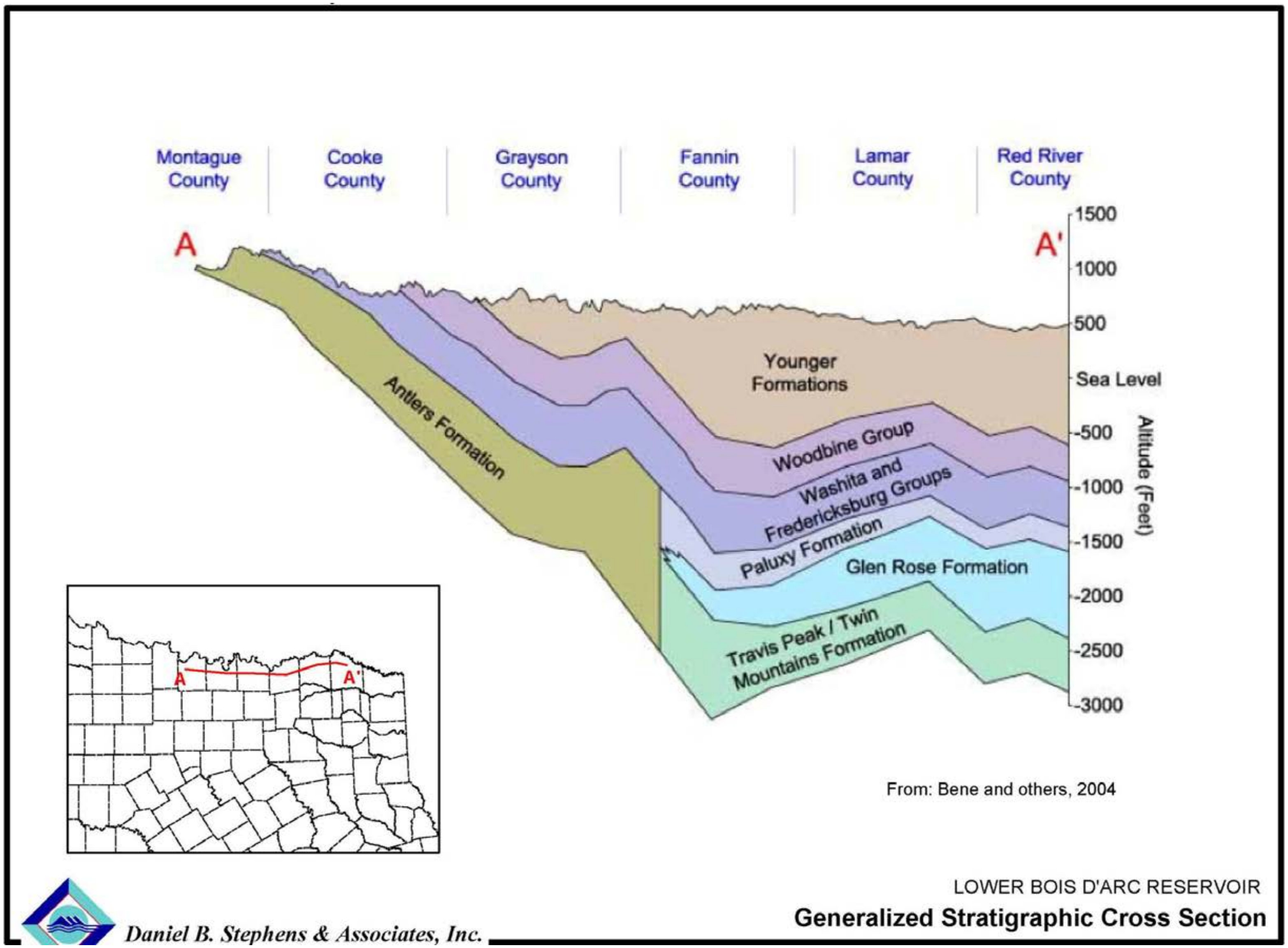


Figure 3-18. Generalized stratigraphic cross section across Fannin County and neighboring counties

It is important to note that the analysis of groundwater conditions in the study area are based on records obtained from the TWDB groundwater database. While this database is the most comprehensive source of data on groundwater wells in the state, it includes only a small percentage of wells in the state. Thus, while the use of this database will provide a valuable source of data 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 study area. The identification of wells that may be inundated by the proposed reservoir would have to be done with a thorough field investigation, and even that would not identify all old and abandoned wells in the area.

3.2.2.1 Woodbine Aquifer

The Woodbine Aquifer is a Cretaceous age sandstone aquifer that crops out 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 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 are also used for livestock and steam-electric purposes. The locations and depths of wells producing from the Woodbine in Fannin County, Texas from the TWDB database are shown in Figure 3-19.

The Woodbine Formation is composed of water-bearing sandstone beds interbedded with shales and clay. The aquifer outcrops 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 downdip to a maximum of over 2,500 feet. Most wells in the Woodbine in the study area are less than 1,800 feet deep.

Wells completed into the Woodbine can yield moderate to large quantities of water. Water-table conditions in the Woodbine occur in the outcrop areas, and quickly become confined down-dip. Water moves from the outcrop areas downdip to the east-southeast. Water levels in some areas of the Woodbine Aquifer are declining, with some wells showing significant declines over time, in some cases hundreds of feet of decline in the water level. The wells with more stable water levels tend to be located in the northern part of Fannin County where the Woodbine Aquifer outcrops. The Woodbine Aquifer contains mostly fresh water (less than 1,000 mg/L TDS) within Fannin County, although some areas in and near the outcrop of the Woodbine contain groundwater of poorer quality. However, these areas are sporadic and may be associated with areas of the Woodbine that are in hydraulic connection with the Red River alluvium.

3.2.2.2 Trinity Aquifer

The Trinity Aquifer is actually 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 beneath the Woodbine Aquifer (Table 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) and 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 is generally from the outcrop areas in a down-dip direction. Because the Trinity does not outcrop within Fannin County, all groundwater in the Trinity Aquifer within the county is found under artesian conditions. Due to the limited number of wells in the

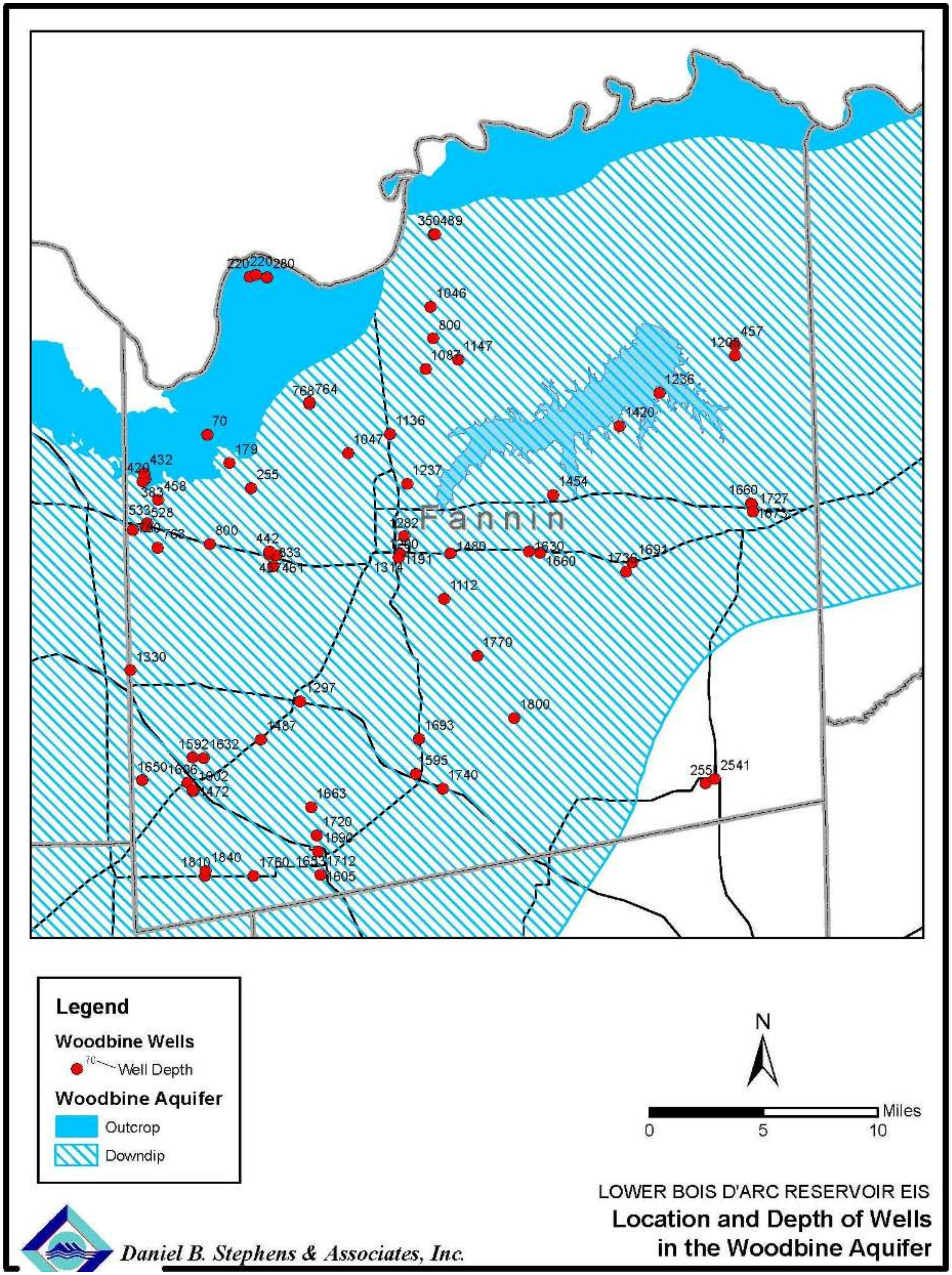


Figure 3-19. Location and depths of wells in the Woodbine Aquifer in Fannin County, Texas

Trinity in Fannin County, it is not possible to delineate groundwater flow directions. However, in general the flow will be in a downdip direction, to the east-southeast. Water levels in 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 3 to 4 feet per year.

Due to the lack of wells producing from the Trinity in Fannin County, it is difficult to fully define the water quality within this aquifer within the county. The available data indicated that the Trinity has very consistent water quality results, with total dissolved solids (TDS) 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 in Fannin County.

3.2.3 Interbasin Water Transfer

On December 29, 2006, the NTMWD submitted an application to the TCEQ for a Texas water right to construct the proposed Lower Bois d'Arc Creek Reservoir and to impound, store, divert and transfer State water. A copy of the water rights application was also provided to the Tulsa District Office of the U.S. Army Corps of Engineers. The submitted water rights application includes the following key requests:

- Impound up to 367,609 acre-feet of water in the proposed Lower Bois d'Arc Creek Reservoir and divert up to 175,000 acre-feet per year for municipal, industrial and agricultural purposes at a maximum diversion rate of 236 million gallons per day.
- Use of Lower Bois d'Arc Creek Reservoir for recreational purposes.
- An interbasin water transfer of 175,000 acre-feet per year from the Red River Basin to the Trinity, Sabine, and Sulphur River Basins. However, subsequently (in 2012) the NTMWD formally notified the TCEQ that it was amending its application for a Texas water right by deleting the request for an interbasin transfer of water from the Red River Basin to the Sabine River Basin (Rochelle, 2012).
- Reuse of 100 percent of the return water flows generated from the diversion and use of water from the proposed Lower Bois d'Arc Creek Reservoir.

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 Lower Bois d'Arc Creek Reservoir, NTMWD has applied for an interbasin water transfer of 175,000 AFY from the Red River basin to the Trinity and Sulphur River basins.

3.3 AIR QUALITY AND CLIMATE

3.3.1 Air Quality in Project Area

Because air quality is measured and regulated on a regional level, the ROI for the air quality analysis in this EIS is the 19-county Air Quality Control Region (AQCR) 215, and those portions of Fannin County where the Proposed Action would occur.

The 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 particles ($PM_{2.5}$), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), ozone (O_3), and lead. Short-term standards (1-, 8-, and 24-hour periods) have been established for 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. Table 3-11 shows the federal standards for ozone.

O_3 is a strong photochemical oxidant that is formed when NO reacts with volatile organic compounds (VOC's), also referred to as hydrocarbons (HC) and oxygen in the presence of sunlight. Ozone is considered a secondary pollutant because it is not directly emitted from pollution sources but is formed in the ambient air.

Table 3-11. Air quality standards and ambient air concentrations near Lower Boise d'Arc Reservoir

Pollutant	2006		2007		2008		Federal Standards	
	Hunt	Collin	Hunt	Collin	Hunt	Collin	Primary[1]	Secondary[2]
Ozone (parts per million - ppm) 8-hour highest[3] 8-hour 2nd highest	0.084 0.082	0.103 0.101	0.072 0.070	0.093 0.089	0.072 0.066	0.093 0.085	0.075 -	Same as Primary Standard

Notes:
[1] National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to Protect the public health.
[2] National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects from a pollutant.
[3] Not to be exceeded by the 3-year average of the annual 4th highest daily maximum 8-hour average.
Source: USEPA, 2010c

Ozone exposure can lead to eye irritation at concentrations above 0.1 parts per million (ppm). Coughing and chest discomfort are caused at concentrations of 0.3 ppm (Davis and Cornwell, 1998). Ozone impairs lung function and reduces resistance to colds and diseases such as pneumonia. Ozone plays a role in bronchitis, emphysema, asthma, and heart disease. With long-term exposure, ozone may cause permanent lung damage. In addition, high levels of ozone have been documented to damage certain trees, plants, and crops.

AQCRs that exceed the NAAQS are designated *nonattainment* areas and those in accordance with the standards are *attainment* areas. Fannin County and therefore all activities associated with the Proposed Action are within the Metropolitan Dallas Fort Worth Intrastate Air Quality Control Region (AQCR 215) (40 CFR 81.39). EPA has designated Fannin County as in attainment for all criteria pollutants (40 CFR 81.39). Because the project is in an attainment area, the air conformity regulations do not apply.

The USEPA monitors levels of criteria pollutants at representative sites in each region throughout the U.S. Fannin County does not have a monitoring station. The County of Hunt regional air monitor is 35 miles from the proposed site, and the Collin County monitor is approximately 51 miles from the proposed site. Table 3-11 shows the monitored concentrations of O_3 for the past 3 years for these two stations. No other criteria pollutants are monitored at these locations. Notably, the highest and 2nd highest 8-hour O_3 level was greater than the NAAQS, which is expected because Collin County is in moderate nonattainment for the 8-hour O_3 NAAQS.

Notably, because portions of the region are nonattainment areas for O_3, TCEQ maintains a comprehensive inventory of air emissions for the region. Valley Steam Electric Station in Savoy, Texas is in Fannin County and the only major source of emissions (USEPA, 2002). Their 2002 emissions are listed in Table 3-12. Notably, these would not be affected by the Proposed Action.

Table 3-12. Criteria air pollutant emissions for Valley Steam Electric, in metric tons (tons)

	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	VOC	HAP[1]
Actual	62.6 (69)	62.6 (69)	1,985.8 (2,189)	26.3 (29)	74.4 (82)	45.4 (50)	63.5 (70)

Notes:
[1] HAP = Hazardous Air Pollutants
Source: USEPA, 2002

3.3.2 Climate

The climate in Fannin County, Texas is characterized by hot summers and cold winters. The average annual temperature is 17°C (62°F) with a minimum monthly average of 1°C (34°F) in January and a maximum of 34ºC (93°F) in July. Temperatures can fluctuate approximately 12°C (22º F) from day to evening regularly.

3.3.2.1 Historical Precipitation and Droughts

Average annual precipitation is 45 inches per year. May, June, and October tend to be wetter, while January and August tend to be drier. Most other months range from 3-3.75 inches of rainfall. The wettest month is May with an average of 5.57 inches (Idcide, 2010).

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 or drought flows within a river basin is affected primarily by changes in the seasonal distribution of precipitation, year-to-year variability, 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 essentially 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 is not yet clearly understood – with different components of evaporation affected differently (IPCC, 2001).

One drought in the southern U.S. began in the winter of 2005-2006. It was caused by a reduction in both precipitation and evaporation and stretched from Arizona to the Atlantic Ocean, and persisted through October 2007 (Seager, 2009). Although the exact areas affected varied, precipitation reduction has not exceeded earlier droughts, including one as recently as 1998 through 2002 (IPCC, 2007).

Historically, the drought that began in the winter of 2005-2006 was a typical event in terms of amplitude and duration. Tree-ring records show a 21-yr-long drought in the mid-16th century, a long dry period in the early- to mid-19th century, and that the Southeast was affected by medieval mega-droughts centered in western North America. In general, the 20th century has been moist from the perspective of the last millennium and free of long and severe droughts that were abundant in previous centuries (Seager, 2009). Severe drought conditions have gripped much of Oklahoma and north Texas since September 2005. In north-central Texas, precipitation during a 12-month period in 2010-2011 was only 64 percent of normal, the driest September-August period since 1956. The U.S. Drought Monitor for late August/early September 2010 showed north-central Texas to be in an "exceptional drought". The average monthly Palmer Hydrological Drought Index (PHDI) for north central Texas for June-August 2006 was -4.34, which according to the PHDI scale is "extreme drought" (NOAA, 2010).

By 2013 much of Texas had emerged from extreme drought conditions. According to State Climatologist John Nielsen-Gammon, a professor of atmospheric sciences at Texas A&M University, 60 percent of the state was no longer in drought. The biggest improvements occurred in East Texas, with areas to the east of Interstate 35 (running north-south from Austin and Dallas-Ft. Worth to Oklahoma City) mostly recovered from the drought, while much of West Texas, particularly the Panhandle, remained very dry. Statewide reservoir storage by the end of 2013 stood at 64 percent of capacity, virtually unchanged from a year earlier (Campbell, 2014).

3.4 ACOUSTIC ENVIRONMENT (NOISE)

3.4.1 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, beautiful to some ears, 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-weighing*, measured in A-weighted decibels (dBA), approximates a frequency response expressing the perception of sound by humans. Table 3-13 includes sounds encountered in daily life and their dBA levels.

Table 3-13. Common sounds and their levels

Outdoor	Sound Level (dBA)	Indoor
Automobile horn	120	Loud rock concert
Power mower at 3 ft.	110	Power saw at 3 ft.
Motorcycle	100	Subway train, pneumatic drill
Tractor, bulldozer, excavator	90	Garbage disposal
Downtown (large city)	80	Ringing telephone
Freeway traffic	70	TV audio
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.

3.4.2 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 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. Fannin County and the State of Texas do not have noise ordinances. The City of Bonham has a nuisance noise ordinance that addresses common noises such as car radios, but not construction noise (Sec. 8.06.002).

3.4.3 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 these parameters, 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. There are no sensitive receptors (e.g., daycares, hospitals, schools) in the immediate project area.

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, small craft motorized boating activities, farm equipment, and natural noises such as the rustling of leaves and bird vocalizations. In general, noise levels would be comparable to 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* (Table 3-14) (ANSI, 2003).

Table 3-14. Estimated existing noise levels in the area

Land Use	Estimated existing sound levels (dBA)		
	DNL	L_{eq} (Daytime)	L_{eq} (Nighttime)
Very quiet suburban and rural residential	45	43	37

Source: ANSI, 2003

The noise ROI for the project encompasses the footprints of the proposed reservoir, dam, new bridge for FM 1396 and treatment plant footprint, plus the pipeline route, out to a distance of one-half mile from construction activities.

3.5 BIOLOGICAL RESOURCES

In 2008 Freese and Nichols prepared a baseline report of biological resources within the proposed LBCR. This was supplemented by the Instream Flow Study in 2010 and the surveys and PJD for the proposed pipeline route and related transmission facilities in 2013. The ROI for the affected environment of biological resources includes the proposed reservoir site, pipeline, water treatment facility, and mitigation site, all of which are located in Fannin County.

3.5.1 Vegetation

3.5.1.1 Regional Vegetation

The proposed project is located in the Blackland Prairie and the Northern Post Oak Savannah Level IV Ecological regions (see Figure 3-20) (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 bluesteam (*Schizachyrium scoparium*), yellow Indiangrass (*Sorghastrum nutans*), and tall dropseed (*Spoiribilus 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 includes 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 illinosniss*) 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.

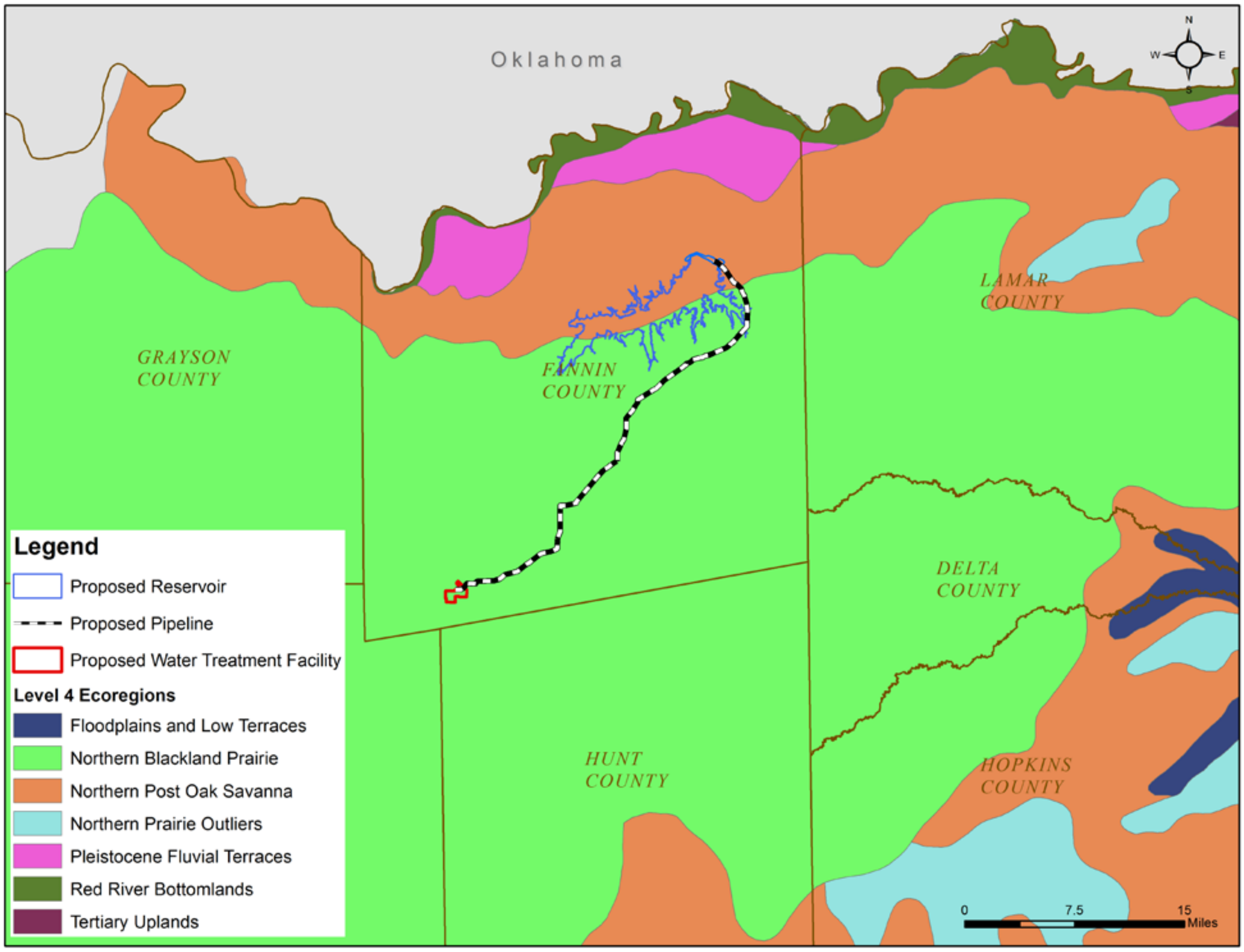


Figure 3-20. Ecoregion types of Fannin County, Texas, with proposed LBCR superimposed

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 virginianus*), 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 includes the Caddo National Grasslands. The proclamation 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 (Freese and Nichols, 2008a). The Bois d'Arc Unit is located adjacent to the north end of the proposed LBCR.

3.5.1.2 Lower Bois d'Arc Creek Reservoir Site

The proposed LBCR site is located in 17,068 acres of bottomland and adjacent upland habitat along Bois d'Arc Creek in north-central Fannin County, Texas. The vegetation composition at any given location in the project area is greatly dependent on climate, soils, geology, topography, and historic land use, particularly related to agricultural practices.

The types and quantities of habitat within the proposed project site were identified as part of the Habitat Evaluation Procedure (HEP) Study, which was conducted during the summer of 2007. Table 3-15 provides a breakdown of vegetation cover types within the reservoir footprint (Freese and Nichols, 2008a). The distribution and location of each vegetation cover type is shown in Figure 3-21.

Table 3-15. Vegetation cover types within proposed Lower Bois d'Arc Reservoir footprint

Habitat Type	Acreage	Percent
Evergreen Forest	228	1
Upland/Deciduous Forest	2,216	13
Riparian Woodland/ Bottomland Hardwood/Forested Wetland (total for HEP Purpose)	6,330	37
Riparian Woodland/Bottomland Hardwood	*1,728*	*10*
Forested Wetland	*4,602*	*27*
Shrubland	63	0
Shrub Wetland	49	0
Grassland/ Old Field	4,761	28
Emergent / Herbaceous Wetland	1,223	7
Cropland	1,757	10
Riverine (not used in HEP analysis)	219	1
Lacustrine (not used in HEP analysis)	87	1
Tree Savanna	132	1
Shrub Savanna	4	0
Grand Total	**17,068**	**100**

Bottomland Hardwood Forest (Deciduous Forest)
The riparian woodland / bottomland hardwood cover type, 6,330 acres, is predominantly deciduous forest, characterized by riparian zones and wetlands (Figure 3-22). This cover type is associated with the floodplains of Bois d'Arc Creek and Honey Grove Creek. The condition of the forest floors in these areas varies from standing water to dry, cracking mud. On the proposed site, the tree canopy cover averages approximately 68 percent, while the shrub cover is approximately 19 percent (Freese and Nichols, 2008a).

Dominant trees include black willow (*Salix nigra*), boxelder (*Acer negundo*), green ash (*Fraxinus pennsylvanica)*, sugarberry (*Celtis laevigata*), and cedar elm (*Ulmus crassifolia*). Overstory trees have an average diameter at breast height (dbh) of nine inches and the basal area averages 97 square feet per acre. Dominant shrubs are often small, immature trees of the species listed above, as well as honey locust (*Gleditsia triacanthos*), poison ivy (*Toxicodendron radicans*), coralberry (*Symphoricarpos orbiculatus*), buttonbush (*Cephalanthus occidentalis*), and Virgina creeper (*Parthenocissus quinquefolia*). Common herbaceous plants in the bottomland hardwood forest include baccharis (*Baccharis* spp.), Cherokee sedge (*Carex cherokeensis*), ragweeds (*Ambrosia* spp.), and Virginia wildrye (*Elymus virginicus*) (Freese and Nichols, 2008a).

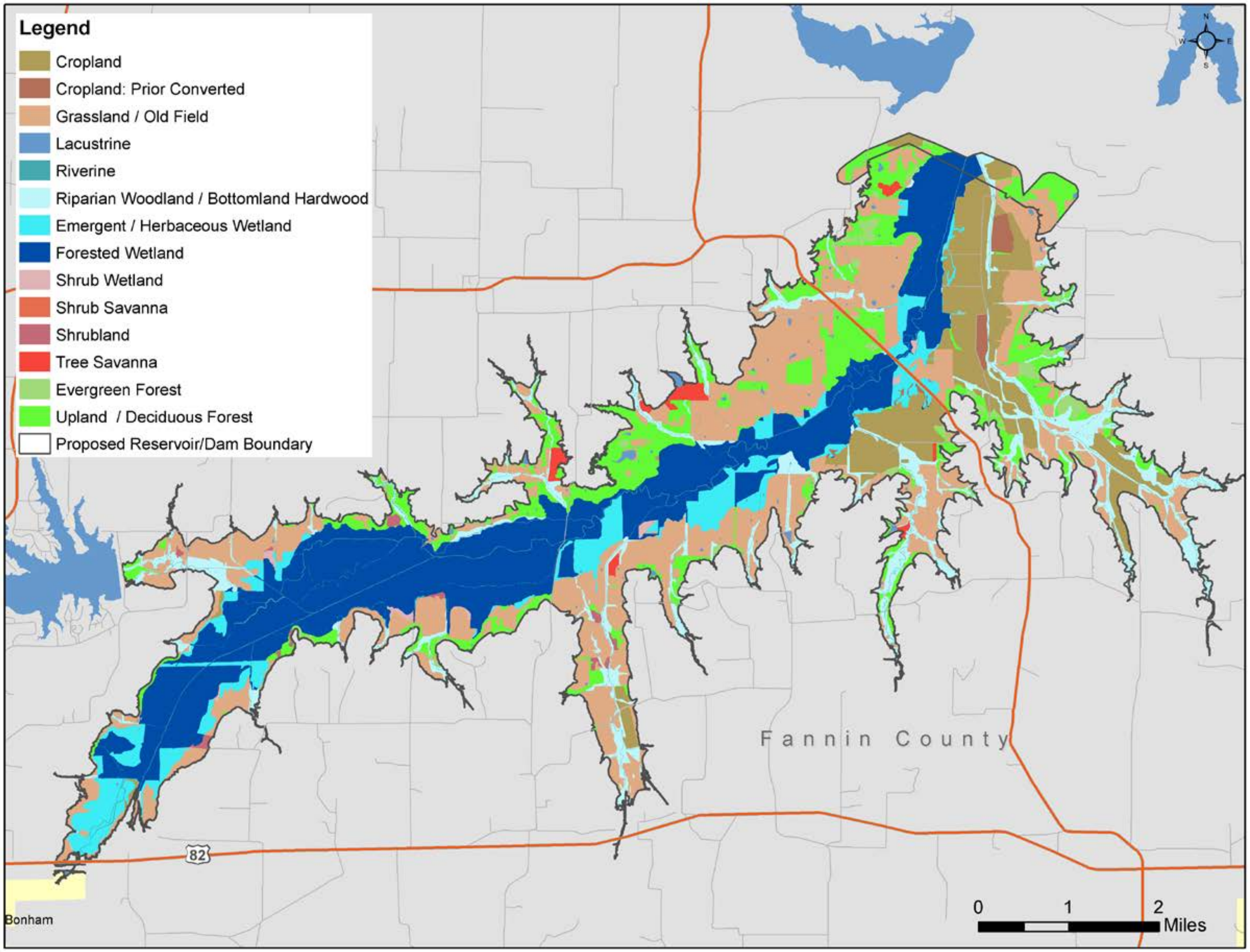


Figure 3-21. Vegetation cover types of the proposed Lower Bois d'Arc Creek Reservoir site

Figure 3-22. Bottomland hardwood forest at the LBCR site

Bottomland hardwood areas and associated riparian vegetation are important for maintaining habitat diversity for wildlife species (USACE, 2000). Bottomland hardwood areas also serve an important role in reducing the risk and severity of flooding to downstream communities because they store floodwater. These areas also help to improve water quality by filtering and flushing nutrients, processing organic wastes, and reducing sediment before it reaches open water.

Nationwide, many bottomland hardwoods have been converted to agricultural fields and the overall amount of area has been reduced to 40 percent of what existed 200 years ago (USEPA, 2009). According to the 2011 Region C Water Plan, in 1984 the USFWS designated 3,911 acres of bottomland hardwoods along Bois d'Arc Creek as Priority 4 bottomland hardwoods, which are "moderate quality bottomlands with minor waterfowl benefits." This designation was part of the *Texas Bottomland Hardwood Preservation Program* (Region C Water Planning Group, 2010). It is uncertain how many of these 3,911 acres designated three decades ago in 1984 retain their character (and would receive the same designation at present) or fall within the footprint of the proposed reservoir, which contains a total of 6,330 acres of bottomland hardwoods (including both 1,728 acres of "riparian woodland/bottomland hardwood and 4,602 acres of "forested wetland").

Like many of these areas, the Bois d' Arc Creek Basin has suffered declines and impacts to bottomland hardwood forests and riparian vegetation. Vegetation along the stream has been removed, and the land has been converted to grasslands, improved pasture, and agricultural lands. The Caddo National Forest and Grassland is one area where bottomland hardwoods are protected and managed by the USFS (USACE, 2000).

The majority of the mainstem of Bois d'Arc Creek was previously channelized and is now characterized by channel straightening, changing vegetated buffer, current incision, and the incision induced widening. Due to this channelization, the hydrology of the creek has been altered, creating a headcut effect up the creek (Freese and Nichols, 2008a).

In general, studies show that channelization and headcutting disrupt the flooding regime, thereby degrading adjacent floodplain ecosystems, including bottomland hardwood forests. Deepened channels and drainage ditches cutting across floodplains effectively lower the water table and reduce the hydroperiod, affecting native plant communities in adjacent bottomland systems. Wetland species frequently struggle to survive under these altered conditions. The drier conditions that commonly prevail in adjacent floodplains following channelization can allow mesic species (those adapted to drier soils) to compete with those adapted to hydric (wetland) conditions (Weins and Roberts, 2003).

Upland Woods (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 (Figure 3-23).

Figure 3-23. Upland deciduous forest at the LBCR site

Dominant tree species include post oak (*Quercus stellata),* water oak (*Q. nigra*), southern red oak (*Q. falcata*), Shumard's oak (*Q. shumardii),* cedar elm, sugarberry, bois d'Arc (*Maclura pomifera*), green ash, and eastern red cedar (*Juniperus virginiana*). Tree canopy closure averages approximately 68 percent.

Common shrub and vine species include coralberry, greenbrier (*Smilax* spp.), honey locust, poison ivy, Virginia creeper, 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, ironweed (*Vernonia* spp.) (Figure 3-24), Venus' looking-glass (*Triodanis* sp.), and wild onion (*Allium ascalonicum*). Average herbaceous canopy cover equals approximately 38 percent (Freese and Nichols, 2008a).

Upland Juniper Woods (Evergreen Forest)

Evergreen forests in the project 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 (Figure 3-25).

Figure 3-24. Ironweed

These forests are dominated by the evergreen eastern red cedar – which is actually a juniper – mixed with deciduous tree species including southern red oak, post oak, and blackjack oak (*Quercus marilandica*). Average tree canopy closure equals approximately 70 percent, with evergreens comprising 98 percent of the tree canopy on average (Freese and Nichols, 2008a).

Figure 3-25. Upland Juniper Woods at LBCR site

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* (sny. *Bumelia*) l*anuginosum*), and possumhaw holly (*Ilex decidua*). Herbaceous species include Cherokee sedge, panicgrass, johnsongrass (*Sorghum halepense*), and KR bluestem (*Bothriochloaischaemum* var. *songarcia*) (Freese and Nichols, 2008a).

Emergent / Herbaceous Wetland

Emergent wetlands (Figure 3-26) comprise 1,223 acres in the project area and are dominated by an herbaceous layer made up of wetland obligates such as rushes (J*uncus* spp.), sedges, smartweed (*Polygonum* spp.), and redstem (*Ammannia* spp.). The shrub layer is primarily comprised of black willow (*Salix nigra*), green ash, baccharis, swamp privet (*Forestiera* spp.), buttonbush, honeylocust, cocklebur (*Xanthium strumarium*), and desert false indigo (*Amorpha fruticosa*). The herbaceous canopy includes numerous grass species, such as barnyardgrass (*Echinochloa crus-galli*), crowngrass (*Paspalum* spp.), and eastern gammagrass (*Tripascum dactyloides*). Other plants found in the herbaceous wetlands include rushes, blue sedge (*Carex glancodea*), spikerush (*Eleocharis* spp.), flatsedge (*Cyperus* spp.), smartweed (*Polygonum* spp.), sumpweed (*Iva annua*), frog fruit (*Phyla* spp.), water primrose (*Ludwigia* spp.), ballon vine (*Cardiosperman halicacabum*), docks, and buttercups (Freese and Nichols, 2008a).

Figure 3-26. Emergent herbaceous wetland at LBCR site

Shrub Wetland

Shrub wetlands in the study area, 49 acres in size, can be considered wetlands in successional transition between herbaceous wetlands and bottomland hardwood forests. This layer is dominated by small trees such as green ash, sugarberry, and cedar elm, and shrub species such as honey locust, and baccharis. Shrub canopy cover averages approximately 48 percent. Dominant herbaceous plants include sedges, ragweeds, ironweeds, goldenrods (*Solidago* spp.), evening primrose (*Oenothera speciosa*), round leaf groundsel (*Packera tampicana*), trumpet vine (*Campis radicans*), and wild pea (*Lathyrus* spp). Herbaceous canopy cover averages about 66 percent (Freese and Nichols, 2008a).

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 was dominated by Cherokee sedge, goldenrods, Johnsongrass, silver bluestem (*Bothriochloa laguroides*), wild pea, and snow-on-the-prairie (*Euphorbia bicolor*). The herbaceous cover is abundant, averaging approximately 89 percent (Freese and Nichols, 2008a).

Grassland/Oldfield

The grassland/old fields (Figure 3-27) in the project are generally upland improved pastures and are 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, vetch (*Vicia* spp.), and wild pea. Herbaceous canopy cover averages approximately 87 percent, while the herbaceous canopy height in spring averages about 13 inches (Freese and Nichols, 2008a).

Figure 3-27. 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, 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, bristlegrass (*Setaria paviflora*), tall fescue, and Bermudagrass (Figure 3-28). Forbs are also common in the herbaceous layer, including docks, pigweed (*Amaranthus* spp.), spurges (*Euphorbia* spp.), morning glory (*Ipomoea* spp.), and black-eyed Susan (*Rudbeckia hirta*). This herbaceous cover stands at an average of 22 inches in the spring, with an average canopy cover of approximately 47 percent (Freese and Nichols, 2008a).

Figure 3-28. Fallow cropland within the LBCR footprint

Tree Savanna
Tree savannas in the project site, comprising132 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, KR bluestem, Indian plantain (*Arnoglossum* spp.), prairie plantain (*Plantago* spp.), croton (*Croton* spp.), and docks (Freese and Nichols, 2008a).

3.5.1.3 <u>Proposed Water Treatment Plant, Pipeline Route, and Related Facilities</u>

The proposed North Water Treatment Plant 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. Table 3-16 lists vegetation species observed at the proposed water treatment site during a preliminary jurisdictional determination to identify potential waters of the United States (Alan Plummer Associates, 2010).

Table 3-16. Plant species observed at the proposed North Water Treatment Plant site*	
Common Name	**Scientific Name**
Canopy	
Bois d' Arc	*Maclura pomifera*
Cedar Elm	*Ulmus crassifolia*
Green Ash	*Fraxinus pennsylvanica*
Black Willow	*Salix nigra*
Honey-Locust	*Gleditsia triacanthos*
Sugar Hackberry	*Celtis laevigata*
Eastern Red Cedar	*Juniperus virginiana*
Pecan	*Carya illinoensis*
Gum Bumelia	*Bumelia langinosa*
Boxelder	*Acer negundo*
American Elm	*Ulmus americana*
Sapling/Shrub Species	
Mexican Plum	*Prunus mexicana*
Rough-leaf Dogwood	*Cornus drummondii*
Chinese Tallow	*Sapium sebiferum*
Locust	*Gleditsia triacanthos*
Eastern Red Cedar	*Juniperus virginiana*
Rusty Blackhaw	*Viburnum rufidulum*
Toothache Tree	*Zanthoxylum clava-herculis*
Hawthorn	*Hawthorn crataegus texana*
Persimmon	*Persimmon diospyros virginiana*
Herbaceous Species	
Bermudagrass	*Cynodon dactylon*
Annual Ragweed	*Ambrosia artemisiifolia*
Dallisgrass	*Paspalum dilatatum*
American Germander	*Teucrinum candense*
Common Sunflower	*Helianthus annuus*
Coralberry	*Symphoricarpos orbiculatus*
Giant Ragweed	*Ambrosia trifida*
Greenbriar	*Smilax spp.*
Snow on the Prairie	*Euphorbia bicolor*
Milkweed	*Asclepias spp.*
Frog Fruit	*Phyla nodiflora*
Buffalograss	*Buchloe dactyloides*
Paspalum	*Paspalum spp.*
Ironweed	*Vernonia altissima*

Common Name	Scientific Name
Johnsongrass	*Sorghum halepense*
Erygno	*Erygnium leavenworthii*
One-seed Croton	*Croton capitatus*
Nightshade	*Solanum spp.*
Verbena	*Verbena spp.*
Poison Ivy	*Toxicodendron radicans*
Mustang Grape	*Vitis mustangensis*
Missouri Violet Viola	*Viola missourienses*
Honeysuckle	*Lonicera japonica*
Compressed Spikerush	*Eleochoris compressa*
Cocklebur	*Xanthium strumarium*
Marsh Spikerush	*Eleochoris smallii*
Lotus	*Nelumbo lutea*
Pondweed	*Potamogeton spp.*
Switchgrass	*Panicum virgatum*
Smartweed	*Polygonum spp.*
Sedge	*Carex spp.*
Arrowhead	*Sagittaria spp.*
Balloonvine	*Cardiospermum halicacabum*
Common Sunflower	*Helianthus annuus*
Virginia Wildrye	*Elymus virginicus*
Vine Mesquite	*Panicum obtusum*
Sumpweed	*Iva annua*

Source: Alan Plummer Associates, 2010
* This is a species list developed across the entire 662-acre parcel owned by NTMWD and is not specific to the location of the proposed water treatment plant, which occupies only a portion of this site.

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. Indeed, 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. During a preliminary 2008 reconnaissance and jurisdictional wetland determination, the plant species shown in Table 3-17 were documented along the proposed route. The current proposed route differs from this alignment, but many of the same plants would be expected to occur, since both alignments pass through similar terrain and habitats.

Table 3-17. Plant species observed along a proposed raw water pipeline route

Common Name	Scientific Name
Canopy Species	
Boxelder	*Acer negundo*
Black Willow	*Salix nigra*
American Elm	*Ulmus americana*
Hackberry	*Celtis laevigata*
Bois d' Arc	*Maclura pomifera*
Post Oak	*Quercus stellata*
Cottonwood	*Populus deltoides*
Sapling/Shrub/Vine Species	
Rough-Leaf Dogwood	*Cornus drummondii*
Greenbriar	*Smilax rotundifolia*
Southern Dewberry	*Rubus trivialis*
Grapevine	*Vitis spp.*
Herbaceous Species	
Bermudagrass	*Cynodon dactylon*
Bushy Bluestem	*Andropogon glomeratus*
Inland Sea Oats	*Chasmanthium latifolium*
Little Bluestem	*Schizachyrium scoparium*
Cherokee Sedge	*Carex cherokeensis*
Lovegrass	*Eragrostis spp.*
Nut Sedge	*Cyperus esculentus*
Smartweed	*Polygonum spp.*
Switchgrass	*Panicum virgatum*
Camphorweed	*Pluchea camphorata*
Threeawn	*Aristida spp.*
Virginia Wildrye	*Elymus virginicus*

Source: Alan Plummer Associates, 2008

In 2013, the alignment of the raw water pipeline route was refined and modified somewhat, in part to account for a change in the location of the water intake pump station. These changes were surveyed for general vegetation and habitat, as well as a HEP study and a PJD, in the summer and fall of 2013. The LOI included the combined permanent and temporary easements (120-feet wide) along the proposed 35-mile pipeline alignment, as well as within the footprints of the proposed WTP, TSR, intake pump station (IPS), electrical substation sites, TSR rail spur, and discharge pipeline/outfall. The total area of the LOI is approximately 875 acres. Approximately 15 acres of the total area, including the proposed IPS, the electrical substation, and a portion of the pipeline alignment, overlap the original HEP study area and were not included in the surveys and HEP. The same habitat types that were used in the HEP study for the reservoir site were used to characterize the vegetation within the LOI. The LOI included 23.0 acres of upland deciduous forest, 16.1 acres of evergreen forest, 2.6 acres of shrubland, 499.6 acres of cropland, 313.5 acres of grassland/old field, and 7.6 acres of riparian woodland/bottomland hardwood, for a total of 852.4 acres (Freese and Nichols, 2013).

3.5.1.4 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. To determine possible invasive plant species within the proposed LBCR area, the Invasive Plant Atlas of the United States 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. While the species listed in Table 3-18 have been detected in Fannin County, are non-native, and present a problem somewhere in the United States, they may not be problematic in Fannin County at this time. Species prohibited by TDA and TPWD are identified in the table below.

Table 3-18. TDA and TPWD prohibited and exotic species

Common Name	Scientific Name
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*
Black medic	*Medicago lupulina*
Yellow sweet clover	*Melilotus officinalis*

Common Name	Scientific Name
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*

Sources: TPWD, 2011b; 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. However, these species may spread by non-intentional means such as by wind, floods, wildlife, and accidental transport on vehicles including recreation 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 prevents drainage (TexasInvasive, 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 the EIS, TPWD is the state agency responsible for managing fish and wildlife resources in Texas. TPWD has been increasing public awareness and education of these species and provides information on prevention of introduction (TPWD, no date-a).

3.5.2 Wildlife

3.5.2.1 <u>Regional Wildlife</u>

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. 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 and its connected actions are within the Texan Biotic Province (TPWD, no date-b). 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 (*Peromyscus leucopus*), hispid cotton rat (*Sigmodon hispidus*), eastern cottontail (*Sylvilagus floridanus*) 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).

3.5.2.2 Lower Bois d'Arc Creek Site

Bottomland Hardwood Forest (Deciduous Forested Wetlands) Habitat

Fauna of the bottomland hardwood forests on-site include white-tailed deer (*Odocoileus virginianus),* 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 (*Procyon lotor*) tracks, hog tracks, and beaver (*Castor canadensis*) chew marks on trees. Reptiles such as the ornate box turtle (*Terrapene ornata*) (Figure 3-29) 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 3-29. Ornate box turtle

Upland Woods (Deciduous Forest) Habitat
Upland forests are non-wetland areas with a minimum tree canopy closure of 25 percent and a canopy composition of at least 50 percent of deciduous trees with dominant trees at least five meters in height.

Bird species observed in this cover type include northern cardinal, blue-grey gnatcatcher (*Polioptila caerulea*), downy woodpecker (*Picoides pubescens*), yellow-billed cuckoo, great blue heron, American crow, brown-headed cowbird, Carolina chickadee, 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 (*Sciurus niger*) (Freese and Nichols, 2008a).

Upland Juniper Woods (Evergreen Forest) Habitat
Evergreen forests in this area are also upland forests and are dominated by trees at least five meters tall. The minimum tree canopy closure is 25 percent and at least 50 percent of the canopy is composed of trees that retain their green foliage year-round.

Bird species observed in this cover type of the project area include tufted titmouse (*Baeolophus bicolor*), northern cardinal, painted bunting (*Passerina ciris)*, Carolina chickadee, pileated woodpecker (*Dryocopus pileatus*), and American crow (Freese and Nichols, 2008a).

Emergent / Herbaceous Wetland Habitat
Herbaceous wetland areas have a total vegetation cover of greater than 30 percent that is dominated by hydrophytic plants growing on or below the water surface.

Many species of birds were found in this cover type, including the northern cardinal, American crow, indigo bunting, tufted titmouse, great blue heron, great egret, 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, 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) (Freese and Nichols, 2008a).

Shrub Wetland Habitat
Shrub (or shrub-scrub) wetlands have a vegetation cover greater than 30 percent and are dominated by woody vegetation that is less than five meters tall. Shrub wetlands in this cover type are found in riparian zones.

Birds observed in this cover type of the project area included northern cardinal, painted bunting, American crow, great egret (*Ardea alba*), solitary warbler (Family: Parulidae), and common yellow throat (*Geothlypis trichas*). Evidence of mammalian residents included tracks of raccoons and bite marks of beavers. Also observed in the shrub wetlands were the southern leopard frog (*Rana sphenocephala*) and crayfish (Freese and Nichols, 2008a).

Shrubland Habitat
Shrublands are upland areas dominated by a shrub layer composed of shrub species and/or small trees with a height less than five meters. The shrub canopy cover should be at least 25 percent.

Wildlife observed in this cover type 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 (Freese and Nichols, 2008a).

Grassland/Oldfield Habitat
The grassland/old field cover type consists of upland areas with at least a 25 percent canopy cover of predominantly non-woody vegetation in which grasses, whether native or introduced, are dominant. This cover type includes mostly prairies and rangeland.

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 (Freese and Nichols, 2008a).

Cropland Habitat
Croplands in the proposed site are agricultural uplands planted and harvested annually with agricultural crops. Pasture and hayland are excluded from this cover type.

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 (*Meleagris gallopavo*), northern cardinal, painted bunting, white-eyed vireo, tufted titmouse, and blue-gray gnatcatcher (Freese and Nichols, 2008a).

Tree Savanna Habitat
In tree savannas the canopy is sparser with trees taller than five meters with a canopy closure at least 25 percent. 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 (Freese and Nichols, 2008a).

3.5.3 Habitat Evaluation Procedure (HEP)

The Habitat Evaluation Procedure (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. 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 give a habitat quality for evaluation species, the Habitat Suitability Index (HSI) is used. The HSI scale ranges from 0.0 to 1.0, with 0.0 being unsuitable and 1.0 being optimal habitat. The HSI value obtained from this comparison becomes an index of carrying capacity for selected evaluation species.

A HEP analysis was conducted within the footprint of the proposed LBCR reservoir (i.e., the area in which existing or baseline habitats would be altered by construction activities, reservoir clearing, and impoundment of water) by multiple interagency teams that included personnel from USFWS, USACE, EPA, USFS, TPWD, TWDB, TCEQ, NTMWD, and Freese and Nichols, Inc. The HEP analysis was conducted to quantify habitat value of the proposed reservoir site. This valuation was made to determine baseline conditions. The Lower Bois d'Arc study area was divided into nine cover types (see Table 3-19).

HEP was also performed on the Riverby Ranch mitigation site, as discussed in Chapter 4 and the mitigation plan in Appendix E of this EIS.

Evaluation species, habitat cover type, and HSIs are shown in Table 3-20. Baseline Habitat Units (HUs) were calculated for each cover type within the proposed reservoir site and are listed in Table 3-20. HU values provide the basis to determine net adverse effects of the proposed reservoir site on wildlife habitat. These values were used in determining and planning mitigation on the Riverby Ranch to compensate for the existing wildlife habitat functions on the proposed Permit-Area (Freese and Nichols, 2008a).

In the summer and fall of 2013, a supplemental HEP analysis was performed of the proposed LBCR pipeline and associated treatment facilities (Freese and Nichols, 2013). The limits of this supplemental HEP study were confined to the combined permanent and temporary easements (120 feet in width) along the proposed 35-mile pipeline alignment, as well as within the footprints of the proposed WTP, TSR, IPS, and electrical substation sites, and the TSR rail spur and discharge pipeline/outfall. The total area equals approximately 875 acres. Approximately 15 acres of the total area, including the proposed IPS, the electrical substation, and a portion of the pipeline alignment, overlapped the original HEP study area and were not included in the additional study area calculations.

Table 3-19. Habitat Suitability Indices by cover type

	Cover Types								
Evaluation Species	**Upland Deciduous Forest**	**Evergreen Forest**	**Tree Savanna**	**Shrubland**	**Cropland**	**Grassland / Old Field**	**Riparian woodland/ Bottomland Hardwood**	**Shrub Wetland**	**Emergent / Herb-aceous Wetland**
American kestrel	--	--	1.00	--	1.00	1.00	--	--	--
Barred owl	0.20	--	--	--	--	--	0.14	--	--
Brown Thrasher	--	0.02	--	--	--	--	--	--	--
Carolina chickadee	0.75	0.40	--	--	--	--	--	--	--
Downy wood-pecker	0.29	--	--	--	--	--	0.34	--	--
Eastern cottontail	--	0.31	0.31	0.31	0.31	0.31	--	--	--
Eastern meadowlark	--	--	0.59	--	--	0.53	--	--	--
Eastern turkey	0.68	0.68	--	--	--	--	--	--	--
Field sparrow	--	--	--	0.43	--	--	--	--	--
Fox Squirrel	0.42	--	--	--	--	--	0.03	--	--
Green heron	--	--	--	--	--	--		0.81	0.87
Raccoon	--	--	--	--	--	--	0.52	0.28	0.17
Racer	--	--	--	0.98	--	0.18	--	--	--
Scissor-tailed flycatcher	--	--	1.00	--	0.83	0.98	--	--	--
Swamp rabbit	--	--	--	--	--	--	--	0.52	--
Wood duck	--	--	--	--	--	--	0.22	0.22	0.22
Average HSI Value	**0.47**	**0.35**	**0.73**	**0.57**	**0.72**	**0.60**	**0.25**	**0.46**	**0.42**

Source: Freese and Nichols, 2008a

Table 3-20. Baseline Habitat Units by cover type			
Cover Type	**Average HSI Values**	**Area (acres)**	**Habitat Units (HU's)**
Upland Deciduous Forest	0.47	2,216	1,042
Evergreen Forest	0.35	228	80
Tree Savanna	0.73	132	96
Shrubland	0.57	63	36
Cropland	0.72	1,757	1,265
Grassland / Old Field	0.6	4,761	2,857
Riparian Woodland/ Bottomland Hardwood	0.25	6,330	1,583
Shrub Wetland	0.46	49	23
Emergent / Herbaceous Wetland	0.42	1,223	514
Total Habitat Units			**7,496**

Source: Freese and Nichols, 2008a

FNI biologists conducted pedestrian surveys of the proposed LBCR pipeline and associated treatment facilities in August, October, and November 2013. Based on field verification and through the use of the 2012 U.S. Department of Agriculture's National Agriculture Imagery Program (NAIP) data, the team assigned HEP cover type designations to appropriate areas within this additional study area (Freese and Nichols, 2013).

For the purposes of this supplemental study, the average HSI values calculated for the cover types within the reservoir study area were also assigned to the cover types identified in the additional study area. Table 3-21 summarizes baseline conditions for each cover type identified within the additional study area, including HSI values, cover type acreages, and calculated HUs.

Table 3-21. Additional Study Area HEP Cover Types, Assigned HSI Values, Areas, and HUs			
Cover Type	**Assigned HSI Values**	**Area (acres)**	**Habitat Units (HU's)**
Upland Deciduous Forest	0.47	23.0	10.8
Evergreen Forest	0.35	6.1	2.1
Shrubland	0.57	2.6	1.5
Cropland	0.72	499.6	359.7
Grassland / Old Field	0.60	313.5	188.1
Riparian Woodland/ Bottomland Hardwood	0.25	7.6	1.9
Total		**852.4**	**564.1**

Source: Freese and Nichols, 2013

3.5.4 Aquatic Habitat and Wildlife

The Permit Area for the proposed reservoir contains 87 acres of open water including ponds, stock tanks, and small lakes, 120 acres of perennial streams and 99 acres of intermittent streams. Wetlands in the proposed project area include 4,602 acres of forested wetland, 1,233 acres of herbaceous wetland, and 49 acres of shrub wetland. The primary stream within the proposed Lower Bois d'Arc Creek Reservoir site is Bois d'Arc Creek itself. All other streams on the site are either direct tributaries of Bois d'Arc Creek or tributaries of a tributary to Bois d'Arc Creek (Freese and Nichols, 2008c). A total of 219 acres of riverine habitat exists within the project site (Freese and Nichols, 2008a).

Much of the Lower Bois d'Arc Creek Reservoir site has been altered over the past 100 years mainly due to agricultural practices and channelization. In 2000 and on more recent site visits, observers noted extensive channelization and losses to the riparian corridor and associated stream bank vegetation, due to agricultural practices that resulted in siltation of the stream, bank caving, and elevated stream temperatures (Figures 3-30 and 3-31). A total of 24 percent of the stream lengths within the project site have been channelized (Freese and Nichols, 2008a).

The Red River Authority conducted *An Assessment of the Biological Integrity of the Eastern Red River Basin in Texas* during 1998 (RRA, 1999). 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 the Lower Bois d'Arc Creek were determined with the use of Rapid Bioassessment Protocols (Freese and Nichols, 2008a). 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) characterizes 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 (EPA, 2012). For this study, each sampling site was classified as being in Limited (<35), Intermediate (35-40), High (41-48), or Exceptional (>48) condition. The calculated Index of Biological Integrity (IBI) scores for both study areas in Bois d'Arc Creek were 35, resulting in a low Intermediate Classification (Freese and Nichols, 2008a).

Figure 3-30. Channelized portion of Bois d'Arc Creek

Figure 3-31. Bois d'Arc Creek bank showing newly exposed roots

The 2010 Instream Flow Study found four mesohabitats within Bois d'Arc Creek and its study area tributaries: runs, riffles, structures (large woody debris, root wads, etc. that provide cover for aquatic species), and pools (Freese and Nichols, 2010a).

3.5.4.1 Fish

Bois d'Arc Creek and the proposed reservoir site are within the Red River Basin. According to Hubbs et al. (2008) and Texas A&M (no date) at least 191 freshwater fish species have the potential to exist in the Red River Basin. Two separate surveys were conducted in 1982 and 1998 to determine fish species occurring in Bois d'Arc Creek. In 1982 over 20 fish species were collected by TPWD in Bois d'Arc Creek (TPWD, no date-c). During the 1998 Assessment of the Biological Integrity of the Eastern Red River Basin in Texas, 11 species were collected (RRA, 1999). Table 3-22 lists the fish species collected during the 1982 and 1998 studies.

Table 3-22. Fish collected in lower Bois d'Arc Creek from two studies in 1982 and 1998

Scientific Name	Common Name	1982 Study (Bois d'Arc Creek)	1998 Study (Red River Basin)
Ameiurus natalis	yellow bullhead		*
Aplodinotus grunniens	freshwater drum	*	
Carpiodes carpio	river carpsucker	*	
Cyprinella lutrensis	red shiner	*	*
Cyprinella venusta	blacktail shiner		*
Cyprinus carpio	common carp	*	*
Fundulus notatus	blackstripe topminnow		*
Gambusia affinis	western mosquitofish	*	*
Ictiobus bubalus	smallmouth buffalo	*	
Ictalurus punctatus	channel catfish	*	
Lepisosteus oculatus	spotted gar	*	
Lepomis gulosus	warmouth		*
Lepomis macrochirus	bluegill		*
Lepomis megalotis	longear sunfish		*
Micropterus salmoides	largemouth bass	*	*
Notemigonus crysoleucas	golden shiner	*	
Notropis amabilis	Texas shiner		*
*Pimephales vigila**	bullhead minnow		*
Various species within the family Centrarchidae	sunfish spp.	*	
Pomo annularis	white crappie	*	

Source: Freese and Nichols, 2008a; RRA, 1999

Freese and Nichols reviewed survey reports from the Statewide Freshwater Fisheries Monitoring and Management Program for Lake Coffee Mill, Lake Davy Crockett, Lake Texoma, and Bonham City Lake to determine if species from Table 3-22 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. Due to the environmental variability of Bois d'Arc Creek, and taking into account these observations, the creek fish biota is comprised of generalist species, that is, those able to survive in both riverine and lacustrine (lake-like) habitats. Table 3-23 shows those species documented both in Bois d'Arc Creek and nearby lakes.

Table 3-23. Selected Bois d'Arc Creek fish species with documented occurrence in lacustrine environments			
Scientific Name	**Common Name**	**Species Accounts from local Reservoirs**	**Reliable Observation or Documentation of Species Occurrence/Survival from Lacustrine Environment**
Ameiurus natalis	yellow bullhead	Lake Bonham, Lake Davy Crockett	Yes
Aplodinotus grunniens	freshwater drum	Lake Bonham, Lake Texoma, Coffee Mill Lake	Yes
Carpiodes carpio	river carpsucker	Lake Texoma	Yes
Cyprinella lutrensis	red shiner		Yes
Cyprinus carpio	common carp	Lake Bonham, Lake Texoma, Coffee Mill Lake, Lake Davy Crockett	Yes
Fundulus notatus	blackstripe topminnow		Yes
Gambusia affinis	western mosquitofish		Yes
Ictalurus punctatus	channel catfish	Lake Bonham, Lake Texoma, Coffee Mill Lake, Lake Davy Crockett	Yes
Ictiobus bubalus	smallmouth buffalo	Lake Texoma	Yes
Lepisosteus oculatus	spotted gar	Coffee Mill Lake	Yes
Micropterus salmoides	largemouth bass	Lake Bonham, Lake Texoma, Coffee Mill Lake, Lake Davy Crockett	Yes
Notemigonus crysoleucas	golden shiner		Yes
Notropis amabilis	Texas shiner		Yes
Pimephales vigilax	bullhead minnow		Yes
Pomoxis annularis	white crappie	Lake Bonham, Lake Texoma, Coffee Mill Lake, Lake Davy Crockett	Yes

Source: Freese and Nichols, 2008a

Fish in lower Bois d'Arc Creek were also sampled in 2009 for the 2010 Instream Flow Study conducted in support of NTMWD's Water Right permit application (Figures 3-32 and 3-33). 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" (Freese and Nichols, 2010a). The interagency team that conducted the Instream Flow Study included participants from USFWS, USACE, USEPA, USFS, TWDB, TPWD, TCEQ, RRA, NTMWD, and FNI.

From March to July 2009, researchers collected a total of 3,138 fish, representing 42 species from 11 families (Table 3-24). The most abundant family was Cyprinidae (59% in percent total relative abundance), followed by Centrarchidae (20%), Poeciliidae (8%), Ictaluridae (6%), and Clupeidae (3%). Species relative abundance across the variables of site, mesohabitat, flow, and season illustrated similar

Table 3-24. Fish collected during March-July 2009 Bois d'Arc Creek Instream Flow Study

Species	Number collected	Species	Number collected
Lepisosteus oculatus	1	*Pylodictis olivaris*	10
Lepisosteus osseus	1	*Labidesthes sicculus*	7
Dorosoma cepedianum	69	*Fundulus notatus*	33
Dorosoma petenense	1	*Gambusia affinis*	247
Campostoma anomalum	20	*Lepomis cyanellus*	154
Cyprinella lutrensis	1,417	*Lepomis gulosus*	12
Cyprinella venusta	21	*Lepomis humilis*	28
Cyprinella hybrid	3	*Lepomis macrochirus*	151
Cyprinus carpio	0	*Lepomis megalotis*	421
Lythrurus fumeus	25	*Lepomis microlophus*	24
Notropis atrocaudalis	1	*Lepomis hybrid*	18
Notropis stramineus	27	*Micropterus punctulatus*	3
Phenacobius mirabilis	26	*Micropterus salmoides*	37
Pimephales vigilax	147	*Pomoxis annularis*	5
Carpiodes carpio	4	*Pomoxis nigromaculatus*	2
Ictiobus bubalus	2	*Etheostoma gracile*	3
Moxostoma erythrurum	1	*Percina caprodes*	10
Ameiurus melas	20	*Percina macrolepida*	1
Ameiurus natalis	112	*Percina phoxocephala*	1
Ictalurus punctatus	39	*Percina sciera*	22
Noturus gyrinus	2	*Aplodinotus grunniens*	1
Noturus nocturnus	9		
Total Number Collected			***3,138***
Total Taxa			***42***

Source: Freese and Nichols, 2010a

Figure 3-32. Electrofishing during interagency biological sampling effort with participants from TCEQ, TPWD, and TWDB

Figure 3-33. Seine haul from deep pool along Lower Bois d'Arc Creek

patterns of dominant species; that is, the same species tended to dominate everywhere within the study area. Fish community composition was found to be dominated by generalist species tolerant of a wide range of environmental conditions. In general, the two most dominant species were red shiner (*Cyprinella lutrensis* – 50% total relative abundance) and longear sunfish (*Lepomis megalotis* – 13.7%) (Freese and Nichols, 2010a).

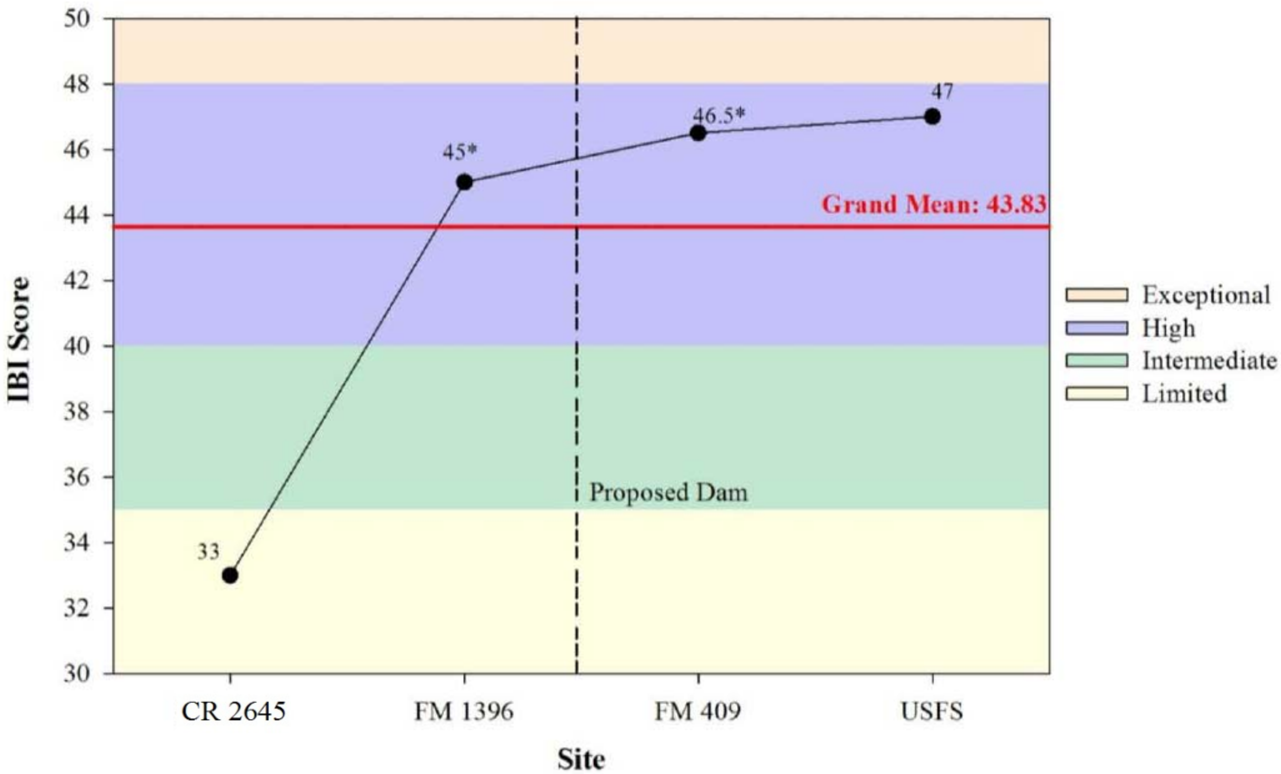
Bois d'Arc Creek is largely dominated by generalist species with opportunistic feeding strategies. For example, red shiner and sunfish species (particularly longear – Figure 3-34) mostly forage by benthic (bottom) grazing or water surface predation. These strategies respond to the creek's turbid (unclear) waters and general paucity of favorable microhabitats. The Instream Flow Study found 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, especially during the low-flow summer survey. This is unsurprising, since sunfish species will likely thrive under these conditions compared to fluvial (stream or flowing water) specialists. The only other apparent pattern was that more filter feeders-planktivores-herbivores were found during the spring high-flow sampling event, probably due to higher primary productivity and increased spawning-associated movement.

Figure 3-34. Longear sunfish (*Lepomis megalotis*), second most abundant fish collected in the Instream Flow Study

The Index of Biological Integrity (IBI) is a measure of fish communities that includes components of species and trophic composition, abundance and condition. The IBI is typically used by TCEQ as an indicator of water quality, with higher scores indicating better water quality. In the Instream Flow Study, IBI scores for fish community structure were Intermediate to High, with a mean of 43.83. IBI scores increased longitudinally within the mainstem of Bois d'Arc Creek (Figure 3-35). These scores were higher than the low Intermediate designation reported in the 1999 RRA study cited earlier. Mainstem site scores ranged from 33 (Limited) to 49 (High), and tributary scores were also in the High range (i.e., 46 and 43 for Honey Grove and Bullard creeks, respectively).

Trophic structure

The word 'trophic' derives from the Greek and relates to feeding and nutrition. In ecology, trophic structure refers to feeding relationships in food chains that include predator-prey, parasite-host and plant-herbivore relationships.



* Indicates average IBI from multiple collections (i.e., FM 1396: 49, 41; FM 409: 45, 48)

Figure 3-35. Fish IBI scores from 2009 Bois d'Arc Creek Instream Flow Study, upstream (left) to downstream

3.5.4.2 <u>Benthic Macroinvertebrates</u>

During the Instream Flow Study, a total of 2,621 aquatic and terrestrial insects, including 103 identified genera 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 (> 80%), with few filter-feeding or shredder species. A high percentage (>36%) of collector-gatherers indicates degradation, while a low to moderate percentage (4% – 15%) of predators reflect a balanced tropic 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 (Freese and Nichols, 2010a).

What are "benthic macroinvertebrates"?

Freshwater benthic macroinvertebrates, or more simply "benthos", are animals without backbones (invertebrates) that are larger than 0.5 millimeter (about the size of a pencil dot) and generally visible – even if often appearing tiny – to the unaided human eye. These aquatic animals live on and under rocks, logs, sediment, debris and aquatic plants during some stage of their lives. The benthos include crustaceans such as crayfish, mollusks such as clams and snails, aquatic worms and the immature forms of aquatic insects such as stonefly and mayfly nymphs.

Macroinvertebrates were sampled using the TCEQ 2007 SWQM Rapid Bioassement Protocol. Rapid bioassessments provide a standardized method for sampling and data analysis that can be used to attach a numerical value to the quality of a stream. The numerical scores 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 in Figure 3-36, the overall biological integrity of Bois d'Arc Creek's macroinvertebrate community was at the higher end of the intermediate range (mean: 28.9). Mainstem sampling site scores ranged from 22 (intermediate) to 37 (high). These results are consistent with previous studies. Tributaries of Bois d'Arc Creek had lower scores than mainstem sites; Bullard and Honey Grove creeks had scores of 25 and 28, respectively (Freese and Nichols, 2010a).

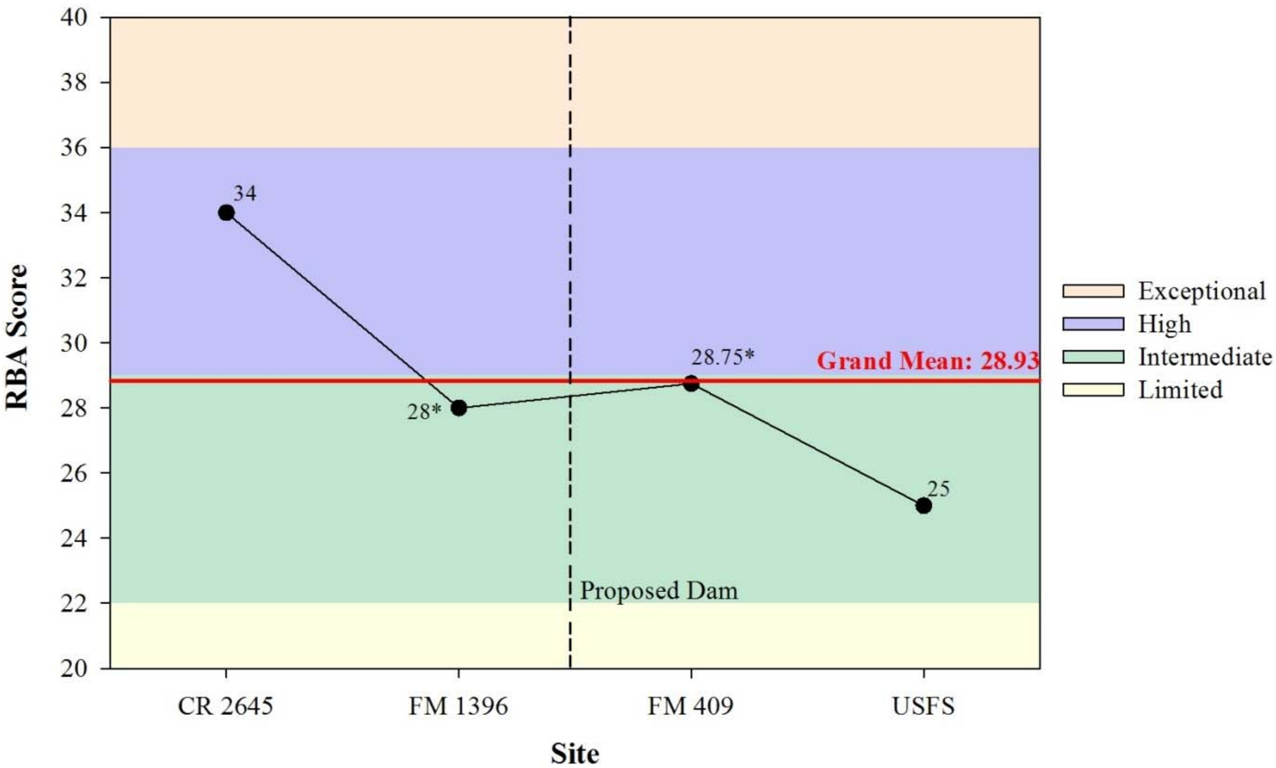


Figure 3-36. Results of benthic macroinvertebrate Rapid Bioassessment (RBA)
Source: Instream Flow Study (Freese and Nichols, 2010a)

In accordance with the recommendations of the interagency team, during the Instream Flow Study, mussels were collected or photographed when they were encountered during other data collection efforts. A total of six mussel species were collected or photographed and later identified as part of this effort (Freese and Nichols, 2010a). They are shown in Table 3-25.

According to the USFWS, no federally listed threatened or endangered mollusk species occur in Fannin County. The TPWD's *Annotated List of Rare Species for Fannin County* indicates that seven mollusk species are listed for Fannin County. None of these species were collected or identified in Bois d'Arc Creek during the current instream flow study (Freese and Nichols, 2010a).

Table 3-25. Mussel species collected in 2009 during Instream Flow Study on Bois d'Arc Creek

Common Name	**Scientific Name**	**Habitat**
Bleufer	*Potamilus purpuratus*	Streams, rivers, and reservoirs
Fragile Papershell	*Leptodea fragilis*	Streams, rivers and possibly reservoirs
Mapleleaf	*Quadrula 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: Freese and Nichols, 2010a

Figure 3-37. Live yellow sandshell mussels collected during Instream Flow Study

3.5.4.3 Proposed Water Treatment Plant, Pipeline Route, and Mitigation Site

The proposed water treatment plan, pipeline route, and mitigation site are located within the Texan Biotic Province (TPWD, no date-b). Much of this area is currently used for agricultural practices, limiting the amount of wildlife that may occur on these sites. Overall, wildlife in these areas is similar to the regional overview. Wildlife in wooded areas on these sites is similar to those found at the Lower Bois d'Arc Creek Reservoir site but species diversity and abundance would be expected to be more limited due to constrained habitat areas and fragmentation.

3.5.5 Threatened and Endangered Species

This section addresses federal and state listed species of the proposed dam and reservoir site, pipeline route, water treatment facility, and mitigation site. The primary ROI for this analysis is Fannin County, because federal and state agencies collect and organize their records on a county by county basis.

3.5.5.1 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). Table 3-26 lists the federally-listed species potentially occurring in Fannin County according to the USFWS technical assistance website.

Table 3-26. Federally-listed species potentially occurring in Fannin County according to the USFWS

Species	Status
Bald Eagle (*Haligeetus leucocephalus*)	Recovery
Interior Least Tern (*Sterna antillarum athalassos*)	Endangered
Black Bear (*Ursus americanus luteolus*)	Threatened/Similarity of Appearance*

NOTES:
Source: USFWS, 2013
* S/A = similarity of appearance with the Louisiana black bear (*U. americanus luteolus*)

The project site contains no nesting and limited foraging habitat for interior least terns and bald eagles (now de-listed by USFWS but still protected under the Bald and Golden Eagle Protection Act). While potential habitat for black bears does occur within the reservoir footprint, none have ever been documented on site.

3.5.5.2 State Listed Species

Table 3-27 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, and timber/canebrake rattlesnake may occur locally**.** These species and their habitats are described below.

Blackside darter (*Percina maculata*)

The blackside darter (Figure 3-38) 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 3-27. 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
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: TPWD, 2010b, 2011c, 2014 Species listed in state by TPWD E = endangered; T = threatened	

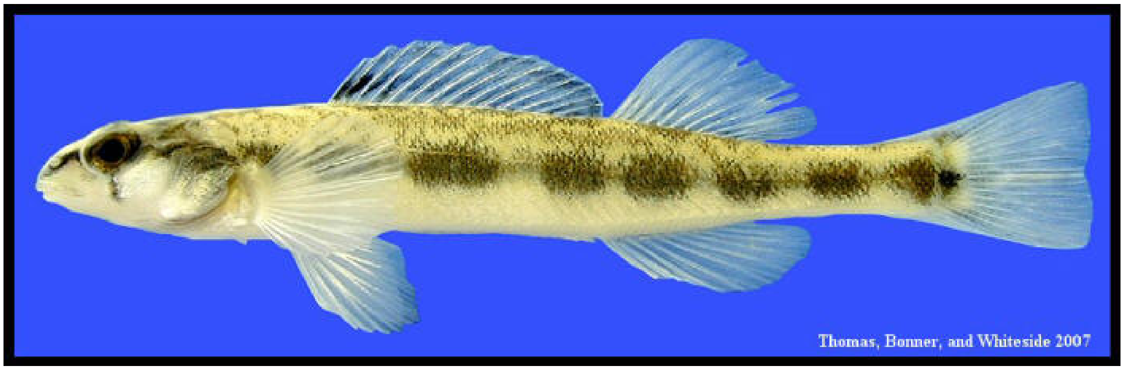


Figure 3-38. Blackside darter
Photo credit: Thomas, Bonner, and Whiteside 2007; www.txstate.edu

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, swa`mpy 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).

3.5.6 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 ROI 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.org, 2011a).

- Eurasian Collar 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.org, 2010).

- 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.org, 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.org, 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.org, 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).

3.6 RECREATION

The main ROI for recreation is Fannin County, while the surrounding Texas counties of Grayson, Collin, Hunt, Delta and Lamar constitute a secondary ROI.

Recreation includes outdoor activities such as fishing, hunting, swimming, picnicking boating, hiking, camping, wildlife observation, photography and other activities. A 2001 Survey by the USFWS, the U.S. Census Bureau and other agencies revealed that 4.9 million Texas residents and nonresidents 16 years or older fished, hunted, or wildlife watched in Texas (USFWS and USCB, 2001), indicating that wildlife recreation is an important social and cultural activity. The most popular activity was wildlife observation, followed by fishing and then hunting. The importance of wildlife observation and fishing to recreation in Texas is particularly important when analyzing the impacts of reservoirs or other water-related projects.

Recreation contributes to the economy. According to the same survey, in 2001, state residents and nonresidents spent nearly $5.4 billion on wildlife-related recreation in Texas (USFWS and USCB, 2001).

This EIS considers the following recreation values and activities which are relevant in this area of north Texas:

- Sport fishing
- Hunting
- Wildlife watching (observing, photographing, feeding fishes and wildlife)
- Boating (motorized and non-motorized)
- Swimming
- Picnicking
- Camping
- Enjoying the scenic quality of nature

These activities will be focused on to evaluate, in Chapter 4, the potential impacts the proposed action will have on local recreation opportunities. In addition to considering the addition or impairment of each of these activities, we will consider whether an activity diminishes or enhances the quality and/or safety of each type of activity.

3.6.1 Lower Bois d'Arc Creek Reservoir Site and Pipeline Route

Recreation land within the reservoir footprint site and pipeline route provides non-commercial opportunities for recreation on individual private lands. There are no designated public recreation areas within the reservoir footprint or along the 35-mile proposed pipeline route. Private landowners and their guests access the Bois d'Arc Creek for recreation activities such as boating, wildlife observation including occasional bird watching, fishing, hunting (for deer, feral hogs, waterfowl, and dove), trapping, and enjoyment of scenic natural beauty (Graves, 2010; Freese and Nichols, 2008a).

One private recreation area in the immediate vicinity 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. Eight percent of the revenue at this golf course comes from out of town golfers, and nine of the 18 holes currently sit below the flood plain level of 541 feet (Rich, 2010).

3.6.2 Other Sites

The affected environment, in regards to recreation, also includes lakes, parks, public and private lands within Fannin, Grayson, Collin, Lamar, Hunt, and Delta counties, primarily Fannin County. This also includes the Caddo National Grasslands, managed by the U.S. Forest Service. Public recreation lands within this area include the following lakes and reservoirs, as listed in Table 3-28.

Table 3-28. Lakes and reservoirs with recreation nearby the proposed LBCR

Lake/Park Name	County	Managing Authority
Primary ROI		
Bonham City Lake	Fannin	City of Bonham
Bonham State Park	Fannin	Texas Parks and Wildlife
Coffee Mill Lake	Fannin (Caddo Nat. Grassland)	US Forest Service
Lake Fannin	Fannin (Caddo Nat. Grassland)	US Forest Service
Davy Crockett Lake	Fannin (Caddo Nat. Grassland)	US Forest Service
Secondary ROI		
Big Creek Reservoir	Delta	Delta County Clerk
Cooper Lake	Delta	Texas Parks and Wildlife
Lake Crook	Lamar	City of Paris
Pat Mayse Lake	Lamar	Army Corps of Engineers
Lake Lavon	Collin	Army Corps of Engineers
Lake Texoma	Grayson	Army Corps of Engineers
Lake Tawakoni	Hunt	Sabine River Authority; Texas Parks and Wildlife
Lake Ray Roberts	Grayson	Texas Parks and Wildlife

Sources: TPWD, 2007c; TPWD, 2007d; TPWD, 2007e; TPWD, 2010c; TPWD, 2010d; TPWD, 2010e; TPWD, 2010f; TPWD, 2010g; TPWD, 2010h; TPWD, 2010i; TPWD, 2010j; TPWD, 2010k

These lakes generate substantial benefits for the local economy, as well as providing locals with recreation and economic opportunities. While several of these lakes managed by city or county governments do not keep records regarding visitation numbers or economic benefits, lakes and parks managed by the USACE and TPWD do record these data. However, because different authorities collect slightly different types of data, or have data available from different times, visitor number and visitor expenditures are in slightly different formats. Nevertheless, the information still provides a point of reference, from which we can predict potential future data. Available data can be found in Table 3-29.

As is evident from the information in Table 3-29, man-made lakes in the area surrounding the proposed project vary considerably in size, visitation, water fluctuation and clarity. Closer inspection reveals that visitation numbers do not correlate directly with lake size or water fluctuation level. Visitation levels and quality of recreation could be affected by a variety of factors, including income level in the surrounding area, quality and number of developed recreational facilities, biological or geological factors, and proximity to population centers. While some lakes experience considerable water fluctuation, which may adversely affect recreation quality for locals and non-local visitors, other lakes, including Bonham State Park, do not experience significant fluctuation. Many lakes in the affected environment have a highly developed recreation and tourism industry with convenient facilities for recreational activities. A number of these lakes have high levels of visitors, many of whom are non-local and thus contribute to a local tourism economy through their spending.

Other public recreational opportunities are found at the two-unit, three-lake, 17,785-acre Caddo National Grasslands. The Grasslands provide opportunities for recreation such as camping, hiking, fishing, hunting, horseback riding, mountain biking, wildlife viewing and photography (USFS, 2008).

3.7 VISUAL RESOURCES

3.7.1 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/or artificial elements of a given landscape and the arrangement and interaction between them is fundamental to visual resources impacts analysis (USDA, 2007). A "viewshed" is a subset of a landscape unit and consists of all the surface areas visible from an observer's viewpoint. The limits of a viewshed are defined as the visual limits of the views located from the proposed project. A viewshed also includes the locations of viewers likely to be affected by visual changes brought about by project features (Caltrans, no date). The ROI for this analysis is the viewshed of the proposed reservoir.

Federal land management agencies such as the Bureau of Land Management (BLM), USFS, and National Park Service are very concerned with managing visual resources. Visual resource management (VRM) is a system developed by BLM for minimizing the visual impacts of surface-disturbing activities and maintaining scenic values for the future. While BLM's VRM was developed for application on the public lands managed by that agency, 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 identifying the visual resources of an area and assigning them to inventory classes using BLM's visual resource inventory process (BLM, no date). Classes I and II are the most valued, Class III represents a moderate value, and Class IV represents the least value. 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.

Table 3-29. Available recreation opportunities, visitation statistics, water fluctuation and clarity descriptions of nearby lakes

Lake Name	County/Counties	Recreation Facilities/Activities	Size (water acres)	Average Visitors (2008-2010, TWPD Lakes) or 2006 Visitors (USACE Lakes)	Water Fluctuation	Water Clarity
Bonham State Park Lake	Fannin	Camping (campground), swimming, fishing, hiking, playground, boating, picnicking	65	31,142	Minimal	Moderate
Pat Mayse Lake	Lamar	Fishing, dock, picnic areas, camping	5,993	289,291	Moderate (2-4 ft)	Stained
Cooper Lake (Jim Chapman Lake)	Delta and Hopkins	Camping (campground), shelters, cabins, beaches, picnic areas, boat ramps, lighted fishing piers	19,300	388,226	Moderate	Stained
Lake Lavon	Collin	Fishing, dock, picnic areas, camping	21,400	1,330,368	Moderate	Moderate
Ray Roberts Lake	Denton, Cook, Grayson	fishing, camping, picnic areas, boat gas, courtesy docks	25,600	662,810	Moderate (3-5 ft)	Clear
Lake Tawakoni	Hunt, Rains, Van Zandt	Fishing, camping, RV sites, motels, boat ramps, bait and tackle shops, water sports	37,879	67,144	Considerable 3-9 feet	Moderately stained
Lake Texoma	Grayson, Cooke	Fishing, camping, picnicking, resorts, cabin rentals, lake house rentals, condo rentals, inns, motels, sailing, golfing	88,000	6,068,032	Considerable 5-8 feet annually	Moderate to clear

Sources: Sunder, 2011; TPWD, 2007e; TPWD, 2010d; TPWD, 2010f; TPWD, 2010h; TPWD, 2010i; TPWD, 2010j; TPWD, 2010k; USACE, 2010

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 given an A, B, or C rating based on its aggregate score in the seven rating criteria.

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.

3.7.2 Visual Setting

The proposed reservoir would affect an area of 17,068 acres of various land use types. The Bois d'Arc Creek, surrounding wetlands, and riparian areas consist of 36 percent (6,180 acres) of the land affected. Cropland, grassland, and old field succession account for another 38 percent (6,518 acres) of the affected area. The remaining area is predominantly forested land with a small area used for transportation, and scattered single family homes (Freese and Nichols, 2008a). The elevations within the proposed reservoir footprint range from 462 to 553.5 feet msl. A maximum change in elevation of 92 feet means a generally flat to gently sloping landscape, thus providing minimal relief to the visual aesthetic.

Due to the large area covered by the proposed action, the visual resource inventory was broken into three Scenic Quality Rating Units (SQRU's). According to the VRM guidelines, SQRU's are delineated on a basis of like physiographic characteristics, areas of similar visual patterns, texture, and color, and areas which have similar impacts from man-made modifications (BLM, no date). In this case they were broken up primarily based on the land cover types described above. See Figure 3-39 for a map of the SQRU's.

The first type of land cover to be addressed will be the creek itself and the wetlands adjacent to the creek (SQRU-1). This first SQRU receives an overall scenic quality score of 12, at the low end of the B range (12-18). The results of the inventory are shown in Table 3-30. The sensitivity analysis results are shown in Table 3-31.

Table 3-30. VRM Scenic quality inventory and evaluation chart for Bois d'Arc Creek and adjacent riparian area (SQRU-1)

Key factors	Score
Landform	2
Vegetation	3
Water	3
Color	3
Influence of adjacent scenery	0
Scarcity	1
Cultural modifications	0
Overall score	**12**

The last evaluation step of VRM's visual resource inventory for the creek and riparian land cover type is to assign a distance zone. This area would be ranked as primarily foreground-middle ground; it is seen from locations less than 3-5 miles away.

Table 3-31. VRM Sensitivity level analysis for LBDC and adjacent riparian area (SQRU-1)

Indicators of public concern	Sensitivity level
Type of users	Low
Amount of use	Low
Public interest	Medium
Adjacent land uses	Low
Special areas	Low
Other factors	Low
Overall rating	**Low**

Based on these three evaluations, the VRM inventory class assigned to the creek and surrounding wetlands was Class III. Class III represents areas of moderate visual value.

The next area evaluated was SQRU-2 which consists of cropland, grassland, and old field succession land types. The cropland and grasslands category received overall scenic quality score of 10, which rates a grade of C. The distance zone is primarily foreground-middle ground; it is seen from locations less than 3-5 miles away.

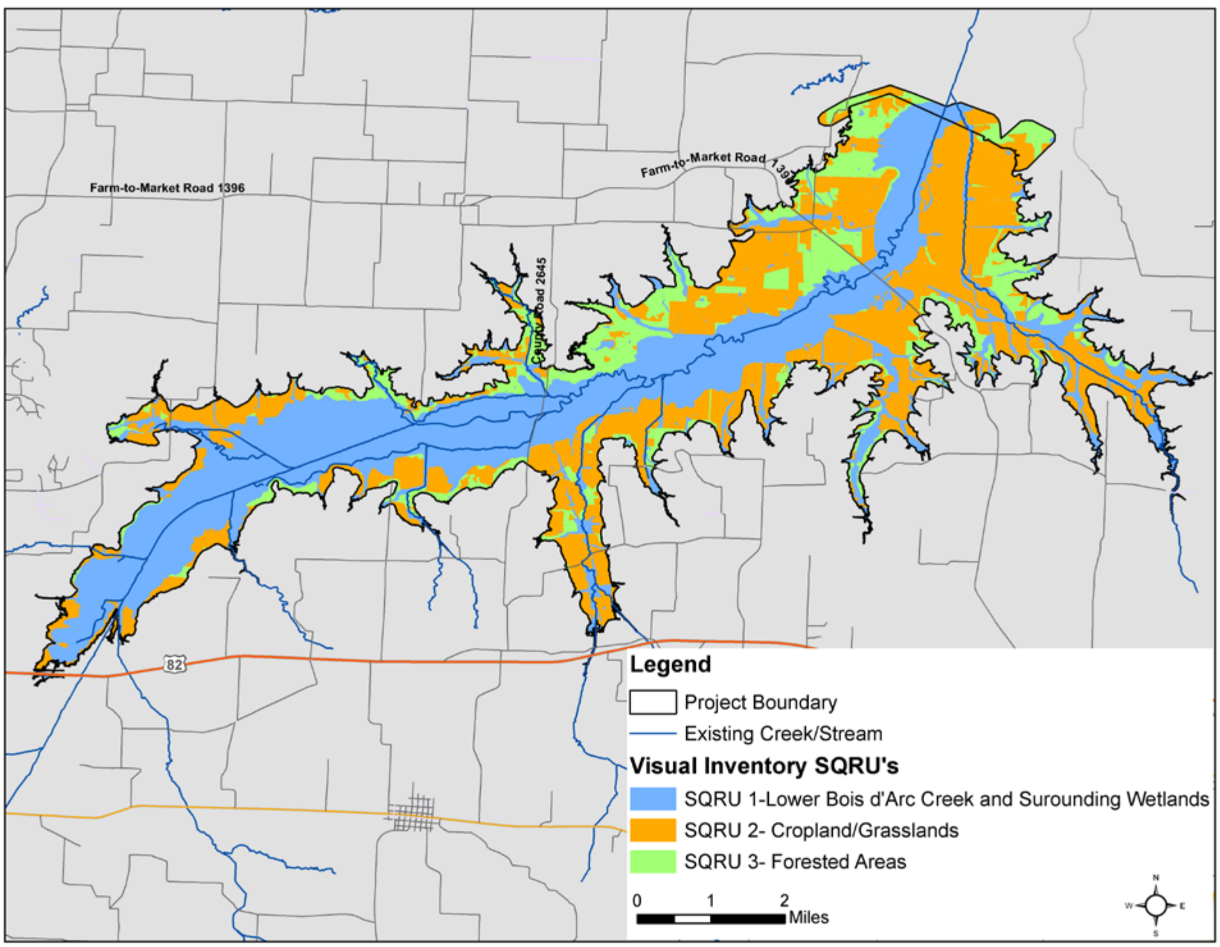


Figure 3-39. Visual Resource Inventory SQRU's

Overall, the visual resource management inventory class assigned to SQRU-2 is Class IV. Class IV represents areas of the least visual value.

The last type of land cover type addressed was the upland forest or woodlands ("forested areas" in Figure 3-39); this includes deciduous forest, evergreen forest, tree savanna, and shrubland (SQRU-3). SQRU-3 receives an overall scenic quality score of 11 which is a C. Overall, the visual resource management inventory class assigned to SQRU-3 is Class IV, representing areas of the least visual value.

Overall, the three ratings for the entire proposed reservoir location range from Class III to Class IV, 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.

3.8 LAND USE

The proposed sites for the Lower Bois d'Arc Creek Reservoir and associated pipeline, water treatment facility, and mitigation site are within Fannin County, Texas, which is the ROI for the project. This is a rural county located 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 the majority of residents being 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 agricultural, which is made up of 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).

3.8.1 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) (Freese and Nichols, 2008c).

3.8.2 Current Land Use

Based on the 2001 National Land Cover Dataset, there are a total of 570,597 acres in Fannin County. Six percent of the land is developed and 71 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 open water (1.27 percent), wetlands (0.42 percent), barren land (0.15 percent), and shrub/scrub (0.06 percent) (Freese and Nichols, 2008a).

The proposed Lower Bois d'Arc Creek Reservoir project would cover 17,068 acres of bottomland and adjacent upland habitat along Bois d'Arc Creek in Fannin County, Texas. This land is predominantly undeveloped. Approximately 10.3%, or 1,757 acres, is in agricultural land use with an additional 27.9%, or 4,761 acres, in grassland or old field succession. The remaining majority is in undeveloped land use consisting of various natural or previously disturbed vegetative cover types. A very small portion is in transportation, utility corridor, and scattered single family residential land use. Land use of the adjoining properties does not differ substantially from that found within the boundaries of the proposed reservoir, with most of the area being agricultural or undeveloped land, but the percentages of land use types differ. 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 as opposed to undeveloped land and a greater proportion of the undeveloped lands have been cleared (Freese and Nichols, 2008a).

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 LBCR site. Public recreational facilities are not present within the LBCR area. If there are recreational activities in the area, such as hunting and hiking, the activities are restricted to the present owners of the properties and their guests (Freese and Nichols, 2008a).

The NTMWD has purchased and proposes to restore natural habitats on the Riverby Ranch to mitigate impacts to waters of the United States from the Lower Bois d'Arc Creek Reservoir. This area consists of an approximately 15,000-acre farm and ranch. The property is located almost entirely within Fannin County with only a small portion in Lamar County. It is partially within the Bois d'Arc Creek watershed, downstream and northeast of the proposed dam site. The Riverby Ranch abuts the Red River along its northern edge. It is primarily used for grazing and crop production at present. The Riverby Ranch currently includes a variety of different cover types, ranging from bottomland hardwood forest to cropland and grassland. Figure 3-40 is a map of current land use in the county excluding the proposed reservoir site; see Figure 3-20 for land cover within the reservoir footprint.

3.8.3 Farmland

Farmland, also known as agricultural land, denotes the land suitable for agricultural production, both crop and livestock. The standard classification divides agricultural land 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 land in permanent crops, constitute so-called cultivable land. The part of arable land actually under crops is called sown land or cropped land. The term farmland is ambiguous in the sense that it may refer to agricultural land or to cultivable or even only arable land. Table 3-32 provides agricultural statistics for Fannin County.

Table 3-32. Agriculture in Fannin County

Average size of farms	245 acres
Average number of cattle and calves per 100 acres of all land in farms	18.41
Harvested cropland as a percentage of land in farms	33.23%
Corn for grain	16,773 harvested acres
All wheat for grain	40,805 harvested acres
Upland cotton	144 harvested acres
Soybeans for beans	11,775 harvested acres
Vegetables	12 harvested acres
Land in orchards	1,240 acres

Source: City-Data.com, 2010

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. This cover type makes up about 1,757 acres of the proposed LBCR. Prime Farmland is addressed in Section 3.1.3.

A recent trend in land use in some parts of the survey area has been the loss of some farmland to industrial and urban uses. The loss of farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated (NRCS, 2001).

3.8.4 Rural Residential

The majority of housing in Fannin County consists of single family residences. Scattered single family residential land use also occurs within the proposed reservoir footprint. Within the footprint of the proposed reservoir are approximately 20 single family homes that would be demolished prior flooding. See Figure 3-41. The majority of these homes had already been acquired by the NTMWD. All remaining units would have to be purchased before construction could begin (McCarthy, 2011).

3.9 UTILITIES

The ROI for utilities is the reservoir footprint itself. While the majority of the land potentially affected by the proposed LBCR and associated pipeline, water treatment facility, and mitigation site is undeveloped, a very small portion is in utility corridors (electrical transmission lines).

Overhead power lines run within the vicinity of the Lower Bois d'Arc Creek reservoir. Overhead power lines are electric power transmission or distribution lines suspended by towers or utility poles. Since most of the insulation is provided by air, overhead power lines are generally the lowest cost method of transmission for large quantities of electric energy. Towers or poles are made of wood or steel. The bare wire conductors on the lines are generally made of aluminum. Figure 3-42 shows electric lines that could potentially be affected by the reservoir. These power lines are classified as medium voltage distribution lines. They 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 would potentially be raised above the conservation pool or would require deconstruction and relocation.

3.10 TRANSPORTATION

The ROI for transportation is the reservoir footprint itself and the surrounding areas of Fannin County. This is a discussion of the existing transportation resources near the proposed 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 but the north, where only one route, Hwy. 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 site is achieved mainly via road and street networks. The closest interstate is approximately 40 miles south which is Interstate (I)-30 running 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 everyday work, living, and recreation trips. Fannin County and its surrounding transportation area is known as the Paris District (TxDOT, 2010).

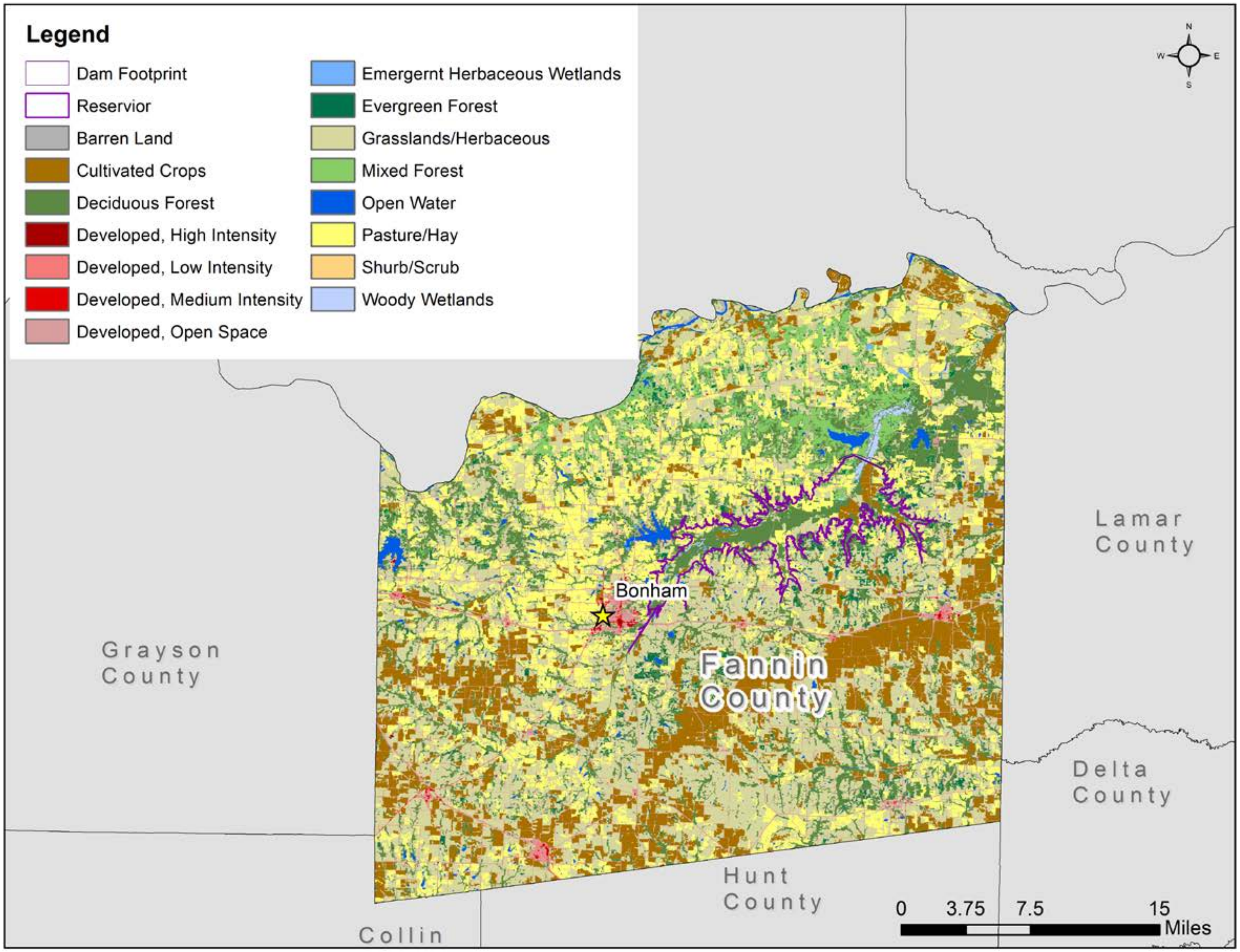


Figure 3-40. Fannin County land use map

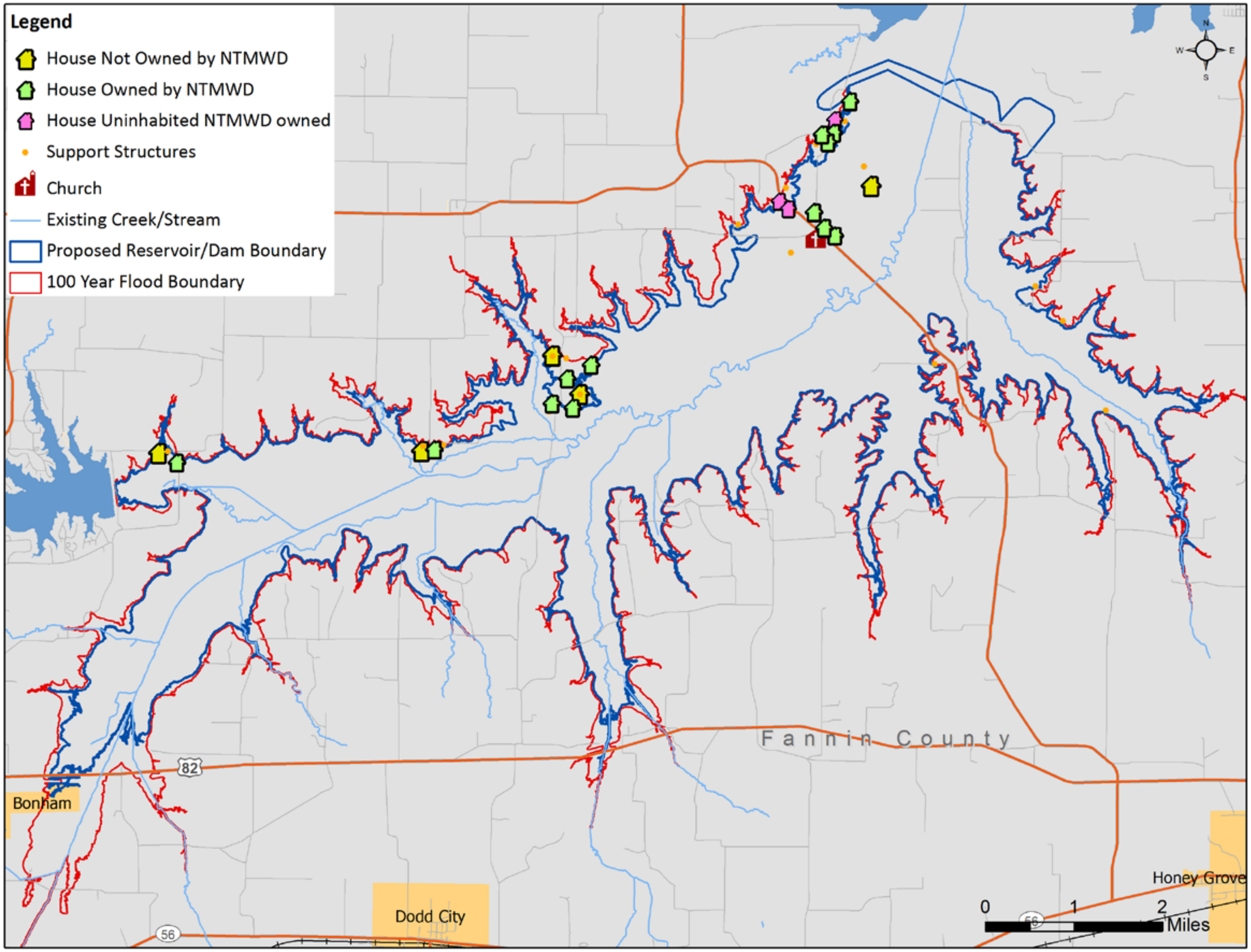


Figure 3-41. Houses and other structures within the proposed reservoir footprint

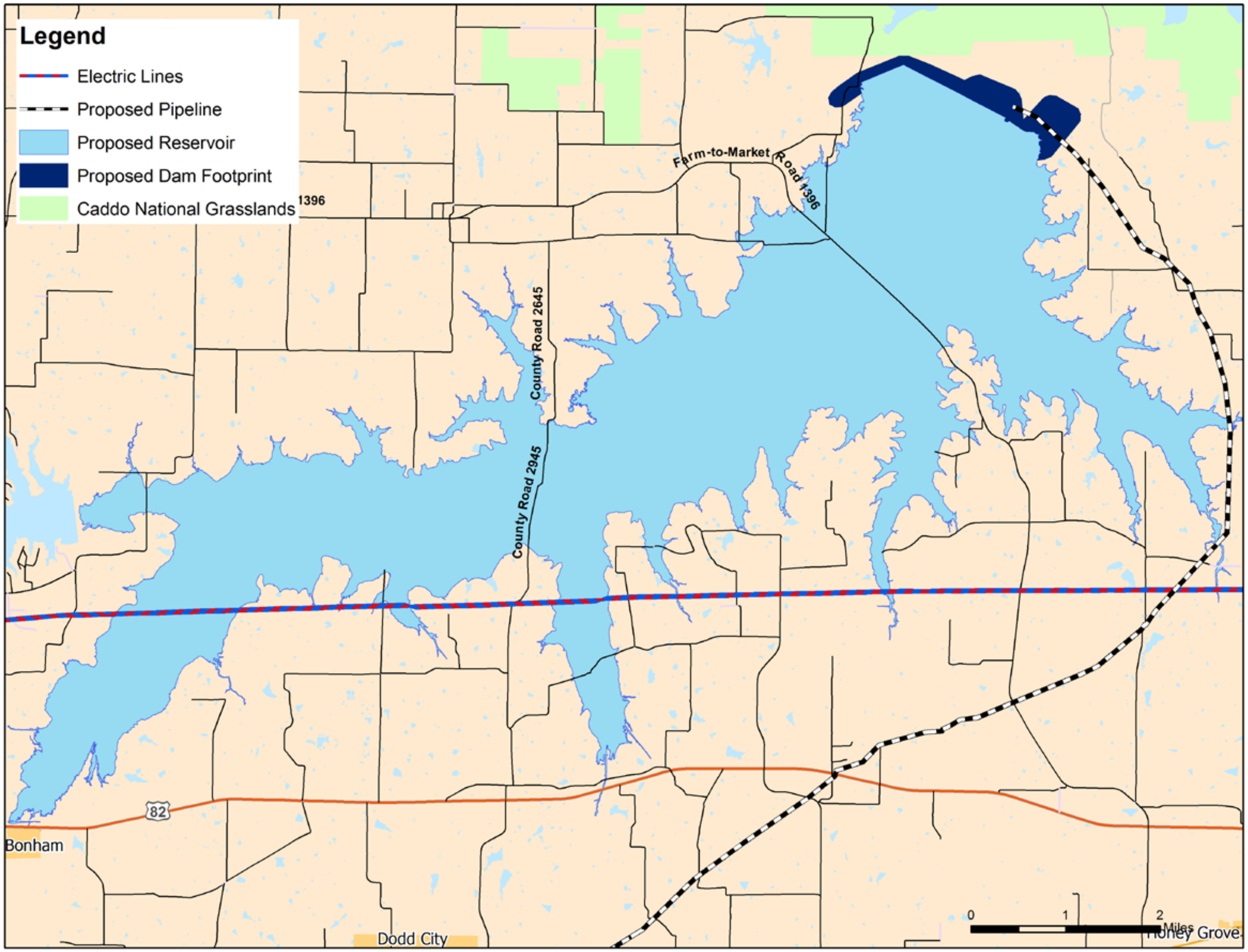


Figure 3-42. Above-ground power lines within the proposed reservoir footprint

A network of State highways and Farm to Market roads leads to major Interstates but there is no direct route to an Interstate from the proposed site. The proposed dam development is between Farm to Market Road (FM) 1396 and FM 409, southwest of the Caddo National Grassland. The closest settlements to the proposed site are Allens Chapel approximately four miles to the south, and Telephone approximately five (5) miles to the north. Highway 121, west of Lake Bonham, travels northeast to Highway 78 and crosses the Red River reaching Bryan County (Figure 3-43). Due to Fannin County's rural location, public transit is unavailable. There is no cohesive network supporting non-motorized and pedestrian transportation.

Average daily traffic counts for Highway 121 approaching the city of Bonham from Trenton are approximately 5,300 vehicle trips per day (vpd). The roadway most likely to be affected is FM 1396, which is adjacent to and crosses the proposed project site but is not listed in the Texas Department of Transportation (TxDOT) traffic counts. A list of roads that currently transect the 16,641-acre proposed reservoir area is presented in Table 3-33. Traffic on roadways surrounding the proposed development is free-flowing during both the a.m. and p.m. peak traffic periods.

Table 3-33. Roadways within the proposed site boundaries

Road Name	Road Length in miles (kilometers)
Farm-to-Market Road 1396	2.1 (3.4)
County Road 2945 & County Rd 2645	1.4 (2.2)
County Road 2655	1.0 (1.7)
County Road 2705	0.8 (1.2)
County Road 2950	0.6 (0.9)
County Road 2700	0.5 (0.8)
County Road 2610	0.3 (0.4)

3.10.2 Air Transit, Rail, and Boating

The North Texas Regional Airport (GYI) is approximately 40 miles west of the proposed dam site. North Texas Regional Airport was founded in 1941 as a training site for World War II pilots and part of the Perrin Air Force Base. Grayson County currently owns and operates GYI, which averages 146 flights per day including single- and multi- engine prop planes, small jets, helicopters, and ultralights (AirNav, 2010). 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, ranked 3rd in the world for operations, opened in 1974 and serves approximately 154,000 passengers daily (DFW, 2010).

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 service to Bonham, and the closest passenger station is approximately 60 miles from the proposed site in Gainesville.

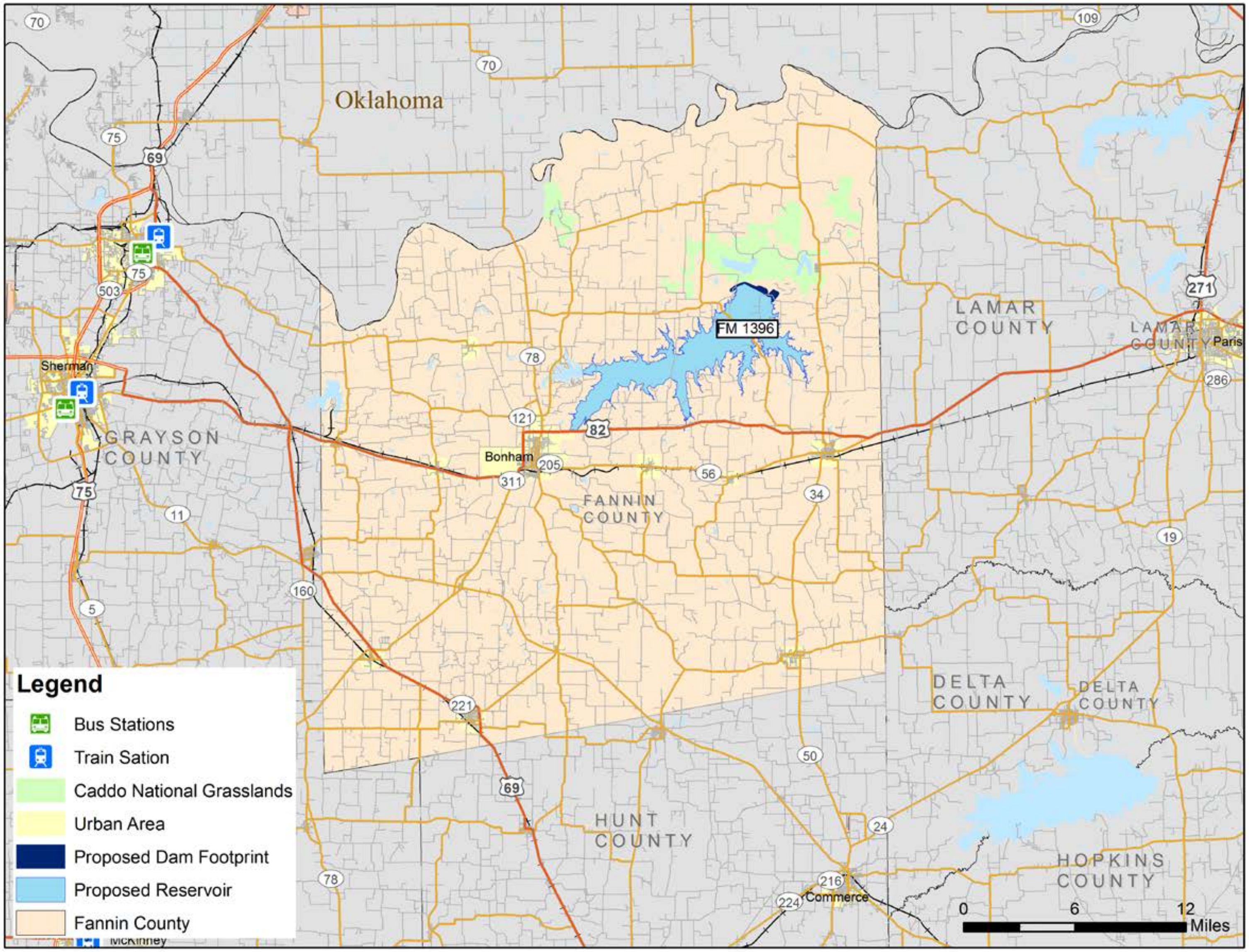


Figure 3-43. Road network in Fannin County and surrounding areas

3.11 ENVIRONMENTAL CONTAMINANTS AND TOXIC WASTES

The ROI for environmental contaminants and toxic wastes is the reservoir footprint itself and areas immediately adjacent to it. This section is based entirely on a limited Phase I Environmental Site Assessment (ESA) conducted by Freese and Nichols for NTMWD in 2010 (Freese and Nichols, 2010c). The purpose of this preliminary study was to broadly characterize environmental conditions at a 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 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 Phase I ESA, but it was conducted in accordance with 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

Future site visits may be made to specific areas of concern at a later date, as appropriate (Freese and Nichols, 2010c).

Aerial photographs studied in the limited Phase I ESA indicate that little development in the area has taken place over the past half-century, other than an increase in agricultural land and homesteads on the outskirts of the proposed reservoir. Heavy farming on agricultural lands is in evidence within the proposed reservoir and environs over the past three decades. The Fannin County Clerk's Office did not have any environmental records for the Project Area or surrounding areas. A review of the regulatory database searches by the specialists Environmental Data Resources, Inc. (EDR) did not disclose any current or historical facilities or incidents that are likely to pose a problem (Freese and Nichols, 2010c).

Agricultural activities conducted in recent decades have included livestock grazing, hay production, and row crop production. It is very probable that agricultural chemicals such as fertilizers, herbicides and pesticides, and petroleum products have been used in the 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 limited Phase I ESA found no documentation of historical industrial facilities or commercial businesses within the proposed reservoir footprint or nearby.

In sum, the limited Phase I ESA did not identify any recognized or potential environmental concerns in the project area (Freese and Nichols, 2010c).

In March 2011, NTMWD was notified by a local resident of suspected illegal disposal and burning of tires on property already purchased by NTMWD and within the LBCR footprint. On behalf of NTMWD, FNI staff conducted a site visit on March 14, 2011 to the tire dump 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, wheels 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 (COCs) 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 heavy metals (RCRA list) (Chambers, 2012).

Thirty-three soil samples were analyzed in a laboratory. VOCs and PAHs were considered to be potential COCs due to the burning of the rubber tires. Several of these organic COCs were detected in many of the samples, however, all detected concentrations were below applicable Tier 1 Protective Concentration Levels (PCLs). Several heavy metals – in particular arsenic, barium, cadmium, lead and selenium – were also found in samples from the tire pits and in adjacent borings.

The investigation indicated that there was not widespread contamination (i.e., a PCL exceedance zone) at the site caused by 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, but 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. Under the scenarios outlined by TCEQ, this site appeared eligible for the "excavation option." If confirmation samples collected after excavation and removal of tire wastes are below action levels, 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.

At the request of NTMWD, this illicit disposal dump and burning site was cleaned up by a contractor under the supervision of Freese and Nichols late in 2012. Notice to proceed was issued on November 15, 2012 and 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 dump/burning site indicate that it is eligible for "no further action" approval from the Texas Commission on Environmental Quality (TCEQ). FNI prepared and submitted a summary report on the investigation of the site and its cleanup to TCEQ.

No further action is expected to be necessary to properly address concerns over toxic/hazardous substances or contaminants on this site.

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. 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. This section addresses the socioeconomic conditions that may be affected by implementation of the proposed actions and any potential sources of impact.

The proposed dam and impoundment are contained within Fannin County, and therefore this county represents the primary focus for any direct impacts that may be associated with implementation of the proposed action. In addition to Fannin County, the five directly surrounding counties – Collin, Hunt, Lamar, Grayson, Delta – are defined as the Region of Influence (ROI) since indirect impacts to individuals, communities, and economic systems are expected, though to a smaller extent. Demographic and economic data are provided to examine the potential impact on employment and worker housing needs during the construction phase, and also due to the fact that NTMWD serves Collin and Hunt counties. Regional impacts would also be expected to the entire NTMWD service area, since the provision of needed water would allow for realization of projected long-term population and economic growth projections within the entire NTMWD service area as discussed in Chapter 1.

As shown in Figure 3-44, 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. The Riverby Ranch, the proposed mitigation area, is located almost entirely in Fannin County except for 109 acres in Lamar County; or less than one percent of its area. Riverby is an approximately 15,000-acre farm and ranch property used primarily for grazing and crop production. 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 4-5 year project construction period. Recurring annual local economic impacts would be expected to occur in Fannin and Lamar counties through the multi-decadal operational life of the project.

Table 3-34 lists those counties within the ROI. These are a table representation of the socioeconomic concerns from the Cause-Effects-Questions diagram (C-E-Q) used to solicit input during scoping meetings.

3.12.1 Population

3.12.1.1 Existing Population

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 Census population of 763,934. As shown in Table 3-35, 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 7th 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 9 percent, respectively, over this same time period. Fannin County experienced still lesser, though still positive growth, at 9 percent. Lamar had the lowest positive growth, at 3 percent. Delta County, the smallest in population size of the five affected counties, grew negatively by 2 percent. Figure 3-45 depicts population centers within Fannin County itself.

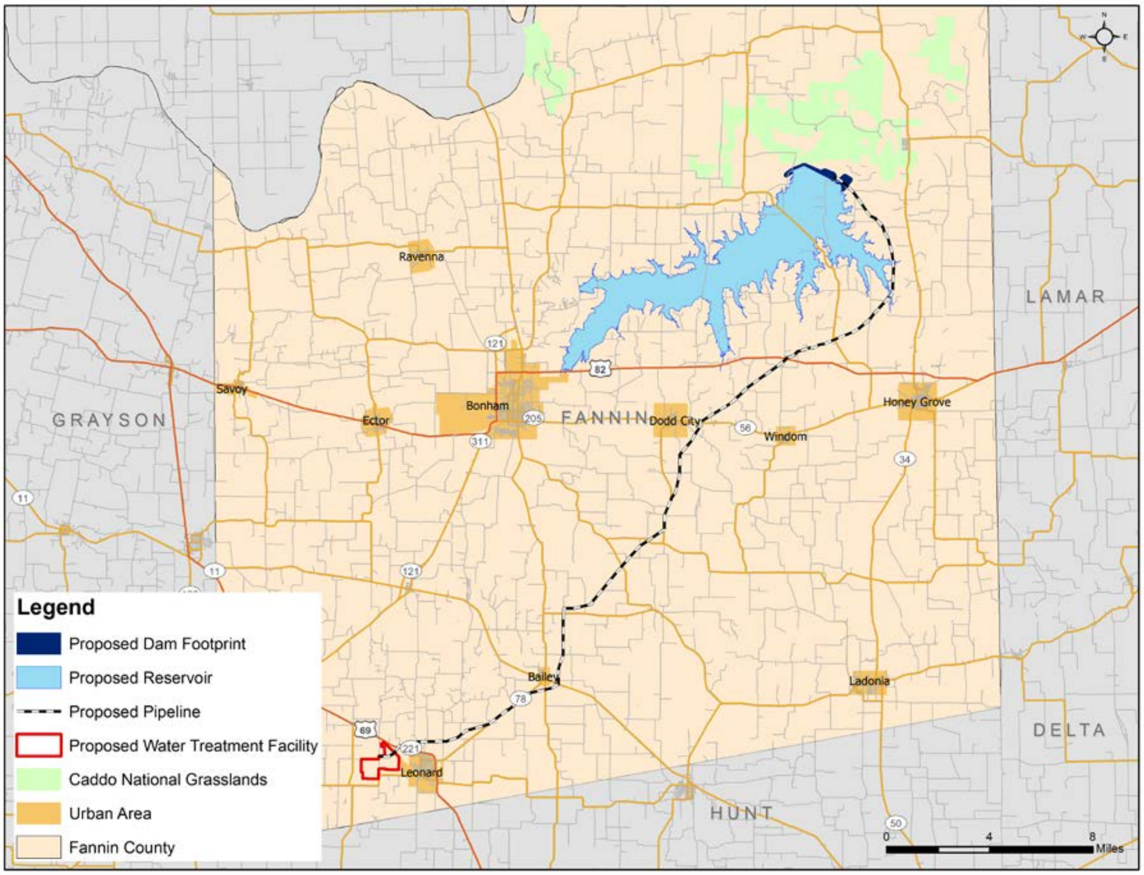


Figure 3-44. Map of proposed reservoir, Fannin and selected surrounding counties

Statewide, the population grew from 20,851,820 in the 2000 Census to 25,145,561 in the 2010 Census, a net increase of 4,293,741 or 21 percent. The Fannin, Hunt, Lamar, Grayson, and Delta county populations, then, grew at rates slower than that of the state of Texas.

3.12.1.2 Projected Population Change

As seen in Table 3-36, the population of Texas is expected to increase from the 2000 U.S. Census level of 20,851,820 to 46.3 million by 2060 (Census, 2000g; TWDB, 2011b) and the state population projections show the NTMWD's service population to increase from 1.5 million to 3.3 million by 2060 (Freese and Nichols, 2006b; TWDB, 2006). Fannin County itself is expected to grow at a faster pace than the state over this same time span.

The six-county ROI is expected to grow at a very fast pace well into the foreseeable future. As exhibited in Table 3-36 and 3-37, Collin County is forecasted to be responsible for most of the six counties' growth. Collin County is expected to add over a million to its not-yet one million current population, or by 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 significantly 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.

Table 3-34. 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	✓					
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	✓	✓		✓		

Table 3-35. Population change in ROI and Texas, 2000-2010

County	Population Estimates				
	2000 Census	2010 Census	Numeric Change	Percent Change	TX Rank
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
Totals	**763,934**	**1,078,286**	**314,352**	**41.1%**	**n/a**
State of Texas	20,851,820	25,145,561	4,293,741	20.6%	n/a

Sources: U.S. Census Bureau, 2000 and 2010

Table 3-36. 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
Totals	**1,078,286**	**1,398,458**	**1,672,575**	**1,999,539**	**2,331,172**	**2,639,530**
Texas	25,145,561	29,650,388	33,712,020	37,734,422	41,924,167	46,323,725

Sources: Census, 2010 and TWDB, 2011b

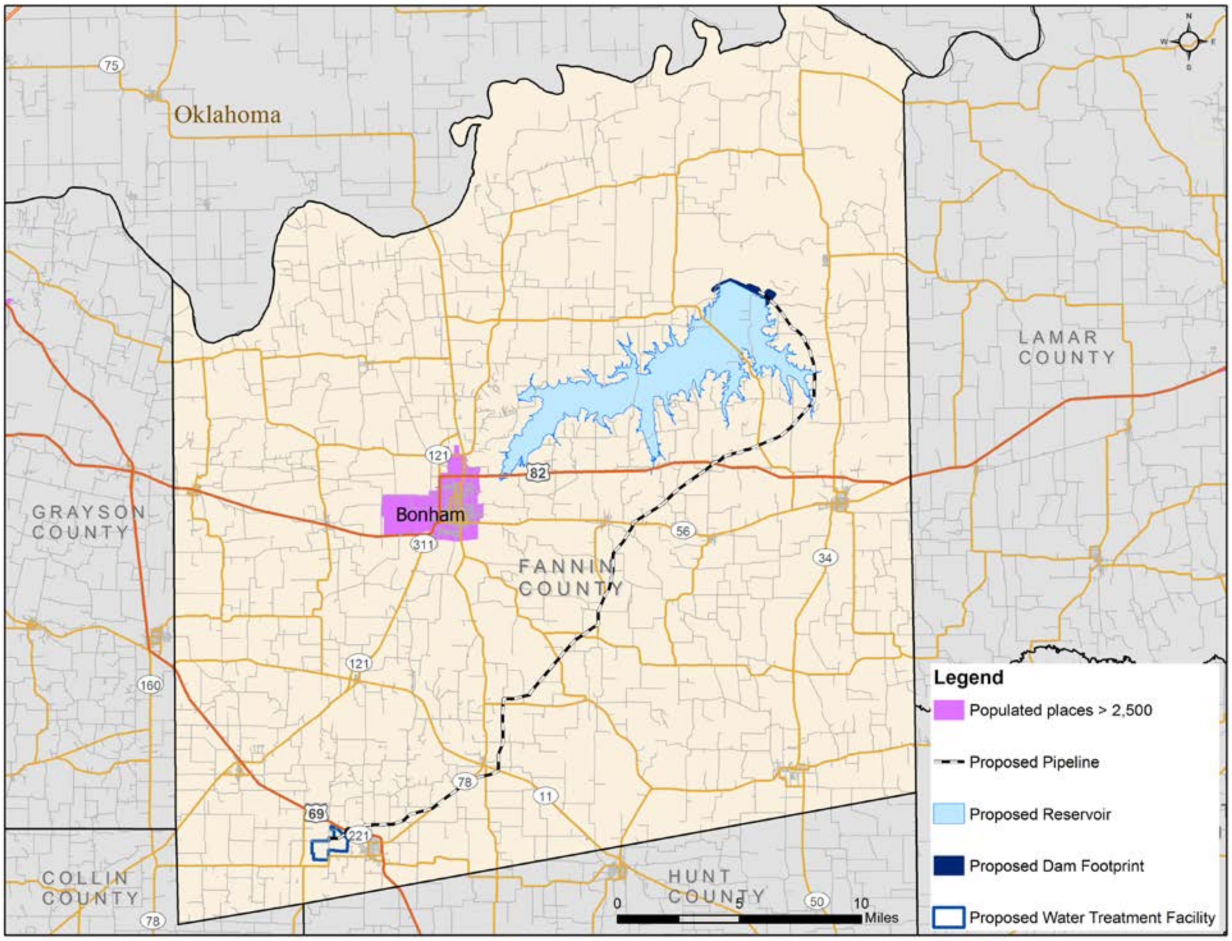


Figure 3-45. Population distribution in Fannin County

Table 3-37. 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%
Totals	**29.7%**	**19.6%**	**19.5%**	**16.6%**	**13.2%**	**144.8%**
Texas	17.9%	13.7%	11.9%	11.1%	10.5%	84.2%

3.12.1.3 Community Cohesion

As documented in the 2010 Scoping Report, comments included concern 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 don't share the same values (USACE, 2010).

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, 2003).

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 (Caltrans, 1997).

Cohesion can be greatly affected by the physical layout of the community. Lynch (1960), in his 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.

- *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 (Lynch, 1960).

Community Cohesion Indicators: Fannin County

Based on the 2010 census, news articles, and phone interviews with community leaders, Fannin County has a medium level of community cohesion.

Fifty-six 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. Additionally, 71 percent of the all households are family households.

Of the 7,048 children under the age of 17 in Fannin County, 6,376 live with two parents. Approximately 35 percent of those children had only one parent in the labor force, or (presumably) one parent at home. Additionally, 17 percent of Fannin County's population is over the age of 65 (Census, 2010c), a relatively high concentration.

Since social classes lack clear boundaries and overlap, there are no definite income thresholds as 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 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 (Census, 2010c). 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. As such, Fannin County is considered to be an area with ethnic homogeneity.

Quality of Life

Quality of life can be characterized as a person's well-being and happiness. Like community cohesion, what constitutes a positive quality of life is subjective 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, convenient shopping and services, 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 3.3 Air Quality and Climate and 3.4 Acoustic Environment (Noise) for more information about air quality and noise impacts.

3.12.2 Labor

3.12.2.1 Civilian Labor Force

The size of a county's labor force is measured as the sum total of those currently employed and those actively seeking employment. As can be seen in Table 3-38, from 2000 through 2010 only the Collin County labor force percent change surpassed the statewide percent change of 17.3 percent. The labor force sizes of Fannin, Hunt, Lamar, and Grayson experienced rather slim but still positive rates. That of Delta County actually shrank in size by almost 11 percent. However, the overall percent change for the ROI was 30.8 percent, much higher than the statewide 17.3 percent, due to the overriding influence of Collin County's large labor force within the ROI and its rapid growth rate.

Table 3-38. Annual labor force size in ROI and Texas, 2000-2010

County	Annual Civilian 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
Totals	**433,764**	**502,774**	**567,341**	**30.8**
Texas	10,347,847	11,150,684	12,136,384	17.3

Source: TWC, 2011

3.12.2.2 Employment

Table 3-39 exhibits 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 to experience not only a positive growth rate but one consistently above the statewide growth of 12.6 percent. The number of employed in Lamar County declined from 2000 to 2005, then increased during the 2005 to 2010 period at a level still below that in 2000; with an overall 0.3 percent change over the entire interval. Fannin, Hunt, Grayson, and Delta counties experienced negative growth rates over the entire decade-long interval.

Table 3-39. 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
Totals	**419,342**	**478,150**	**520,955**	**24.2**
Texas	9,896,002	10,551,547	11,141,903	12.6

Source: TWC, 2011

3.12.2.3 Unemployment Rates

The counties of Fannin and Lamar have had annual unemployment rates consistently at or above the statewide averages from 2000 through 2010. Collin County has had consistently lower than state rates of unemployment during this same time period. The unemployment rate in Grayson County was lower than the state level in 2000, and at or above 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 for the state in 2000, was 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 3-46.

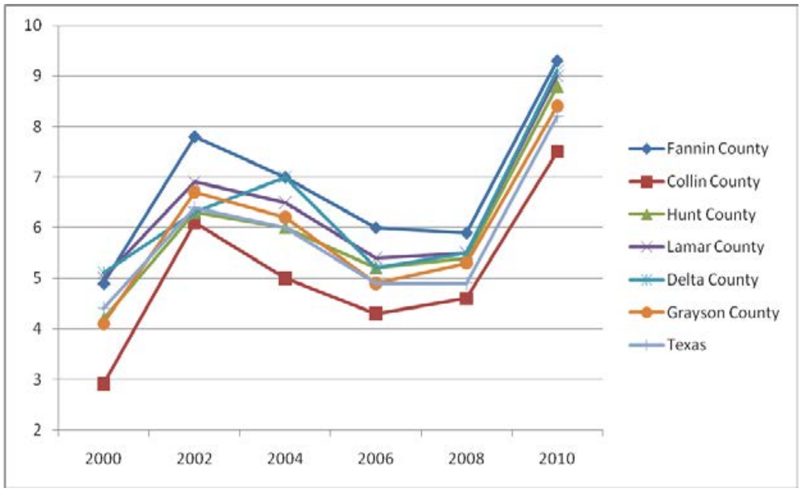


Figure 3-46. Annual unemployment rates in ROI and Texas, 2000-2010
Source: TWC, 2011

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 the place of residence. Per capita personal income, then, is the personal income for the county divided by population in the county. Compensation data, however, are measured and reported for the county of work location, and are typically reported on a per job basis. Total compensation includes wages and salaries as well as employer contribution for employee retirement funds, social security, health insurance, and life insurance.

3.12.3.1 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 (USDOC, 2011a). This includes earnings from work received during the period. It also includes interest and dividends received, as well as 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 3-40 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 per capita smaller than that for the statewide average.

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 increase statewide. 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 3-40. Annual per capita personal income in ROI and Texas (in dollars)

County	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
Texas	28,506	33,220	37,747	32.4

Note: not adjusted for inflation
Source: USDOC, 2011

3.12.3.2 Total Industry Compensation

What is often termed in economic data as total industry compensation is somewhat of a misnomer, in that a portion of the "industry earnings" stems from government-related activity. This will be made clear when the composition of industry compensation is presented later in this report. Nevertheless, total industry compensation provides a good picture of the relative sizes of market related economic activity, or business activity, performed in the various counties (Table 3-41). Collin County clearly dominates in economic activity, with Grayson County coming in distant second.

Table 3-41. Total compensation of employees in ROI (in $1,000s)

County	2001	2005	2010
Fannin	270,405	291,801	314,560
Collin	9,191,622	14,833,163	19,663,877
Hunt	899,538	1,178,016	1,502,058
Lamar	685,189	742,817	867,000
Delta	34,546	29,786	42,889
Grayson	1,632,270	1,800,205	2,015,911

Source: USDOC, 2011

Income is generated by economic activity in the local area counties through a variety of sectors, including various types of business as well as government. This income is not always received by a person in the county, for a person from neighboring counties may cross county lines to go to work. The employee compensation by industry, however, is a measure of economic activity generated in the counties, regardless of where the employee resides.

Compensation for work is broader than salaries and wages. Total compensation 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. Also, rather than measuring per capita personal income, which includes government transfers to people who are not employed, 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.

The average compensation per job for 2010 for the counties which comprise the ROI, are: Fannin, $42,520; Lamar, $42,256; Collin, $64,285; Hunt, $50,585; Grayson, $45,065; and Delta, $29,477. The 2010 statewide average compensation per job is $57,303. The local area counties display a variety of business activity. The sources of economic activity in the six counties are individually discussed below.

3.12.3.3 Fannin County, Compensation by Industry

As can be seen in Table 3-42, Government and Government Services 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 Red River Regional Hospital that 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."

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, 2007). 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 (Pigott, 2012).

Table 3-42. Compensation of employees by industry in Fannin County (in $1,000s)

Sector	2001	2005	2010
Farm	4,051	4,514	4,821
Forestry, Fishing, Related Activities	(D)	(D)	1,822
Mining	(D)	(D)	2,353
Construction	9,885	10,572	7,727
Manufacturing	54,788	31,016	23,828
Transportation and Warehousing	3,171	4,986	6,643
Utilities	5,665	4,906	6,234
Wholesale Trade	9,597	13,596	14,248
Retail Trade	29,333	27,000	29,674
Information	1,282	1,442	1,672
Real Estate &Rental & Leasing	812	1,266	1,566
Finance & Insurance	15,724	19,585	10,711
Professional, Scientific, and Technical Services	4,788	(D)	5,072
Management of Companies	0	(D)	(D)
Administrative and Waste Services	1,346	(D)	(D)
Educational Services	(D)	(D)	(D)
Health Care and Social Assistance	(D)	(D)	(D)
Arts, Entertainment, Recreation	(D)	468	644
Accommodation &Food Services	(D)	5,820	6,372
Other Services Except Public Adm.	9,150	10,489	12,799
Government and Gov't Enterprises	94,473	118,730	146,492

Source: USDOC, 2011; (D) Not shown to avoid disclosure of individual confidential information

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 (Pigott, 2012).

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 milk cattle to beef cattle. Swine production slowly declined in the twentieth century to only a little over a thousand hogs in the 1980s. By 1987, Fannin County had nearly 65,000 beef cattle but only a few thousand producing milk cows. 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 (Pigott, 2012).

Record-breaking droughts and temperatures in the last few years have compounded economic losses in Texas. In 2011, the Texas AgriLife Extension Service economists reported that crops count for about $3.2 billion in losses and livestock accounts for $2.06 billion. Lost hay production was valued at $750 million, cotton had $1.8 billion in losses, corn had $327 million, wheat had $243 million and sorghum had $63 million, according to the AgriLife service. The losses also represent 27.7 percent of the average value of agricultural production over the last four years, according to the AgriLife service (Crowe and Gouch, 2011).

Much of the land to be inundated by the proposed reservoir 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. It has been assumed that of the acreage that would be inundated and the estimated acreage that may be required for environmental mitigation, 50 percent is irrigated crop land valued at $323 per acre for tax purposes; 30 percent is valued at $157 per acre; and 20 percent is improved land at $88 per acre. Typically irrigated land is not used for environmental mitigation (Clower, 2012).

3.12.3.4 Collin County, Compensation by Industry

Table 3-43 displays the compensation of employees by industry for Collin County in 2001, 2005, and 2010. 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.

Table 3-43. Compensation of employees by industry in Collin County (in $1,000s)

Sector	2001	2005	2010
Farm	5,069	5,681	6,246
Forestry, Fishing, Related Activities	1,985	2,845	4,535
Mining	56,817	39,178	131,965
Construction	530,151	771,516	773,024
Manufacturing	1,650,755	2,016,385	2,058,642
Transportation and Warehousing	51,114	143,767	146,032
Utilities	19,540	18,440	51,072
Wholesale Trade	562,671	954,305	1,198,676
Retail Trade	925,299	1,636,757	1,408,688
Information	1,245,719	1,826,647	1,911,718
Real Estate &Rental & Leasing	269,959	245,406	346,340
Finance & Insurance	646,160	1,743,975	1,959,089
Professional, Scientific, and Technical Services	589,925	1,122,414	2,007,142
Management of Companies	56,022	93,597	1,298,365
Administrative and Waste Services	336,147	655,265	997,334
Educational Services	33,777	60,954	946,989
Health Care and Social Assistance	620,482	1,056,303	1,678,040
Arts, Entertainment, Recreation	59,411	106,738	106,211
Accommodation &Food Services	289,103	459,369	585,617
Other Services Except Public Adm.	240,716	351,431	575,823
Government and Gov't Enterprises	1,000,800	1,522,190	2,314,273

Source: USDOC, 2011

3.12.3.5 Hunt County, Compensation by Industry

Table 3-44 below displays the compensation of employees by industry for Hunt County in 2001, 2005, and 2010. In 2010 the manufacturing sector, primarily of wood products, 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. The City of Greenville contains the Greenville Municipal Airport, and Hunt Regional Healthcare serves the county.

Table 3-44. Compensation of Employees by Industry in Hunt County (in $1,000s)

Sector	2001	2005	2010
Farm	1,985	3,117	4,232
Forestry, Fishing, Related Activities	(D)	(D)	(D)
Mining	(D)	(D)	(D)
Construction	37,208	38,840	39,312
Manufacturing	324,403	455,549	641,387
Transportation and Warehousing	22,830	34,353	35,149
Utilities	9,791	11,455	14,214
Wholesale Trade	26,421	46,191	41,929
Retail Trade	70,587	82,393	95,350
Information	16,034	10,608	11,946
Real Estate &Rental & Leasing	6,500	10,913	9,331
Finance & Insurance	21,431	28,394	31,841
Professional, Scien. & Tech. Services	16,645	27,055	42,301
Management of Companies	0	(D)	(D)
Administrative and Waste Services	10,635	(D)	(D)
Educational Services	2,247	2,924	4,636
Health Care and Social Assistance	50,754	73,292	98,370
Arts, Entertainment, Recreation	1,481	2,519	2,054
Accommodation &Food Services	24,442	27,694	34,691
Other Services Except Public Adm.	26,026	30,377	38,817
Government and Gov't Enterprises	228,232	280,254	337,302

Source: USDOC, 2011
(D) Not shown to avoid disclosure of individual confidential information

3.12.3.6 Lamar County, Compensation by Industry

Table 3-45 below displays the compensation of employees by industry for Lamar County in 2001, 2005, and 2010. In 2010 the manufacturing sector, especially of durable goods, was the leader in employee compensation, reaching $262.8 million in total compensation. The county is home to several historic homes, in addition to a 65-foot high replica of the Eiffel Tower in its county seat, Paris. Government and government enterprises and Health Care and Social Assistance are close second and third sources for 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 center for healthcare for much of Northeast Texas and Southeast Oklahoma. Both campuses are now operated jointly under the name of the Paris Regional Medical Center, a division of Essent Healthcare. The health network is the largest employer in the Paris area.

Table 3-45. Compensation of employees by industry in Lamar County (in $1,000s)

Sector	2001	2005	2010
Farm	2,349	2,703	3,061
Forestry, Fishing, Related Activities	(D)	(D)	(D)
Mining	(D)	(D)	(D)
Construction	22,108	29,723	57,845
Manufacturing	250,642	235,286	262,826
Transportation and Warehousing	13,824	21,154	18,228
Utilities	11,085	19,859	18,200
Wholesale Trade	17,137	19,138	16,352
Retail Trade	57,415	64,506	71,386
Information	7,240	8,285	6,848
Real Estate &Rental & Leasing	2,685	3,477	4,004
Finance & Insurance	20,979	24,843	34,102
Professional, Scientific, and Technical Services	(D)	(D)	(D)
Management of Companies	(D)	(D)	(D)
Administrative and Waste Services	13,174	15,659	22,206
Educational Services	478	631	1,098
Health Care and Social Assistance	103,086	114,375	126,284
Arts, Entertainment, Recreation	1,814	1,328	4,794
Accommodation &Food Services	19,131	19,545	25,804
Other Services Except Public Adm.	19,485	23,503	25,958
Government and Gov't Enterprises	112,136	127,275	150,171

Source: USDOC, 2011
(D) Not shown to avoid disclosure of individual confidential information

3.12.3.7 Delta County, Compensation by Industry

As shown in Table 3-46, 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 3-46. Compensation of employees by industry in Delta County (in $1,000s)

Sector	2001	2005	2010
Farm	489	710	1,000
Forestry, Fishing, Related Activities	(D)	(D)	(D)
Mining	0	0	0
Construction	1,380	769	(D)
Manufacturing	(D)	237	(D)
Transportation and Warehousing	(D)	(D)	(D)
Utilities	(D)	(D)	(D)
Wholesale Trade	3,635	940	9,629
Retail Trade	978	1,416	696
Information	(D)	(D)	(D)
Real Estate &Rental & Leasing	(D)	455	(D)
Finance & Insurance	(D)	906	(D)
Professional, Scientific, and Technical Services	(D)	2,513	(D)

Sector	2001	2005	2010
Management of Companies	0	(D)	(D)
Administrative and Waste Services	(D)	(D)	(D)
Educational Services	0	0	0
Health Care and Social Assistance	4,781	5,864	10,410
Arts, Entertainment, Recreation	(D)	(D)	(D)
Accommodation &Food Services	(D)	(D)	(D)
Other Services Except Public Adm.	1,735	1,735	(D)
Government and Gov't Enterprises	10,953	12,321	14,205

Source: USDOC, 2011
(D) Not shown to avoid disclosure of individual confidential information

3.12.3.8 Grayson County, Compensation by Industry

As shown in Table 3-47, the manufacturing sector led in employee compensation, primarily durable goods and computer and electronic product manufacturing. 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 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 3-47. Compensation of employees by industry in Grayson County (in $1,000s)

Sector	2001	2005	2010
Farm	2,324	4,539	6,543
Forestry, Fishing, Related Activities	1,375	2,522	3,697
Mining	9,003	8,830	13,730
Construction	105,946	115,322	115,462
Manufacturing	471,352	430,643	418,827
Transportation and Warehousing	39,113	45,445	48,387
Utilities	16,725	19,962	21,131
Wholesale Trade	39,095	48,302	61,665
Retail Trade	150,428	166,237	173,955
Information	21,103	23,689	22,577
Real Estate &Rental & Leasing	11,855	12,112	16,004
Finance & Insurance	103,566	124,043	113,282
Professional, Scientific, and Technical Services	(D)	38,268	38,248
Management of Companies	(D)	904	1,744
Administrative and Waste Services	29,631	48,295	61,915
Educational Services	18,177	23,630	25,469
Health Care and Social Assistance	257,544	300,903	381,398
Arts, Entertainment, Recreation	10,645	11,025	16,073
Accommodation &Food Services	48,440	58,142	77,613
Other Services Except Public Adm.	39,595	51,009	65,427
Government and Gov't Enterprises	215,893	266,383	332,764

Source: USDOC, 2011
(D) Not shown to avoid disclosure of individual confidential information

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. Retail sales that are qualified for taxation are taxes at a state sales tax plus potential county and city tax rates. Part of these taxes helps fund schools in the local area.

3.12.4.1 Property Taxation

The Fannin County Appraisal District (FCAD) is responsible for appraising properties within the county boundaries. The following jurisdictions fall within the scope: Fannin County, City of Bailey, City of Bonham, City of Dodd City, City of Ector, City of Honey Grove, City of Ladonia, City of Leonard, City of Pecan Gap, City of Savoy, City of Trenton, Town of Windom, 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), Wolfe City ISD (Split with Hunt County).

The district is comprised of 33,246 property accounts (Table 3-48). The following table depicts 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.

Table 3-48. 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, 2011-2012; FCAD, 2012.

The Chief Appraiser certified market and taxable values to each taxing jurisdiction on July 17, 2012. The values are included in Table 3-49:

Table 3-49. 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 in Fannin	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
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, 2011-2012.

As shown in Table 3-50, the total appraised value available for county taxation in Fannin County in 2012 is almost $1.5 billion. Table 3-50 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 a the lowest rate with $0.24 of tax per $100, which is more than $0.6 less per $100 in assessed property value than in Delta County.

Table 3-50. 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

Source: TAC, 2012a and 2012b. * per $100 of assessed property value

3.12.4.2 Agriculture and Timber

Fannin County assesses taxable values for agricultural land according to mainly the use of the land, but also 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. 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. Of the approximately 16,000 acres that would be inundated and the estimated 15,000 acres that may be required for environmental mitigation, 50 percent is irrigated crop land valued at $323 per acre for tax purposes, 30 percent is valued at $157 per acre, and that 20 percent is improved land at $88 per acre (Clower, 2012).

In 2012, the Fannin County Appraisal District appraised 33,246 property accounts, or parcels. 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, 2012). In 2012, 27.2 percent of parcels in Fannin County were appraised as agricultural land (Table 3-51). These 9,050 parcels are equal to $947,204,160 in market value; or 35.3 percent of the county's total market value. The following table displays the aforementioned property types and their percent of the overall parcel count and market value, respectively (FCAD, 2012).

Table 3-51. 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: Fannin County Appraisal District, 2012.

Farmers and ranchers are not exempt entities; nor are all purchases by farmers and ranchers exempt from sales tax. Some agricultural items, however, are exempt, while others are taxable unless purchased for exclusive use on a commercial farm or ranch in the production of agricultural products for sale.

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, 2012).

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 (Real Estate Center, 2011). The main natural resource in Fannin County is timber. Consequently, wood-product manufacture has been important in the local economy (TSHA, 2011). Large swaths of clearcut bottomland timber are already visible in the area, as landowners, in anticipation of the proposed project, sell off their timber to make additional income before selling the land.

3.12.4.3 Retail Sales Taxation

The State of Texas retail sales tax stands at 6.25%. Local sales taxes vary by county and by city. As displayed in Table 3-52, most counties in the local area have a retail sales tax of 0.5%, but as in the case of Collin and Grayson, some have none. In addition, as is common in Texas, most cities and towns in the local area impose additional tax rates on retail sales of 1-2%.

Table 3-52. Retail sales tax rates in ROI

County	City	Retail Sales Tax Rate	Total
Fannin		0.5%	
	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%	
	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%

County	City	Retail Sales Tax Rate	Total
	Parker	1.0%	7.25%
	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%	
	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%	
	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%	
	Cooper	1.0%	7.75%
	Pecan	1.0%	7.75%
Grayson		0.0%	
	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
	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

3.12.4.4 Taxable Sales and Local Sales Dollars Returned

Table 3-53 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 only 10% of Collin County's total.

The allocation historical summary in Table 3-54 show the 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 3-53. 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, 2011b

Table 3-54. Local sales taxes returned to the counties in ROI by the Texas State Comptroller's Office (in dollars)

County	2005	2006	2007	2008	2009	2010
Fannin	599,276.35	710,162.43	719,443.09	944,226.77	782,322.47	708,672.94
Collin, Grayson	0.0	0.0	0.0	0.0	0.0	0.0
Hunt	2,517,479.64	2,669,123.10	2,884,755.51	2,945,433.90	2,909,476.85	2,991,815.64
Lamar	2,157,350.76	2,293,670.85	2,328,929.59	2,830,631.68	3,199,651.74	2,517,828.59
Delta	51,939.21	77,500.26	44,987.22	49,662.76	56,593.91	56,238.81

Source: TCPA, 2011a

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 a million, a net increase of about 40 percent since 2000.
- The six-county ROI is expected to grow by almost 150 % 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, barely increased in Lamar County, and grew by 37% 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% increase in income from 2000-2010.
- The average compensation per job for 2010 for Delta is just under $30,000; Fannin, Lamar, and Grayson, in the $40,000 range; Grayson, just over $50,000; Collin, about $65,000.
- The Government and Government Services, 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 is almost $1.5 billion. In 2005, 37% of Fannin County parcels were appraised as agricultural land and 17% as farm and ranch improvement.
- The Texas retail sales tax is 6.25%. Local sales taxes vary. Most counties in the local area have a retail sales tax of 0.5%, but Collin and Grayson have no retail sales tax.
- 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 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, low-income, and indigenous populations are more likely to be exposed to, and have increased health and safety risks from, environmental contamination than the general population.

The ROI for environmental justice and protection of children is Fannin County, and the Region of Comparison (ROC) is defined as the five surrounding counties and the State of Texas.

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 alternatives 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).

Since the proposed Lower Bois d'Arc Creek dam and impoundment are contained within Fannin County, it represents the primary focus and ROI for any direct and indirect impacts related to environmental justice and protection of children that may be associated with implementation of the proposed action. For purposes of this analysis, the five surrounding counties – Collin, Hunt, Lamar, Delta, and Grayson – are defined as the ROC, or appropriate units of geographic analyses and the general population. For purposes of comparison, census data is also provided for the state of Texas.

3.13.1.1 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). Calculation of the percentage minorities (sum of population groups) and individual population groups was based on population data available from the 2010 U.S. Census. Census Block Group and county level census data are used where appropriate.

As stated above, 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 population consists of minorities, 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 this analysis, 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 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. This approach also applies to individual minority groups. A discrepancy of 10 percent or more between individual minority groups (American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic Origin; or Hispanic) as compared to the percentage of individual minority groups in the five counties or the state of Texas would be considered "substantially" higher. A substantially higher percentage of any one minority group or minorities in Fannin County as compared to the five surrounding counties or the state of Texas would identify Fannin County as constituting an environmental justice 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. The percentage of minorities in Fannin County is only higher than the percentage of minorities in Delta County, and less than the statewide proportion of 54 percent minority. The minority population also represents less than half of the Fannin County population (Census, 2010h; Census, 2010i; Census, 2010j; Census, 2010k; Census, 2010l; Census, 2010m; Census, 2010n).

Within the broader category of minority, American Indians and Alaska Natives represent 1.1% of the total Fannin County population, which is lower than the percentages in Delta, Grayson, and Lamar counties. These ratios of the aforementioned counties are all higher than the 0.7% state average. Representation of the American Indian and Alaska Native population in Hunt and Collin counties are equal to the state average. While the representation of American Indians and Alaska Natives in Fannin County is 0.4% more than the statewide figure, it is 0.3, 0.4, and 0.3 percent lower than the figures in Delta, Grayson, and Lamar counties, respectively. These representations are not considered greater than the general population in a meaningful way and therefore does not qualify Fannin County as an environmental justice population (Census, 2010h; Census, 2010i; Census, 2010j; Census, 2010k; Census, 2010l; Census, 2010m; Census, 2010n).

The Asian population represents 0.4% of the total Fannin county population, and ranges from 0.6% to 1.1% in Lamar, Hunt, Grayson, and Delta counties. Asian populations constitute a larger percentage of the Collin County population – 11.2% – and are higher than the Fannin County percentage. The Asian population in Fannin County is lower than that of all five counties and Texas, and therefore does not constitute it an environmental justice population (Census, 2010h; Census, 2010i; Census, 2010j; Census, 2010k; Census, 2010l; Census, 2010m; Census, 2010n).

The Black or African American population in Fannin County represents 6.8% of the population, lower than the percentages in Lamar and Hunt counties. The Fannin County Black or African American population represents a smaller percentage than that of the State of Texas' 11.8%. The percentage in Fannin County is 0.9% higher than the respective percentages in Grayson County. However, this is not considered greater than the general population in a meaningful way and therefore does not qualify Fannin County as an environmental justice population (Census, 2010h; Census, 2010i; Census, 2010j; Census, 2010k; Census, 2010l; Census, 2010m; Census, 2010n).

The Native Hawaiian and Other Pacific Islander population in Fannin County is nonexistent, as is also the case in Lamar, Delta and Grayson. The Native Hawaiian and Other Pacific Islander population represents 0.2% in Hunt, and 0.1% in Collin County and the state as a whole. Since the representation of Native Hawaiian and Other Pacific Islanders in Fannin County is lower than or equal to the representation in the surrounding counties and the state, it does not constitute an environmental justice population (Census, 2010h; Census, 2010i; Census, 2010j; Census, 2010k; Census, 2010l; Census, 2010m; Census, 2010n).

Hispanics comprise 9.5% of the total Fannin County population, and the percentages in the surrounding five counties range from 5.5 to 14.7 % of their total populations. All were significantly less than the 37.6 percent representation in the State of Texas. Fannin County, then, does not constitute an environmental justice population by this basis (Census, 2010j; Census, 2010k; Census, 2010h; Census, 2010n).

The minority populations in Fannin County are neither greater than 50 percent of the county population nor are they a substantially greater percentage in the five surrounding counties or the state as a whole. The breakdown of minority populations is summarized in Table 3-55.

Table 3-55. Summary of minority populations in the ROI and ROC

County	Population	Minority	American Indian and Alaska Native	Black or African American	Asian	Native Hawaiian and Other Pacific Islander	Hispanic or Latino
Fannin	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 *(24.1)*	804 *(0.9)*	7,133 *(8.3)*	916 *(1.1)*	147 *(0.2)*	11,751 *(13.6)*
Grayson	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)
State of 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)*

Source: U.S. Census Bureau, 2010; percentage in parentheses

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, census Block Group data are used to describe the distribution of minorities in the vicinity of the reservoir and pipeline. A census Block Group is a statistical subdivision of a census Tract, 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 Census Bureau tabulates sample data, i.e. data which are only collected from a fraction of households. Block Groups 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.

Census tracts 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 census tracts and 30 Block Groups.

Figure 3-47 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 census Tract data. Each Block Group is outlined black, and the percentage of minorities in each Block Group is demarcated in the figure.

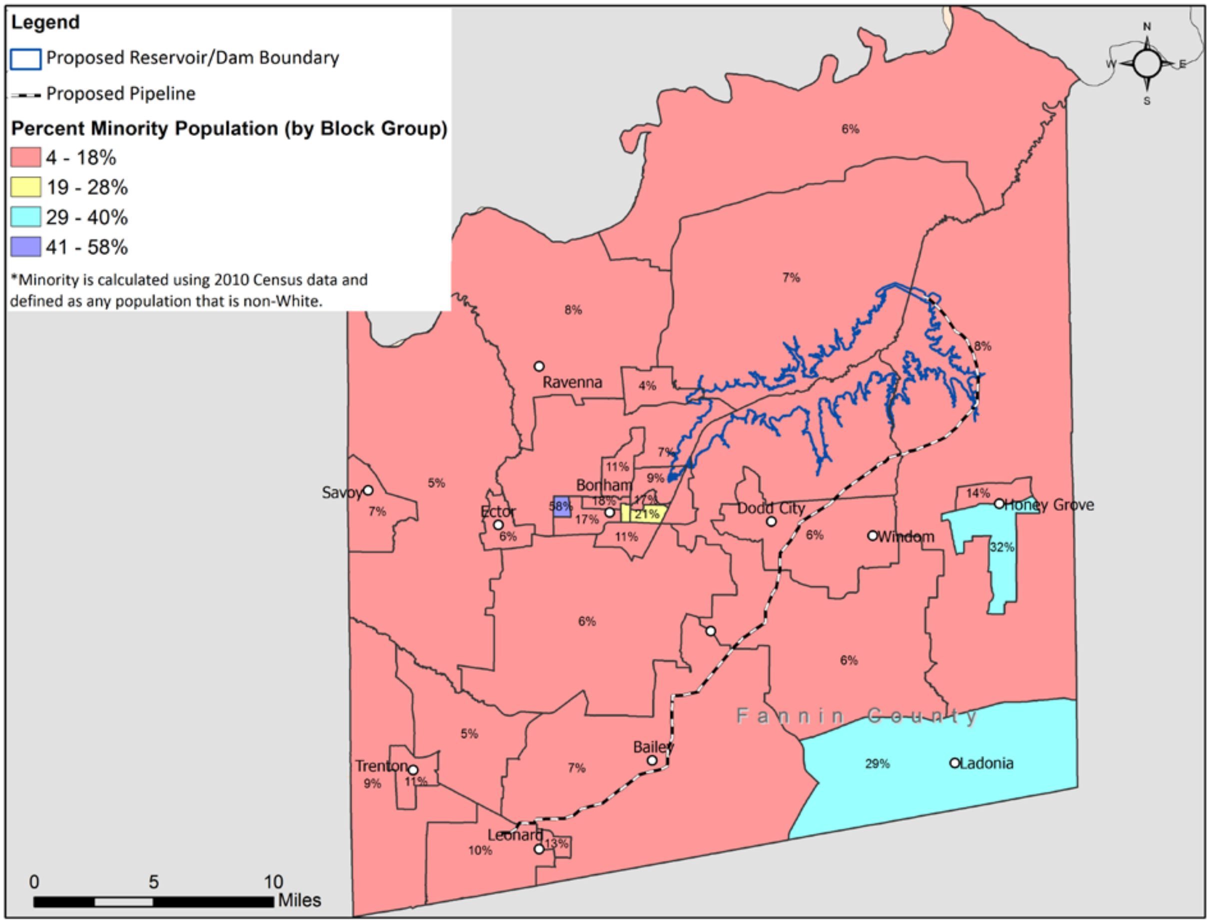


Figure 3-47. Distribution of minority populations within Fannin County

When considering the distribution of minority populations, the Region of Influence (ROI) is defined as any of the following: the impoundment area, Bonham, Savoy, Ector, Ravenna, Honey Grove, Windom, Dodd City, Bailey, Trenton, or Leonard. The Region of Comparison (ROC) is defined as Fannin County. Minority Block Group data for each town and its surrounding area or the impoundment area in Fannin County is compared to data on the county level (17.8 percent). Race is identified for people within those Block Groups, whether they are owners of property that could possibly be sold due to the proposed reservoir, owners of property that would not be sold for the proposed reservoir, or renters of property.

The data revealed that the proposed reservoir would impound an area where minority populations represent 7 or 8 percent of the population (Color-coded red in Figure 3-47), which is less than Fannin County's overall 17.8 percent of the total population. The southwestern portion of the proposed impoundment area would occur adjacent to Bonham, though technically avoiding the city itself. Bonham is comprised of 58 percent minorities (color-coded purple in Figure 3-47), more than three times Fannin County's 17.8 percent. East of the pipeline, minorities represent 32 and 29 percent of the population in Honey Grove and Ladonia (color-coded blue in Figure 3-47), respectively; both figures are "substantially" higher than the county's. Since the representation of minorities in Honey Grove, Ladonia, and Bonham is substantially higher than that of the county overall, these three areas constitute environmental justice populations on this basis.

3.13.1.2 Low-Income Populations

Table 3-56 provides some measures relevant to assessing the importance of low-income populations in the areas that would be affected by the proposed project.

Table 3-56. Income and poverty statistics in the ROI and ROC

County	Population	Median Household Income*	Persons Below Poverty *(Percent)*	Homeownership Rate	Persons 65 Years and Older *(Percent)*
Fannin	33,915	$42,605	4,748 *(14.0)*	74.0%	5,765 *(17.0)*
Collin	782,341	$77,090	63,370 *(8.1)*	68.0%	60,048 *(7.7)*
Hunt	86,129	$40,218	19,637 *(22.8)*	69.4%	12,001 *(13.9)*
Lamar	49,793	$37,659	8,614 *(17.3)*	66.5%	8,276 *(16.6)*
Delta	5,231	$37,908	759 *(14.5)*	78.5%	1,037 *(19.8)*
Grayson	120,877	$45,577	17,406 *(14.4)*	69.4%	18,775 *(15.5)*
State of Texas	25,145,561	$48,615	4,501,055 *(17.9)*	63.7%	2,601,886 *(10.3)*

Source: U.S. Census Bureau, 2010.
*In 2010 inflation-adjusted dollars

The median household income in Fannin County is $4,946 higher than the median for Lamar County; $4,697 higher than for Delta County; and $2, 387 higher than for Hunt County. It is $2,972 and $34,485 lower than the medians for Grayson and Collin, respectively. Median household income is $6,010 lower than the statewide median (Census, 2010c; Census, 2010a; Census, 2010f; Census, 2010e; Census, 2010b; Census, 2010d; Census, 2010g).

The homeownership rate measures the percentage of households that own their home (including homeowners with and without a mortgage), as opposed to those households that rent their homes. It is calculated by dividing the number of owner-occupied housing units by the number of total occupied housing units. The homeownership rate in Fannin County is 74 percent, higher than all of the surrounding counties except the 78.5 percent rate in Delta County. It is also higher than the statewide rate of 63.7 percent. The percentage of persons 65 years and older in Fannin County is lower than the percentages in Delta counties, and is higher than the percentages for Hunt, Collin, Grayson, and Lamar.

The percentage of senior citizens in Fannin County is higher than the statewide 10.3 percent (Census, 2010i; Census, 2010j; Census, 2010n).

According to the U.S. Department of Health and Human Services, the 2010 poverty threshold is defined as a maximum annual income of $18,310 or less for a family of three (USDHHS, 2010). Socioeconomically disadvantaged individuals, or those living at or below the poverty line, represent 14 percent of the Fannin County population. A smaller percentage of the Collin population is below the poverty line than in Fannin County. A larger percentage of the Lamar, Grayson, Delta and Hunt County populations are at or below the poverty threshold as compared to Fannin County. Socioeconomically disadvantaged individuals in Fannin County constitute proportions smaller than for the State of Texas. Representation of poverty in Fannin County is not greater than Delta County population in a meaningful way, and is less than the statewide population. It therefore does not qualify as an environmental justice population on this basis (Census, 2010h; Census, 2010i; Census, 2010j; Census, 2010k; Census, 2010l; Census, 2010m; Census, 2010n). Figure 3-48 displays the results.

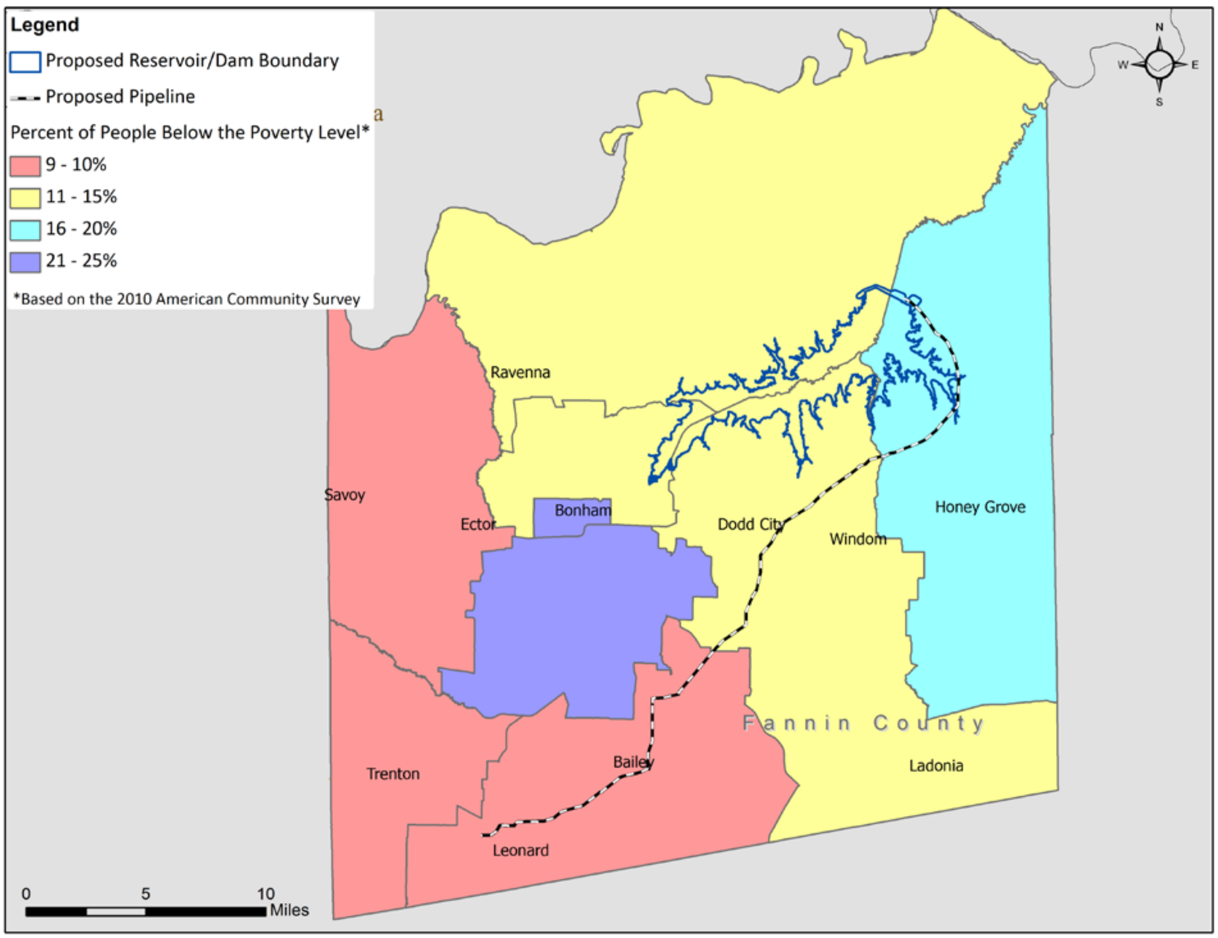


Figure 3-48. Distribution of low-income populations in Fannin County

Additionally, to examine the distribution of wealth in the vicinity of the reservoir, all census tracts in Fannin County were identified. From census data annual income could be documented for people within those census tracts. The results displayed in Figure 3-48 indicate that low-income populations represent between 21 and 25 percent of the population in Bonham, compared to 14 percent of the county's population overall. Additionally, low income populations represent between 8.1 and 17.9 percent of the populations in the surrounding counties and the State of Texas; except for Hunt County (22.8 percent). As such, Bonham constitutes an environmental justice population on this basis.

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 things like exposure to mobile source air pollution, particulate matter from construction or diesel emissions.

The Memorandum Addressing Children's Health through Reviews Conducted Pursuant to the National Environmental Policy Act and Section 309 of the Clean Air Act (EPA, 2012) recommends that the 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, and other areas of apparent frequent and/or prolonged exposure" (EPA, 2012).

This analysis for EO 13045 requires assessment of readily available information regarding demographic data on the local, regional, and national populations, and, in particular, children less than 19 years old to evaluate the number and distribution of children in the region and whether these children are exposed to environmental health and safety risks from the Proposed Action. Information to support this analysis is derived from the US Census Bureau 2010 Census and identified locations with potentially high concentrations of children, such as schools, recreational areas for children, and residential areas.

In general, the Fannin County population is older than that of the state as a whole (Table 3-57). The Fannin County contains approximately 1,981 children under the age of five and 6,380 children between five and 19; or 5.8 and 18.8% of the total population, respectively. The representation of children under the age of five is less than the representations in all the surrounding counties. There are a total of 8,361 children under the age of 19, or about 24.6 percent of the population in Fannin County. The representation of children in Fannin County under the age of five and also between the ages of five and 19 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 19 was always lower than the 30.3 percent state average (Census, 2010c; Census, 2010b; Census, 2010g).

Pursuant to the EPA's 2012 memorandum Addressing Children's Health, census tracts were examined to identify the age distribution in Fannin County, specifically children under the age of five in the vicinity of the dam and pipeline. The data revealed that the proposed reservoir site and pipeline are almost entirely located in an area where children represent six or seven percent of the total county population. Figure 3-49 displays the findings.

Table 3-57. Age distribution in the ROI and ROC

County	Population	Children Under 5 *(Percent)*	Children 5 to 19 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)*
State of Texas	25,145,561	1,928,473 *(7.7)*	5,693,241 *(22.6)*

Source: U.S. Census Bureau, 2010.

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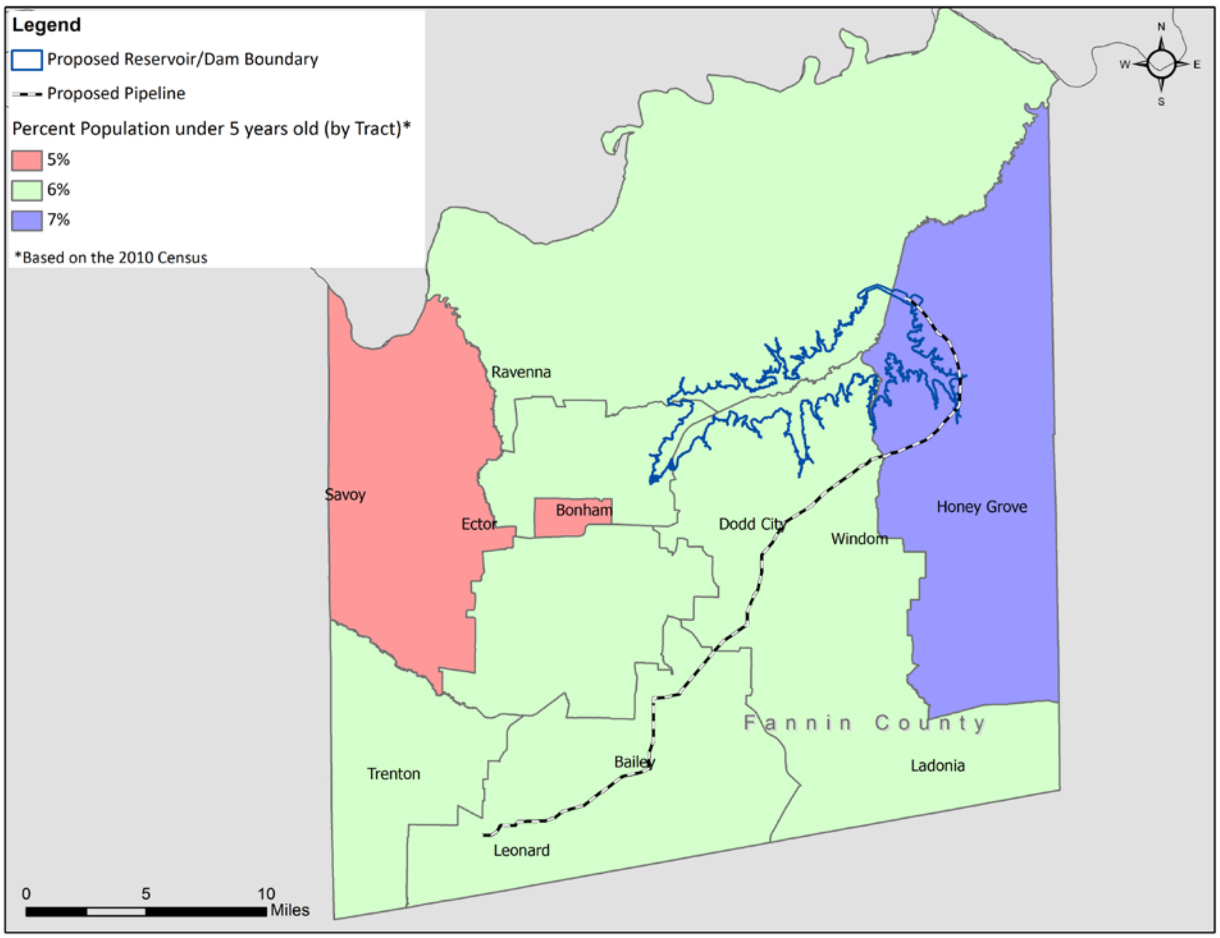


Figure 3-49. Age distribution in Fannin County

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)

3.14.1.1 <u>Paleoindian Period 12,000 B.C. to 6,000 B.C.</u>

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 (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.

3.14.1.2 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; TASA). 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 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 (Skinner et al., 2011).

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 and 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).

3.14.1.3 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 (2007) documented a structure dating to this period in Lamar County 20 by 80 feet in size. 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 (Skinner et al., 2011; 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 1999:123, 230).

3.14.1.4 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 (Skinner et al., 2011). 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 Caddoan sites in the middle Red River Valley are typically located on elevated, arable land along major creek and river drainages. Sites include single structures, small villages, some with burial mounds (Jones, 2008).

3.14.1.5 Middle Caddo Period A.D. 1200 to 1400

Middle Caddoan settlements along the middle Red River area include such site types as farmsteads, middens, dispersed farmsteads and hamlets, 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 lithic assemblage commonly seen in Middle Caddoan sites include 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).

3.14.1.6 Late Caddo Period A.D. 1400 to 1700

The population increase, social complexity, and agricultural dependence that occurred within the Middle Caddoan subperiod continued to evolve and expand during the Late Caddoan subperiod. The recovery of Gulf Coast shell artifacts and Kay County flint within burials suggest extensive trade occurred during this time period with groups located along the Gulf Coast and Great Plains (Perttula, 2001). 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 1700's and moved to the Caddo Lake area along the Texas/Louisiana border. Historic Caddoan sites commonly contain historic European beads and metal trade goods such as points, knives, lead shot, and gun parts.

3.14.1.7 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).

3.14.1.8 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).

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, 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% 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 made the desired stronghold. Beef cattle fared better and their numbers continued to grow (Pigott, 2012).

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 with the population in 2009 having risen 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

The unincorporated community of Carson, formerly Gum Springs, is located directly west of the proposed LBCR 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 south of FM 1396. Today, Carson is a small, loosely-grouped collection of homes noticeable only by a central water tower.

Dodd City

Dodd City is located east of Bonham on State Highway (SH) 56 and will be approximately 2.2 miles (3.5 km) southwest of the Bullard Creek arm of 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 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. Today, Dodd City is a quaint small town with a population of 419 (Skinner et al., 2011; 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. 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, J. H. 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, 2012b; City-Data.com, 2012b).

Lamasco
Lamasco is located about 750 meters north of the main Sandy Creek arm of the proposed Lower Bois d'Arc Creek Reservoir on FM 1396. The name of this community was derived from three founders (Law, Lason, and Scott). While the town was never outstandingly large, it did support a steam gristmill, sawmill, two hotels, a general store, and 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).

3.14.2 Cultural Resource Investigations

3.14.2.1 Pre-Reservoir Investigations

Previous archeological work in Fannin County has been sparse relative to the more populated urban centers of Texas. To date, 59 archeological surveys and 142 archeological sites (48 of which were documented as part of ARC's survey of the proposed Lower Bois d'Arc Creek Reservoir) have been carried out within the county.

The first documented survey in the county was conducted by Texas Power & Light in 1960-1962 at Valley Lake, straddling the Fannin/Grayson County line. This 1,600+ acre survey documented several prehistoric lithic scatter sites, ranging in age from Archaic to Caddo, one of which contained ground stone.

A 1968 Texas Building Commission and TWDB Survey for a smaller, earlier attempt at a reservoir on Bois d'Arc Creek was carried out approximately six miles (10 km) southwest of the current undertaking. This survey discovered 13 new sites (41FN17-FN29), all prehistoric surface scatters or erosional exposures along stream banks. These sites ranged in age from Middle Archaic to Caddo (unspecified division). Two sites, 41FN17 and 41FN22, were reported to have previously produced human burials, though no human remains were reported in the 1968 report. Site 41FN19, on a knoll over an old channel of Bois d'Arc Creek, was reported as a possible Caddo village site and yielded mussel shell, burned rock, flakes, points, and potsherds during the survey. The landowner had previously found incised sherds, several axes (polished full groove and hematite), and polished celts. No subsurface testing was conducted during the 1968 investigations, leaving no evidence or suggestions of stratigraphic integrity of any of the sites (Skinner et al., 2011; Hsu, 1968).

A 1989 Southern Methodist University survey of three Caddo National Grassland units summarized archeological site potential in the region by stating that the floodplain of Bois d'Arc Creek was high in potential for prehistoric sites and valley slopes had medium potential. Historic sites were evaluated as high in probability in upland settings for the reasonable assumption that frequently flooded areas are not conducive to building permanent structures. However, certain specific-use sites deviate from the generalization such as crossings and mills (Jurney et al., 1989; Skinner et al., 2011).

In 2005, ARC completed a 1,700-acre survey within the proposed Lake Ralph Hall (Skinner et al., 2005). Located approximately 10 miles (16 km) south of the proposed Lower Bois d'Arc Creek Reservoir along a rechanneled section of the North Sulphur River, this 15% sample discovered 17 new sites 41FN60-FN76). Three of these sites were recommended for further testing (TASA; Skinner et al., 2011), including: 41FN68, a Middle to Late Archaic habitation site with lithic debris, fire-cracked rock, mussel shell, animal bone, and a possible human tooth; 41FN66, a deeply buried Middle Archaic open campsite; and 42FN73, an *in situ* Paleoindian occupation.

Prior to the current proposal to impound the Bois d'Arc Creek, three previous archeological surveys are known within one mile (1.6 km) of the proposed reservoir. These include a 1968 survey of 1,535 acres at Lake Bonham for the Texas Building Commission and Texas State Water Development Board; a 2009 survey of a 2.5-mile (4 km) long pipeline for the City of Bonham; and a 2010 survey of a bridge replacement location on Onstott Branch for TxDOT.

3.14.2.2 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 North Texas Municipal Water District (NTMWD); U.S. Army Corps of Engineers (USACE), Tulsa District; Texas Historical Commission (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 action).

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 documented and that any adverse effects to those historic properties are identified and resolved prior to the issuance of a Section 404 permit.

The PA also specifies that the Area of Potential Effects (APE) of this undertaking consists of the reservoir footprint itself, up to the elevation of the planned top of flood pool (elevation 541 ft. 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). 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 the 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 consists of tasks to "accomplish identification, evaluation, effect determination, and resolution." The first task instructs 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 should propose a survey methodology appropriate for the particular landscape encompassed by the APE; it should also develop research questions relevant to the APE that guide testing and data recovery efforts.

In keeping with the PA stipulations, a draft research design was prepared in 2010 by AR Consultants, Inc. 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 AR Consultants and a second revised draft was submitted and reviewed in the same manner.

The next steps specified in the PA are initial cultural resources investigations and eligibility determinations for the National Register of Historic Places (NRHP). Whenever historic or cultural resources are identified within the APE, their eligibility for inclusion in the NRHP is to be assessed using the criteria outlined in 36 CFR 60. Should NTMWD, USACE, and SHPO agree that a property is or is not eligible, this consensus shall be deemed conclusive. However, should NTMWD, USACE, or SHPO disagree regarding the eligibility of a given property, the Tulsa District shall then obtain a determination of eligibility from the Keeper of the National Register pursuant to 36 CFR 63. Cultural resources determined to be ineligible for inclusion in the NRHP shall require no further protection or evaluation. Historic resources that are eligible for listing on the NRHP are classified as "historic properties," consistent with terminology defined in 36 CFR 800.16 (NTMWD et al., 2010).

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.

3.14.2.3 Reservoir-Related Investigations – Archeological

Throughout 2011, consistent with the stipulations outlined in the PA above, AR Consultants carried out archeological and historical architectural field investigations at proposed Lower Bois d'Arc Creek Reservoir site in Fannin County, Texas. The 2011 survey 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 (AR Consultants, 2014).

Research Design

The 2011 ARC survey was 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

A stratified hierarchical approach was used in developing the survey methods assuming that certain areas are inherently more likely to contain intact cultural deposits than others. This assumption is based on archeological site locations being associated with certain landforms, elevations, soil types, and proximity to resources. Historical maps and imagery were also examined for potential historical sites. Based on their research, ARC designated terraces and their associated slopes as the higher probability areas and floodplains, where recurring occupations were less common due to recurring flooding events, as low probability. Historic archeological resources were expected to coincide with the trends for prehistoric resources with the exceptions being infrastructural or non occupational sites (roads, bridges, trash piles, etc).

Field Survey Methodology

Two separate methodologies were used for the archeological surveys carried out by ARC: A visual inspection of stream beds and banks and a 20 percent sampling of the proposed lake.

First, the pedestrian survey with visual inspection and limited shovel testing of the non-channelized portions of creek beds and banks ("Transect K") was conducted (Table 3-58). This survey covered 39.75 miles (64.4 km) of portions of Bois d'Arc Creek's and several tributary stream channels (including visible portions of the abandoned Bois d'Arc Creek channel) representing approximately 509 acres of coverage. Because the pedestrian inspection survey was conducted during the low water season of an exceptionally dry year, much was gained from this approach. Geomorphology of Bois d'Arc Creek and its tributaries was documented, several sites were found, and a better understanding of the stream valley was gleaned. This visual survey was followed by a geomorphologic inspection of the floodplain and lower terraces to evaluate the potential for archeological sites. Limited shovel tests were carried out on low berms and overbank levees adjacent to the original stream channel. These elevated areas were identified by LIDAR survey, which indicated potential site locations along the original portions of Bois d'Arc Creek. Data gathered from this inspection were used to determine specific areas for the second stage of archeological survey.

The 20-percent (3,200-acre) intensive survey of the proposed Lower Bois d'Arc Creek Reservoir investigated 13 separate "Transect" areas (Table 3-58, Figure 3-50).

The survey transects explored a wide spectrum of landforms and microenvironments across the floodplain and surrounding terraces. Several transects were broken into two pieces due to right-of-entry issues, to eliminate low probability areas, or to avoid areas covered by the Bois d'Arc Creek channel survey. Individual transects were 20 to 30 meters apart, incorporating shovel testing at THC-recommended rates.

Table 3-58. Quantitative transect descriptions

Transect	Length (Miles)	Width (Miles)	Acres	Floodplain (Miles)	Terraces (Miles)	Percent Floodplain	Percent Terrace
Dam	1.9	0.50	608	1.40	0.50	73.7%	26.3%
A	2.9	0.25	464	0.60	2.30	20.7%	79.3%
B	3.8	0.25	608	0.25	3.55	6.6%	93.4%
C	1.0	0.25	160	0.22	0.78	22.0%	78.0%
D	1.0	0.25	160	0.60	0.40	60.0%	40.0%
E	0.7	0.25	112	0.70	0.00	100.0%	0.0%
F	0.5	0.25	80	0.15	0.35	30.0%	70.0%
G	1.9	0.25	304	0.45	1.45	23.7%	76.3%
H	1.7	0.25	272	1.00	0.70	58.8%	41.2%
I	0.4	0.25	64	0.10	0.30	25.0%	75.0%
J	1.4	0.13	112	0.00	1.40	0%	100.0%
L	1.4	0.13	112	0.86	0.54	61.4%	38.6%
M	1.8	0.13	144	0.08	1.72	4.4%	95.6%
subtotal	**20.4**	**3.13**	**3,200**	**6.41**	**13.99**	**31.4%**	**68.6%**
Channels (K)	39.75	0.02	508.8	39.75	0.00	100%	0%
Total	**60.15**	**3.15**	**3708.8**	**46.16**	**13.99**	**76.7%**	**23.3%**

Source: Skinner et al., 2011

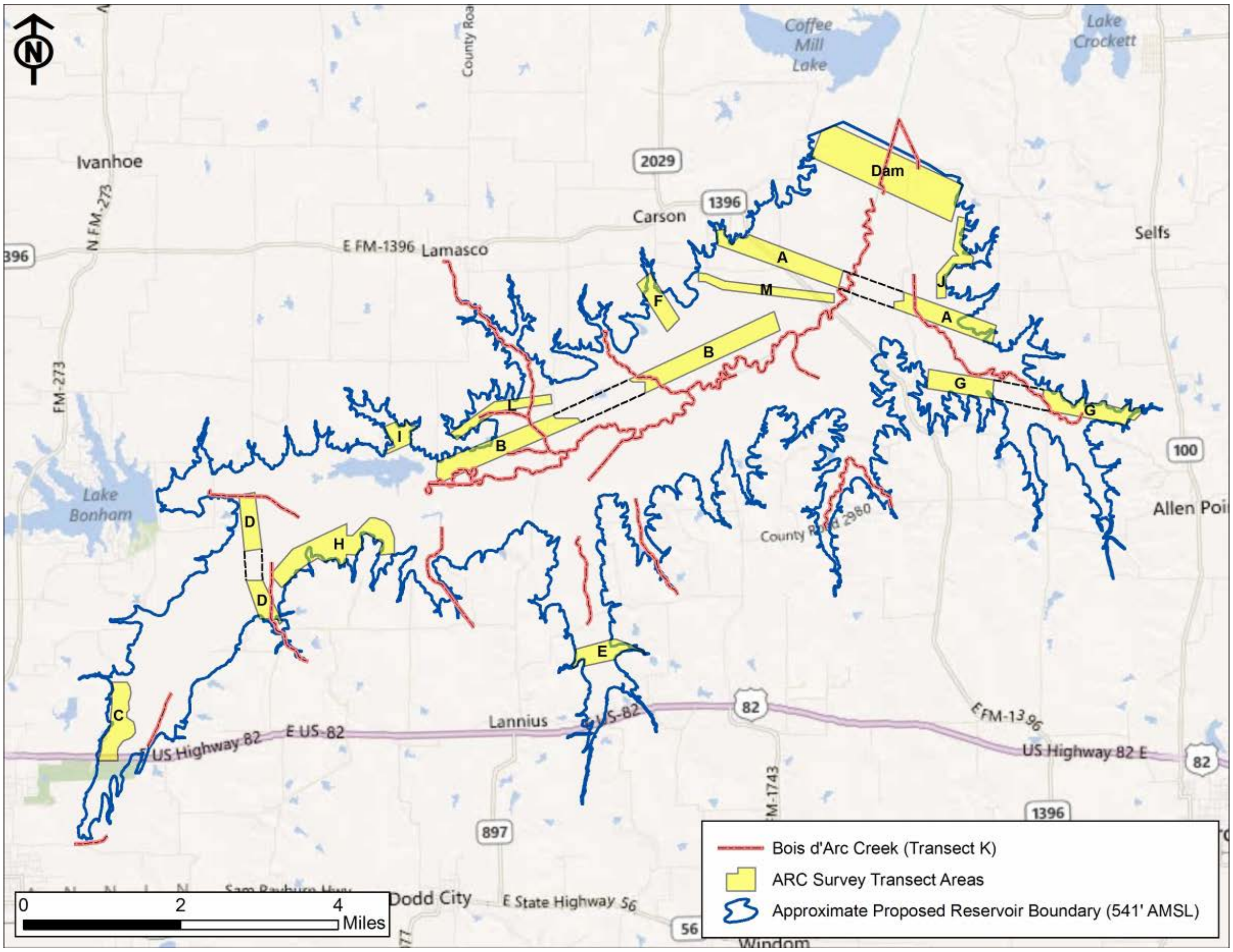


Figure 3-50. ARC survey transect areas

Shovel tests were also excavated in greater quantity in areas of heightened probability or surface artifacts. Tests were excavated 30-cm wide in 10-cm levels to depths of 80 cm or to pre-cultural deposits if encountered first. Excavated material was screened using ¼-inch hardware cloth or hand sorted if unscreenable. Munsell color, soil type, cultural materials, and geographic coordinates were recorded on standardized shovel test forms for each shovel test. Any artifacts encountered in shovel tests were collected and curated. Artifacts discovered on the surface were collected if considered to be diagnostic to a particular period or use. Artifacts were washed (in most cases), cataloged, numbered and assigned lot numbers, and prepared for final curation in accordance with Texas Archeological Research Laboratory (TARL) standards. Organic remains and some lithic and ceramic samples were left unwashed and set aside for future radiocarbon and/or residue analysis.

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. 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 sites were delineated using exploratory shovel tests, historic maps and aerial photographs, and visible surface artifacts or structural remains. An architectural historian evaluated and documented all standing structures to make NRHP eligibility evaluations.

Cemeteries (prehistoric and historic burials of any type), if found, were to be extensively evaluated using mechanical equipment to determine horizontal extent. Section 711 of the Texas Health and Safety Code requires mitigation and re-interment of human remains to be inundated or otherwise negatively impacted. Additionally, the Native American Graves Protection and Repatriation Act (NAGPRA) 43 CF 10 requires that any Native burials and associated grave goods be mitigated and re-interred.

An extensive geomorphology survey was conducted using a backhoe to provide cross sections of terraces throughout the project area. 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. Trenches were also used to define the vertical limits of deeply buried deposits within sites. 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. Personal interviews were also 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.

Prehistoric artifacts collected during the 2011 survey were analyzed using a variety of methods to gain the maximum amount of information from the sampling at hand. 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.

Field Survey Results

Forty-eight new sites were recorded during the archeological survey effort, including 20 historic-era sites, 26 prehistoric sites, and two multiple component sites. One site (Wilks Cemetery, 41FN96) was determined by AR Consultants to be eligible as a NRHP property and ten other sites (eight prehistoric, two historic-era) were defined as undetermined and in need of further investigation to make determinations. The remaining 37 sites were determined to have no potential for listing on the NRHP.

Nineteen of the prehistoric (or multi-component) sites were assignable to specific age-ranges through seriation of artifacts. These consist of eight sites with an Archaic-aged aspect, ten sites with a Late Prehistoric-aged aspect, and one site specifically assigned as a Caddo occupation. Eleven prehistoric sites had no diagnostic artifacts and were therefore considered to be of undetermined age. Eight of the prehistoric sites were determined to have unknown eligibility for listing on the NRHP, the rest were determined to be ineligible.

Twenty-two historic-era archeological sites were identified during the archeological survey. Of these sites, nine were also identified and described by the historical architecture survey. Two sites (a cemetery and a trash midden) were determined to date to the 19th century and nineteen sites were dated to the 20th century. Two sites were multi-component sites, including both a prehistoric aspect as well as historic. Of the historic sites, two were assigned unknown status for eligibility to the NRHP; only the Wilks Cemetery was determined to be eligible for the NRHP.

Roughly 20 percent of the proposed reservoir was surface inspected, including areas that were not within the designated archeological survey areas (i.e., Bois d'Arc Creek and tributary stream channel areas). Half of the 48 sites identified during field investigations were located outside the designated intensive survey area.

AR Consultant's historical architecture survey encompassed the entire proposed lake area (541 feet AMSL and below) and identified 34 structures. Of these structures, none were determined to meet the requirements for listing as NRHP properties. Because the historical architecture survey encompassed the entire project area, no further survey will be required.

The eleven hypotheses under three research topics which guided the sampling strategy for ARC's archeological investigations were largely accepted except in cases, as for Pleistocene Geomorphology, where physical evidence was lacking. Prehistoric sites were mostly associated with Middle to Late Archaic and Early Caddo periods while historic sites dated to the early to mid 20th Century with the exception of the Wilks Cemetery. These findings largely validated the research design and are similar to findings from the Lake Ralph Hall survey. Deeply buried archeological deposits are not likely within the valley due to periodic flushing of sediments from the valley into the Red River drainage.

Conclusions
ARC's 2011 field investigations at the proposed Lower Bois d'Arc Creek Reservoir included an estimated 20-percent sample intensive archeological investigation, a stream bed and banks survey, and a 100-percent historic structure survey. New sites were found at an average of one site per 77 acres surveyed. As a result of fieldwork, 48 new sites were defined and one historic cemetery 34 historic structures were evaluated for eligibility for the NRHP. The Wilks Cemetery was determined to be eligible as an NRHP property and 10 other archeological sites were determined to require further testing to evaluate NRHP eligibility.

3.14.2.4 Reservoir-Related Investigations – Historical and Architectural

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 (Skinner et al., 2011).

Methodology
The historical architecture survey was carried out to identify any potential NRHP properties that would 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 (from Skinner et al., 2011):

(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 National Register: 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 (from Skinner et al., 2011):

(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 productive life.

(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 Texas Historical Commission'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 to great effect in locating potential structures to visit during fieldwork.

Results
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 the 2011 survey, many more structures had disappeared and two had burned in wildfires. Three structures were not accessible due to right-of-entry issues and were not evaluated by historians.

During the 2011 survey, 34 structures were identified and described by the historic architecture survey within the proposed Lower Bois d'Arc Creek Reservoir boundaries, nine of which were also given preliminary investigation by ARC during the archeological survey and were subsequently assigned (archeological) site trinomials by the Texas Archeological Research Laboratory. Most structures were conglomerations of styles and were not readily identified with any particular style of construction.

Conclusions
The historical architecture survey discovered that early culturally-distinct structures within the project area have been replaced with 20th century vernacular structures and most have subsequently been added to or otherwise modified. Of the 34 structures documented during the survey, none were determined to meet the requirements for listing as NRHP properties, nor did any structure meet any of the special requirements under NRHP Criteria Considerations A-G.

3.14.3 Known Cultural Resources at Reservoir and Vicinity

3.14.3.1 National Register Properties

Within the APE
There are no properties listed on the NRHP within the basin of the proposed Lower Bois d'Arc Creek Reservoir.

Outside of the APE
No National Register properties are located within one mile (1.6 km) of the proposed undertaking. The nearest National Register property is the Clendenen-Carleton House, built in about 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.

3.14.3.2 Historical Markers

Within the APE
There are no State of Texas Historical Markers within the proposed Lower Bois d'Arc Creek Reservoir basin.

Outside of the APE
Within a one mile (1.6 km) radius mile of the proposed LBCR there are four State of Texas Historical Markers:

- The Shiloh Cemetery (Marker Number 13221), which dates to the 1860s, is located 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 the1847, is located 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 are 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.

3.14.3.3 Historic Cemeteries

Within the Reservoir APE

Only the Wilks Cemetery (FN C020) is located within the area to be inundated (TASA). This cemetery was used until 1932 and contains burials dating back to 1852, quite early for the region (TASA; Skinner et al., 2011). The Wilks Cemetery is located on the north shore of the proposed reservoir basin, about one mile (1.6 km) south of Coffee Mill Lake and approximately 0.8 mile (1.3 km) west of Bois d'Arc Creek. It is at an elevation of 533 ft MSL. According to existing records, this cemetery has 10 marked interments ranging from 1861 to 1932. An additional 14 interments ranging from 1852 to 1901 are suspected but are no longer marked. In addition, records suggest that two more marked interments dating to 1864 and 1865 are in the immediate vicinity (Table 3-59).

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), located on the outskirts of Bonham and north of Pig Branch. The site is at an elevation of 580 ft MSL and covers an area of 30 x 30 m. 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 ft 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 ft MSL elevation. Records suggest this cemetery contains an estimated 15 interments raging from 1870 to 1940.

Table 3-59. Known interments in the Wilks Cemetery, Fannin County, Texas

Type	Name	Birth Date	Death Date	Notes
marked	Bonham, Charity	1812	24 Dec 1865	wife of David Bonham; isolated under tree west of cemetery
marked	Bonham, Louisa A.	18 Apr 1864	18 Apr 1864	d/o J. & P. Bonham; isolated under tree west of cemetery
unmarked	Cagle, M.C.	1809	1852	-
marked	Cagle, M.G.	15 Jun 1809	11 Dec 1861	-
marked	Cagle, S.C.	22 Oct 1814	31 Aug 1861	-
marked	E.C.C.	-	-	-
marked	J.S.C.	-	-	-
marked	M.S.C.	-	-	-
marked	M.V.C.	-	-	-
marked	Unknown, Baby	-	-	-
unmarked	Wife of Milton	-	-	-
unmarked	Wilks, Betty	1853	1887	Wife of Milton
unmarked	Wilks, Charles Jefferson	1888	1896	Son of Newton & Mary
unmarked	Wilks, Cora	-	1889	dau. of Milton & F.E.
unmarked	Wilks, Eliza N.	1886	1888	Son of N.& M.H.
unmarked	Wilks, Emsy E.	1884	1885	Son of M.& B.
unmarked	Wilks, Florence E.	1872	1901	(2nd wife)
unmarked	Wilks, Frederick B.	1884	1885	son of Newton & Mary
unmarked	Wilks, Infant	1881	1881	child of Milton & Betty
unmarked	Wilks, Margaret J.	1814	1869	wife of Thomas A.
marked	Wilks, Mary	1855	01 April 1932	wife of Newton
marked	Wilks, Milton	14 Apr 1857	06 August 1927	-
unmarked	Wilks, Newton	1855	1901	-
unmarked	Wilks, Noah	1882	1883	son of M. & B.
unmarked	Wilks, Thomas A.	1800	1871	-
marked	Wilks, Thomas J.	7 Sep 1881	7 Sep 1881	son of Milton & Betty Wilks

Source: www.txfannin.org/cemeteries/ceme-wilks/index.html [accessed 30 September 2009]

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 ft 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 ft 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 ft 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 ft 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 ft 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 ft 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 ft 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 0.9 km east of Bullard Creek at an elevation of about 560 ft 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 ft 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 ft 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 250 m east of Burns Branch at an elevation of about 610 ft 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 ft 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 ft aMSL.

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 ft 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 ft 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 ft MSL.

3.14.3.4 Historic Buildings and Structures

Within the Reservoir APE

AR Consultant's historical architecture survey identified 34 structures within the proposed Lower Bois d'Arc Creek Reservoir boundaries. Of these structures, none were determined to meet the requirements for listing as NRHP properties. Individual descriptions of these structures are provided in Table 3-60.

Table 3-60. 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 1/2 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	Barn with rectangular footprint; gabled roof clad with sheet metal.	pre-1976

Of the 34 historic structures documented, agricultural outbuildings are the most numerous, composing 59 percent of the total followed by domestic structures (primary and secondary), which compose 35 percent of the sample, followed by the single commercial structure, and the one religious structure documented. One-half of the structures documented were built in the years between 1939 and 1955 with most of the other half being made during the gaps in aerial photography from 1950 to 1976. An exception is the New Jerusalem Baptist Church (41FN98) in Carson. This structure was made some time prior to 1936 when it appears on a Fannin County Highway map. The structure was moved to the present location from two miles north in 1940 after its African-American congregation was displaced by formation of the Caddo National Grassland.

Outside of the APE
Possibly more than one thousand structures exist within one mile of the project area and above the 541-foot MSL contour. No survey data are available of historical architecture outside the physical APE for the project.

3.14.3.5 Archaeological Sites

Known Sites Within the APE
Within the proposed Lower Bois d'Arc Creek Reservoir, 44 sites were recorded as a result of ARC's 2011 archeological survey. In addition, four sites were recorded outside the APE for a total of 48 sites. Of these 48 sites, 20 are historic-era sites, 26 are prehistoric sites, and two are multiple component sites (Table 3-61). Two sites (41FN96, 41FN120) have been determined to be eligible as a National Register property and nine other sites (including seven prehistoric and two historic-era) were assessed of undetermined significance and were recommended for further investigation. The remaining 37 sites were evaluated as not significant and were recommended as not eligible for listing on the NRHP. Sites are listed in Table 3-61.

Table 3-61. Known archeological sites within the reservoir APE

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN95	Historic	Undefined	Barn	No
41FN96	Historic	1852 - 1927	Cemetery	Yes
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	No
41FN109	Historic	Mid-20th Century	Well or Cistern & Trash Scatter	No
41FN110	Prehistoric	Unknown	Buried Artifact Scatter	Unknown
41FN111	Prehistoric	Late Prehistoric	Artifact Scatter	No
41FN112	Prehistoric	Unknown	Surface Artifact Scatter	No
41FN113	Prehistoric	Archaic	Buried Stratified Artifact Scatter	Unknown
41FN114	Prehistoric	Late Prehistoric	Buried Artifact Scatter	Unknown
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	No
41FN119	Prehistoric	Late Prehistoric	Unstratified Artifact Scatter	No
41FN120	Prehistoric	Archaic - Late Caddo	Stratified Alluvial Terrace Site	Yes
41FN121	Prehistoric	Unknown	Thin Artifact Scatter	No
41FN122	Prehistoric	Archaic - Late Prehistoric	Unstratified Artifact Scatter	No
41FN123	Prehistoric	Late Prehistoric	Thin Artifact Scatter	No

Site Trinomial	Age	Age Specific	Site Type	NRHP Eligible?
41FN124	Prehistoric	Archaic	Artifact Scatter	No
41FN125	Prehistoric	Unknown	Possible Hearth Features	No
41FN126	Prehistoric	Unknown	FCR Concentration	No
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	Unknown
41FN137 *	Historic	Undefined 20th Century	Well	Unknown
41FN138 *	Historic	Undefined 20th Century	Cistern	Unknown
41FN139	Prehistoric	Late Prehistoric	Artifact Scatter	Unknown
41FN140	Prehistoric	Archaic - Late Prehistoric	Artifact Scatter	No
41FN141 *	Prehistoric	Unknown	Artifact Scatter	Unknown
41FN142 *	Prehistoric	Unknown	Lithic Quarry	Unknown

*site was recorded outside the APE.

Individual Site Descriptions

Site 41FN95 is a standing historic barn. Six exploratory shovel tests carried out at the site found no artifacts. The structure was later evaluated by an architectural historian, named Architectural Resource 7a, and was recommended as not eligible for listing in the NRHP.

Site 41FN96, the Wilks Cemetery 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 (Figure 3-51). The date range of use for the cemetery is 1852 (M.G. Gagle) to 1927 (Milton Wilks), including 20 marked graves within the cemetery proper. Exploratory shovel tests were conducted outside of the cemetery to test for additional graves, but none were found. The site was recommended as eligible for listing in the NRHP.

Site 41FN97 is a historic-aged shed. Six shovel tests were excavated near the structure, all of which were negative. The structure was later evaluated by an architectural historian and named Architectural Resource 7b and was recommended as not eligible for listing in the NRHP.

Site 41FN98 is the New Jerusalem Baptist Church, described in the historic structures summary above. Six shovel tests excavated in the area were negative. The structure was later evaluated by an architectural historian and named Architectural Resource 10 and recommended as not eligible for listing in the NRHP.

Site 41FN99 is a historic-aged house (Architectural Resource 12a) and outbuilding (Architectural Resource 12b). Six shovel tests excavated in the area were negative. The structure was later evaluated by an architectural historian and was recommended as not eligible for listing in the NRHP.

Figure 3-51. Wilks Cemetery and outlying grave location on aerial photograph

Site 41FN100 is a historic-aged single-family house and three associated outbuildings with a historic-aged trash scatter. Ten shovel tests were excavated in the area around 41FN100, all of which were negative. The site encompasses the cluster of structures and extends an additional 220 feet north-south and an additional 265 feet east-west. The structures were later evaluated by an architectural historian and named Architectural Resources 8a through 8d and recommended as not eligible for listing in the NRHP.

Site 41FN101 is a historic-aged house and outbuilding. Six shovel tests were excavated near the structures, all of which were negative. The structures were later evaluated by an architectural historian and named Architectural Resources 4a and 4b and recommended as not eligible for listing in the NRHP.

Site 41FN102 is a historic-aged house. Six shovel tests were excavated near the site, all of which were negative. The structure, in poor condition, was a cross-shaped gable-roofed building and contained wallpaper and a stove dating to the 1930s to 1940s. The structure was later evaluated by an architectural historian and removed from the architectural resource survey because the structure had been moved to the present location after 1976. Site 41FN102 is recommended as not eligible for listing in the NRHP.

Site 41FN103 is a reinforced foundation and associated bricks, glass, and partial building footing, which appear to have been dozed from adjacent uplands onto the terrace over the original Bois d'Arc Creek channel. Six shovel tests were excavated at the site, three of which were positive, containing brick and bone fragments, most likely mixed into the soil during dozing of the surface features. Site 41FN103 is not eligible for listing in the NRHP.

Site 41FN104 is a historic-aged commercial building. Seven shovel tests were excavated near the structure, all of which were negative. The structure was later evaluated by an architectural historian and named Architectural Resource 11 and recommended as not eligible for listing in the NRHP.

Site 41FN105 is a historic house, barn, and three outbuildings recorded as a single site. Three shovel tests were excavated within the site, two of which were positive, containing glass sherds and a single nail. The structures were later evaluated by an architectural historian and named Architectural Resources 5a through 5e and recommended as not eligible for listing in the NRHP.

Site 41FN106 is a historic surface trash scatter dating from the 1930s to 1970s. The site measures approximately 80 feet by 30 feet by six inches in depth (on the surface) along a trail and scattered into undergrowth vegetation. This site contains a dense assemblage of glass jars and bottles, miscellaneous metal scraps, aluminum cans, ceramics, etc. No artifacts were collected and because of the large quantity of materials, no count effort was made. Site 41FN106 is not eligible for listing in the NRHP.

Site 41FN107 contains unidentifiable metal fragments, bricks, and numerous diagnostic glassware including: amethyst glass sherds, aqua glass, pink Depression glass vessels, and several bottles dating to the 1930s and 1940s. There are apparently no buried deposits at the site. Site 41FN107 is not eligible for listing in the NRHP.

Site 41FN108 is a historic-aged well or cistern. The site covers an area of about 100 by 100 feet and contains a light scattering of Depression glass, amethyst glass, milk glass, and cobalt glass as well as some earthenware ceramics. The well or cistern is represented in a rodent den as a few mortared bricks. The bricks' maker marks and glass sherds associated with the site point an early 20th century date for 41FN108. Five shovel tests excavated near the feature were all negative. Because of the lack of coherence and disturbance within the site, it is ineligible for listing in the NRHP.

Site 41FN109 is historic-aged site containing a brick and mortar well or cistern. The site measures about 125 feet north-south by 200 feet east-west. The collar of the feature extends one-foot eight inches above the ground surface and is silted to one-foot four-inches below the ground surface on the inside and measures three-foot seven-inches in diameter. Fifty feet east of the well or cistern feature was a patch of irises, further indicating a former homestead. Six shovel tests were carried out within the site, four of which contained brick fragments and non-diagnostic glass sherds and a single Hawk-brand bib overalls button, manufactured from the 1920s to 1950s. The commercial bricks incorporated into the well were found to date to the early 20th century. Because there is no distinctive or unique construction style, 41FN109 is recommended as not eligible for listing in the NRHP.

Site 41FN110 is a buried prehistoric artifact. The site is located in a heavily wooded area on a terrace ridge and measures 130 meters north-south by 80 meters east-west. Twenty-six shovel tests were excavated in delineating the site, eight of which were positive with artifacts occurring from the surface to 100 cm below the surface (cmbs) in yellowish brown sandy loam. The recorded artifact assemblage contains 27 pieces of lithic debitage of local petrified wood and imported or naturally transported Ogallala quartzite gravel, as well as Alibates chalcedony, a biface made form heat-treated Ogallala quartzite, five fire-cracked rocks, and one undecorated ceramic sherd. Because the site is located on thick deposits atop a terrace ridge, there is potential for deeply buried deposits and more information from future careful excavations. The site contains datable material and a diversity of artifact types. Site 41FN110 is recommended for further testing before NRHP eligibility can be determined.

Site 41FN111 is a small artifact scatter located on a low knoll above Bois d'Arc Creek's floodplain. Artifacts were located at depths of 45 to 90 cmbs in yellowish brown to brown sandy clay. Artifacts encountered included 37 pieces of debitage, three fire-cracked rocks, a biface, and two undecorated ceramic body sherds. No datable materials were noted at the site and no distinguishable features or stratified deposits were discovered, making the site not eligible for listing in the NRHP.

Site 41FN112 is a prehistoric surface artifact scatter on a slope above a small unnamed tributary to Honey Grove Creek. Twenty-one shovel tests were excavated in delineating the site, four of which were positive (four pieces of fire-cracked rock, two flakes, and two sherds of historic whiteware). The surface assemblage included seven pieces of fire-cracked rock, eight interior flakes, one uniface, two bifaces, one bifacial tool distal, one core, one turtle carapace fragment, and four historic ceramic sherds (three whiteware and one stoneware). Artifacts were largely located on the site's surface or shallowly buried in topsoils. Because the site has no stratigraphic integrity and artifacts present are most likely naturally transported downslope, site 41FN112 is recommended as not eligible for listing in the NRHP.

Site 41FN113 is a buried stratified artifact scatter. The site measures 70 meters north-south by 50 meters east-west and is located on a heavily vegetated hilltop and may have been part of a T4 terrace as evidenced by the presence of 0.5 to 5-cm gravels overlaying archeological deposits. Twenty-eight shovel tests were conducted in delineating the site, 13 of which were positive and produced a total of 46 artifacts. The artifact assemblage includes five pieces of fire-cracked rock, two biface fragments (one of which was a proximal from a large Ogallala quartzite projectile point), one dart point fragment (Gary-type), and 37 pieces of lithic debitage. Because the site appears to have stratigraphic integrity and because diagnostic artifacts are present, it is recommended that further work be performed prior making a determination of eligibility for listing in the NRHP.

Site 41FN114 is a buried artifact scatter on a narrow finger of terrace deposits extending into Bois d'Arc Creek's floodplain. The site measures 165 meters northwest-southeast by 85 meters northeast-southwest. Two hundred and sixty-one artifacts were encountered in 12 out of 23 shovel tests excavated at the site, occurring at depths from the surface to 80 cmbs. The assemblage recorded included 75 pieces of lithic debitage, two pieces of fire-cracked rock, a biface fragment, one sherd of undecorated prehistoric ceramic, one modern sherd of clear glass, 71 pieces of bone and 110 pieces of shell. Most artifacts were limited to the slightly elevated finger of terrace. Because of the presence of datable materials, the high potential for intact well-stratified deposits, site 41FN114 is recommended for further work prior to making a determination of eligibility for listing in the NRHP.

Site 41FN115 is a 30 meters north-south by 40 meters east-west thin artifact scatter on a finger slope above an unnamed tributary of Sandy Creek. Eight artifacts were encountered in two shovel tests of eleven excavated at the site. Artifacts documented included seven pieces of chert and fine quartzite debitage and one piece of fire-cracked rock, all found in the upper 10 to 20 cmbs.

Because the site has no datable materials, features, or well defined stratigraphy, site 41FN115 is recommended as not eligible for listing in the NRHP.

Site 41FN116 is a thin artifact scatter measuring 25 meters north-south by 20 meters east-west, located on a slight slope northeast of Sandy Creek. Nine shovel tests were excavated to delineate the site, four of which were positive, including 22 artifacts (18 pieces of chert, fine quartzite, and petrified wood debitage, one piece of fire-cracked rock, one utilized flake, one biface, and two bone fragments). Artifacts were recovered from the surface to 30 cmbs in compact dry clay. Because the site lacks any diagnostic artifacts and the lack of potential for useful information to be produced from further work at the site, 41FN116 is recommended as not eligible for listing in the NRHP.

Site 41FN117 is a surface artifact scatter located on the southwest slope of a hill north of Bois d'Arc Creek near an unnamed tributary stream. The site measures approximately 21 meters north-south by 18 meters east-west and contained a small eroded basin where surface artifacts were noted. One of the seven shovel tests that were excavated contained one quartzite chip and one piece of fire-cracked rock in the upper 10 cmbs in pale brown silt. Surface artifacts noted at the site included one Gary point, a bifacial distal fragment, a primary flake, two secondary flakes, an interior flake, and one piece of fire-cracked rock. Because site 41FN117 is heavily eroded with no discernable stratified deposits, it is recommended as not eligible for listing in the NRHP.

Site 41FN118 is an unstratified buried artifact scatter measuring 140 meters north-south by 110 meters east-west. The site was located based on information from a local collector. Twenty-nine shovel tests were excavated to explore and delineate the site, 18 being positive and recovering 87 artifacts at depths from the surface to 50 cmbs in mottled sandy clays. The documented assemblage included 68 pieces of lithic debitage from a variety of sources, two cores, seven pieces of fire-cracked rock, one undecorated prehistoric ceramic body sherd, one piece of historic-aged whiteware, six bone fragments, and two mussel shell fragments. Backhoe trenching was carried out at the site, which demonstrated that no intact stratigraphic deposits exist, and therefore the site is recommended as not eligible for listing in the NRHP.

Site 41FN119, or the Alibates Flake site, named after the single surface flake that led to the site's discovery, is an unstratified artifact scatter measuring about 120 meters east-west by 40 meters north-south on a small knoll above Bois d'Arc Creek's floodplain. Thirty-six shovel tests, one 50x50 cm hand excavation unit, and one backhoe trench were excavated in exploration of the site. Artifacts were encountered from the surface to 30 cmbs in shovel tests and included 90 items: 52 pieces of chert debitage, nine fire-cracked rocks, two bifaces, two utilized flakes, five undecorated body sherds, 15 bone fragments, and five charcoal samples. The 50x50 cm unit recovered 19 flakes, 11 fire-cracked rocks, one biface, one utilized flake, two undecorated body sherds, four pieces of burned clay, 11 pieces of daub, and two charcoal samples. Backhoe trenching, along with the shovel tests and excavation unit demonstrated that there was no clear stratification at the Alibates Flake site and therefore the site is recommended as not eligible for listing on the NRHP.

Site 41FN120 is a stratified alluvial terrace site above Bois d'Arc Creek's channel. The site measures approximately 140 meters northwest-southeast by 60 meters northeast-southwest. Site 41FN120 is the largest and most artifactually diverse site discovered during fieldwork. A total of 58 shovel tests (16 of which were positive) were excavated in exploring and delineating the site and two 50x50 cm hand excavated units and three backhoe trenches were dug to better define the stratigraphy and context of the site. Artifacts were encountered from the surface to 90 cmbs and included a broad spectrum of artifacts in large quantities. Surface finds included numerous diagnostic artifacts (one Red River Jasper drill, three bifaces, one Gary point, and six undecorated sherds) and subsurface testing provided 184 pieces of lithic debitage, 62 fire-cracked rocks, two cores, four bifaces, five projectile points, 69 undecorated ceramic body sherds, 14 bone fragments, three mussel shell fragments, and 25 pieces of burned clay. Additionally, nine samples of charcoal were collected, three of which were submitted for dating, procuring dates of 750±30 B.P., 1650±30 B.P., and 830±30 B.P. Ceramic concentrations within the site indicate that 10 to 40 cmbs coincides with an occupation zone. Based on projectile and ceramic typology at the site, 41FN120 represents a repeat-use terrace site dating mostly to the Woodland/Early Caddo periods. Due to the presence of datable materials, a diverse assemblage, and well-stratified deposits, site 41FN120, ARC recommended more work before a determination for NRHP eligibility could be made. However, the Tulsa District of the US Army Corps of Engineers did not concur but stated that "… *work performed at the site to date has clearly established that the site has the potential to provide information important to our understanding of prehistory, and is therefore eligible for the NRHP under Criterion D.*" (letter from the USACE Tulsa District dated April 02, 2012).

Site 41FN121 is thin artifact scatter located on a small knoll. Twelve shovel tests were excavated to explore and define the site, four of which were positive. Artifacts encountered included five pieces of debitage in the upper 20 cm within a compact brown to yellowish brown sandy loam. An isolated Gary point was discovered in a shovel test 30 meters east of the site, but was apparently unrelated to the site's deposits. Because the site has a limited assemblage and count it is recommended as not eligible for listing in the NRHP.

Site 41FN122 is an unstratified lithic scatter on a northeast/southwest ridge measuring 200 meters northeast-southwest by 60 meters northwest-southeast. Eighteen positive and 25 negative shovel tests were excavated to define and delineate the site. Artifacts present at the site included 65 chert and quartzite debitage pieces, one core, one Ellis dart point stem, 10 pieces of fire-cracked rock, 25 undecorated ceramic sherds, and a large bone fragment. One backhoe trench was excavated at the site, which demonstrated a lack of stratigraphic continuity. Site 41FN122 is recommended as not eligible for listing in the NRHP.

Site 41FN123 is a thin artifact scatter measuring approximately 25 meters across. Four of ten shovel tests were positive and included seven quartzite flakes, two chert interior flakes, and one undecorated body sherd at depths from the surface to 30 cmbs. The site is recommended as not eligible for listing in the NRHP.

Site 41FN124 is an artifact scatter measuring 20 meters north-south by 15 meters east-west. Artifacts documented from the surface included 18 pieces of debitage, 19 fire-cracked rocks, a core, and burned clay. Shovel testing (three positive, seven negative) produced 29 artifacts including 18 fire-cracked rocks, 10 pieces of chert and quartzite debitage, and one quartzite dart point distal fragment. The site is actively eroding and many of the artifacts are out of context. Site 41FN124 is recommended as not eligible for listing in the NRHP.

Site 41FN125 is a prehistoric campsite with possible hearth features located in the northern (left) bank of Bois d'Arc Creek. The site contains two burned areas 5.5 meters horizontally separated and 2.75 meters below the modern ground surface. No artifacts were located in association with the possible hearths; an undecorated sherd was found in the streambed nearby. The upstream hearth was collected and provided a date of 510±40 B.P. Because there are no artifacts associated with the possible hearths, they may be ecofacts (natural rather than manmade) and therefore ineligible for listing in the NRHP as recommended by ARC.

Site 41FN126 is an FCR concentration found eroding from the eastern (right) bank of Bois d'Arc Creek channel. The feature was determined to be eroding from about one meter below the ground surface down the stream bank. No artifacts or charcoal were associated with the feature; the site is not recommended for listing in the NRHP.

Site 41FN127 is located on both sides of Bois d'Arc Creek. Two Gary points were found washed out of the northwest (left) bank (one Edwards chert and the other Ogallala gravel quartzite) and a mussel shell lens (136 cmbs) and bison bone (124 cmbs) were noted eroding from the east (right) bank. Samples of the bison bone and mussel shell were radiocarbon dated, providing dates of 150±30 for the bison bone and 1110±40 for the mussel shell, apparently reflecting an erosional event in the intervening 900 years. Due to the erosional nature of the site, further work is not necessary and 41FN127 is recommended as not eligible for listing in the NRHP.

Site 41FN128 is a historic-aged well. A barbed-wire fence surrounds the well, which is 12 feet deep at present, though has been silted an unknown amount. The chamber of the well has been deformed by soil pressure. No artifacts were associated with the well other than some decayed lumber fragments and no structures appear on historic maps of the area. Site 41FN128 is recommended as not eligible for listing in the NRHP.

Site 41FN129 is a multi-component large historic trash and thin lithic scatter with a well feature. The site measures 280 meters north-south by 130 meters east-west atop a ridge immediately south of extinct Lake Onstott. The site was extensively shovel tested in 30-meter intervals due to the proximity to Civil War-era Camp Benjamin. A total of 48 tests (13 positive) were excavated to define and delineate the site. Artifacts were recovered at depths from the surface to 30 cmbs (over one meter in one rodent-burrowed test) and included five pieces of debitage, three fire-cracked rocks, 16 historic-aged ceramic sherds, five mussel shell fragments, 21 pieces of window glass (dating to late 19th /early 20th Centuries), 64 pieces of miscellaneous glass, seven wire nails, one fence staple, and a metal turn latch. Additionally, a 3.5-foot wide well was found, constructed of commercial brick 27 feet deep. A metal detector was used to test for more historic-aged artifacts in an effort to determine if the site was part of Fort Benjamin. Twenty-three shovel tests were excavated at metal detector hits, recovering four pieces of prehistoric debitage, two historic-aged ceramic fragments, six square nails, one metal buckle, and various unidentifiable metal fragments. Surface finds across the site included another square nail, a flake, miscellaneous metal fragments and a toy gun (roughly modeled after a Colt 1911) dating from the 1920s to 1950s. The site was thoroughly examined and no evidence was found of a connection to Fort Benjamin, nor were prehistoric deposits stratified or diverse. Site 41FN129 is therefore recommended as not eligible for listing in the NRHP.

Site 41FN130 is a prehistoric campsite with a shell lens located on the eastern (right) bank of Bois d'Arc Creek. A 30 cm-thick mussel shell lens 12 m in length was identified eroding from the creek bank 250 to 300 cmbs. The stream bank was profiled and 50 cm by 1 m unit was excavated, the soil removed and wet screened. Material documented at the site included 100 mussel shell fragments, one quartzite interior flake, a quartzite biface/core, seven bone fragments, one piece of burned clay, a sandstone slab metate. Two shell samples were radiocarbon dated, providing dates of 3770±40 B.P. from a sample from the stream bank exposure and 3830±40 B.P. from a shell sample from the excavation unit. Because site 41FN130 appears to have stratigraphic integrity, datable material, and a fairly diverse assemblage, further work is recommended before eligibility can be determined for listing in the NRHP.

Site 41FN131 is a multi-component site located in the eastern (right) bank of Bois d'Arc Creek. A 12 cm-thick charcoal and ash lens is located 30 cmbs, below which an Edwards chert Bulverde point was located on the stream bank surface. A metal can was discovered 15 cm below the ash lens while profiling the site. It appears that there is no prehistoric occupation at the site. Further work is not necessary and the site is recommended as not eligible for listing in the NRHP.

Site 41FN132 is a historic-aged 20th Century bridge location on Honey Grove Creek upstream of its confluence with Bois d'Arc Creek. Metal pipes that once served as support posts are all that remain of the bridge; no artifacts were observed in association with the site. Site 41FN131 is not eligible for listing in the NRHP.

Site 41FN133 is a historic-aged 20th Century bridge location on Bois d'Arc Creek. The bridge remains include wood pilings, large wire nails, and bridge floor planks. Because the bridge is in a deteriorated condition it is not recommended as eligible for listing in the NRHP.

Site 41FN134 is a prehistoric campsite located in the southwest (right) bank of Bois d'Arc Creek. The site was identified by a thin layer of burned clay, charcoal, and mussel shell 1.3 meters below the surface. Two sherds of prehistoric ceramics were found loose below the layer; one sherd was decorated with a red slip. Because the artifacts were not *in situ* and because the layer is thin, the site is recommended as not eligible for listing in the NRHP.

Site 41FN135 is a prehistoric campsite located in the southeast (right) channel wall of Bois d'Arc Creek. The site consists of a burned clay layer 3 meters below the modern surface and an associate quartzite core. Because the site has no datable features or artifacts it is recommended as not eligible for listing in the NRHP.

Site 41FN136 is a Late Prehistoric-aged campsite. This site was located in a backhoe trench and contains a diverse assemblage within an occupation surface buried between 190 and 205 cmbs. Six pieces of debitage, two fire-cracked rocks, two undecorated ceramic sherds, 165 bone fragments, and 27 fragments of mussel shell were recovered from the trench. Three charcoal samples were recovered as well, one of which was radiocarbon dated 1890±30 B.P, along with a sample of bone, which also returned a date of 1890±30 B.P. Because the site is in an undisturbed and sealed context, which could facilitate the recovery of well-stratified cultural deposits, further work is recommended before eligibility for the NRHP can be determined.

Site 41FN137 is a historic-aged well. The well chamber was found to be lined with commercial bricks. The site was found to be outside the project area and was therefore not delineated or fully recorded. No eligibility recommendations can be made for listing in the NRHP at this time.

Site 41FN138 is a historic cistern. The well chamber was found to be lined with commercial bricks. The site was found to be outside the project area and was therefore not delineated or fully recorded. No eligibility recommendations can be made for listing in the NRHP at this time.

Site 41FN139 is prehistoric lithic and ceramic scatter. The site's location and information was provided to ARC by an informant after fieldwork was complete; no fieldwork was conducted at the site. The site should be fully documented before NRHP eligibility recommendations can be made.

Site 41FN140 is a prehistoric-aged artifact scatter north of Timber Creek. Like site 41FN139, this site was identified by an informant, however a site visit was performed which identified lithic debitage, one prehistoric ceramic sherd, and a Gary projectile point. The site has been heavily impacted by the construction of a home and several outbuildings. Therefore, site 41FN140 is recommended not eligible for listing in the NRHP.

Site 41FN141 is a prehistoric lithic scatter located east of CR 2610 outside of the proposed Lower Bois d'Arc Creek Reservoir. Because the site is located outside the project area it was not delineated or fully recorded. No eligibility recommendations can be made for listing in the NRHP at this time.

Site 41FN142 is a prehistoric lithic quarry located northwest of the north end of CR 2725. The site was brought to ARC's attention by an informant and subsequently visited by archeologists. Because the site is located outside the project area it was not delineated or fully recorded. No eligibility recommendations can be made for listing in the NRHP at this time.

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 survey, 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

In 2013, AR Consultants conducted a pedestrian survey of the proposed LBCR pipeline route and associated features, intensively investigating approximately 1,033 acres. Overall, seven historic archaeological sites were documented. Only one prehistoric artifact was found during the survey – an interior chert flake. The flake was discovered in the terrace sediments near the proposed dam site (AR Consultants, 2013).

It was initially believed that there was potential for buried prehistoric site deposits in the floodplain sediments in the portion of the pipeline route north of US 82. Additionally, sites might have been found on elevations in the narrow floodplains. However, the results of the survey demonstrated that they were not present; no prehistoric archaeological sites were recorded. These negative findings are consistent with previous investigations of uplands in the surrounding region.

Lithic procurement sites were another type of prehistoric site expected to be found on the drainage divides where Ogallala Gravels were deposited in Late Pliocene times. However, the survey found no evidence of major gravel fields containing quartzite and chert cobbles. These fields would have been the primary potential source for knappable material or for resources that could have been used in the process of cooking plant or animal foods. (Knapping is the shaping of flint, chert, obsidian or other appropriate rocks to manufacture stone tools.)

Each of the seven historic sites recorded during this study sites represents the remains of either late 19th or 20th century farmsteads or homesteads found on upland divides. Only one site contained historic-age structures. Yet, these structures had been modified and updated over the years, dimensioning their integrity. Additionally, the well-maintained degrading upland surface surrounding the structures contained no artifacts. Of the remaining six sites, only one did not have any associated features. This site consists of historic artifacts found on the surface and worked into the plow zone. Its location corresponds to a farmstead which was demolished prior to 1995 according to Google Earth aerials (AR Consultants, 2013).

The remaining five sites likely represent the remains of homesteads and farmsteads, but are only represented by historic artifacts and water related features. They represent a diverse selection of late 19th or early 20th century cisterns, wells, or well-cisterns.

Overall, the results of the 2013 LBCR pipeline route concur 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. However, farming and urban growth have eliminated nearly all traces of mid-19th century sites. Only sparse remains of late 19th and early 20th century sites remain, and more often than not, they contain no structures and are only represented by artifacts and features such as cisterns or wells. The historic sites documented during this study have all been heavily impacted by farming and can offer little or no information about the early history of Fannin County (AR Consultants, 2013).

3.14.5 Ongoing Investigations at the Riverby Ranch Mitigation Site

Preliminary cultural resource investigations and archeological surveys are underway within the Riverby Ranch mitigation site. They are being conducted according to procedures specified in the PA. USACE recognizes that this work is ongoing and has not been completed. Investigations on the Riverby Ranch mitigation site will be completed in accordance with Section 106 and the PA.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

Chapter 4 assesses the potential environmental consequences associated with the Proposed Action (construction and operation of the proposed water supply dam and reservoir) and secondary or connected action(s) (e.g. construction and operation of the raw water line, water treatment plant, and mitigation area). The terms "consequences," "impacts," and "effects" are used synonymously 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 included "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 effects of this habitat conversion on wildlife species occurring onsite.

Potential environmental consequences are discussed under each resource topic for two possible alternatives: 1) No Action, in which none of the above facilities would be built, 2) Proposed Action, or the construction and operation of the Lower Bois d'Arc Creek dam and reservoir and ancillary facilities at the proposed site on Bois d'Arc Creek in Fannin County, TX.

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 and Proposed Action alternatives. 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 potentially could occur as a result of implementing the Proposed Action were identified. As mentioned above, direct effects are immediate impacts caused by an action approximately at the same time and in the same location as the action. Indirect effects are impacts caused by the action(s) that occur at some distance in space and/or time from the action, or, as described above, by means of a longer chain of cause-and-effect linkages.

The following five pages (Figure 4-1) present the preliminary C-E-Q diagram 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 in the scoping meeting in Bonham to solicit input from the public.

4.2.1 Environmental Impact Statement Significance Criteria

A project like the proposed reservoir can have a wide variety of impacts on different components of the environment. The importance, or "significance," of each of these diverse impacts depends on several factors. Some of these factors are matters of objective fact. For example, if a Federal law would clearly be violated by any aspect of the proposed action, then that would obviously be a significant impact. Other factors affecting significance are matters of judgment, such as the importance of losing some amount of wildlife habitat. The CEQ's NEPA regulations provide a list of factors to be considered in determining impact significance. These factors are presented in the text box on the right side of p. 4-9. The EIS study team used an assessment methodology that combines these multiple factors into an overall assessment of significance.

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 4-1a. Preliminary Causes-Effects-Questions (C-E-Q) for LBCR

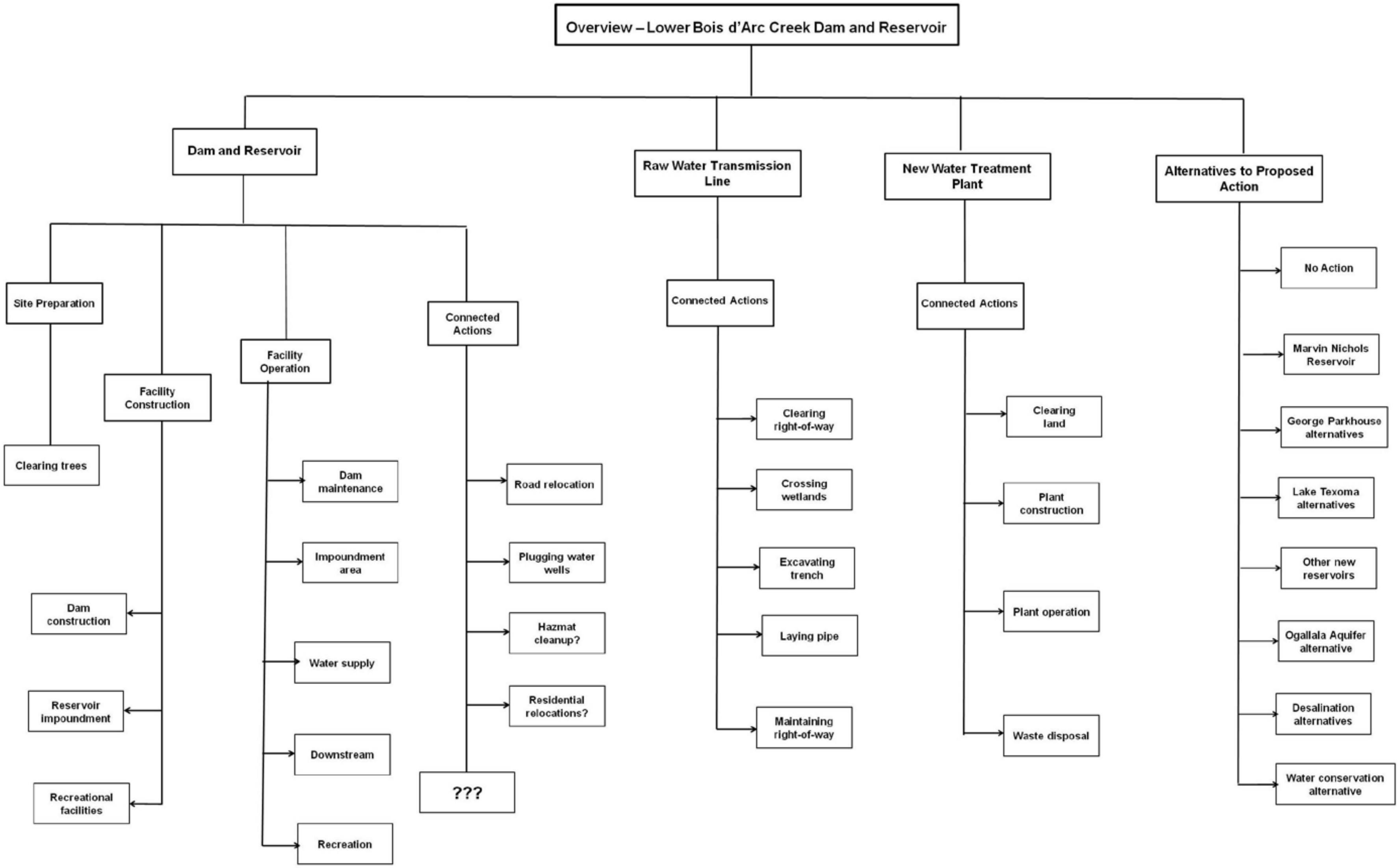


Figure 4-1b. Preliminary Causes-Effects-Questions (C-E-Q) for LBCR (cont.)

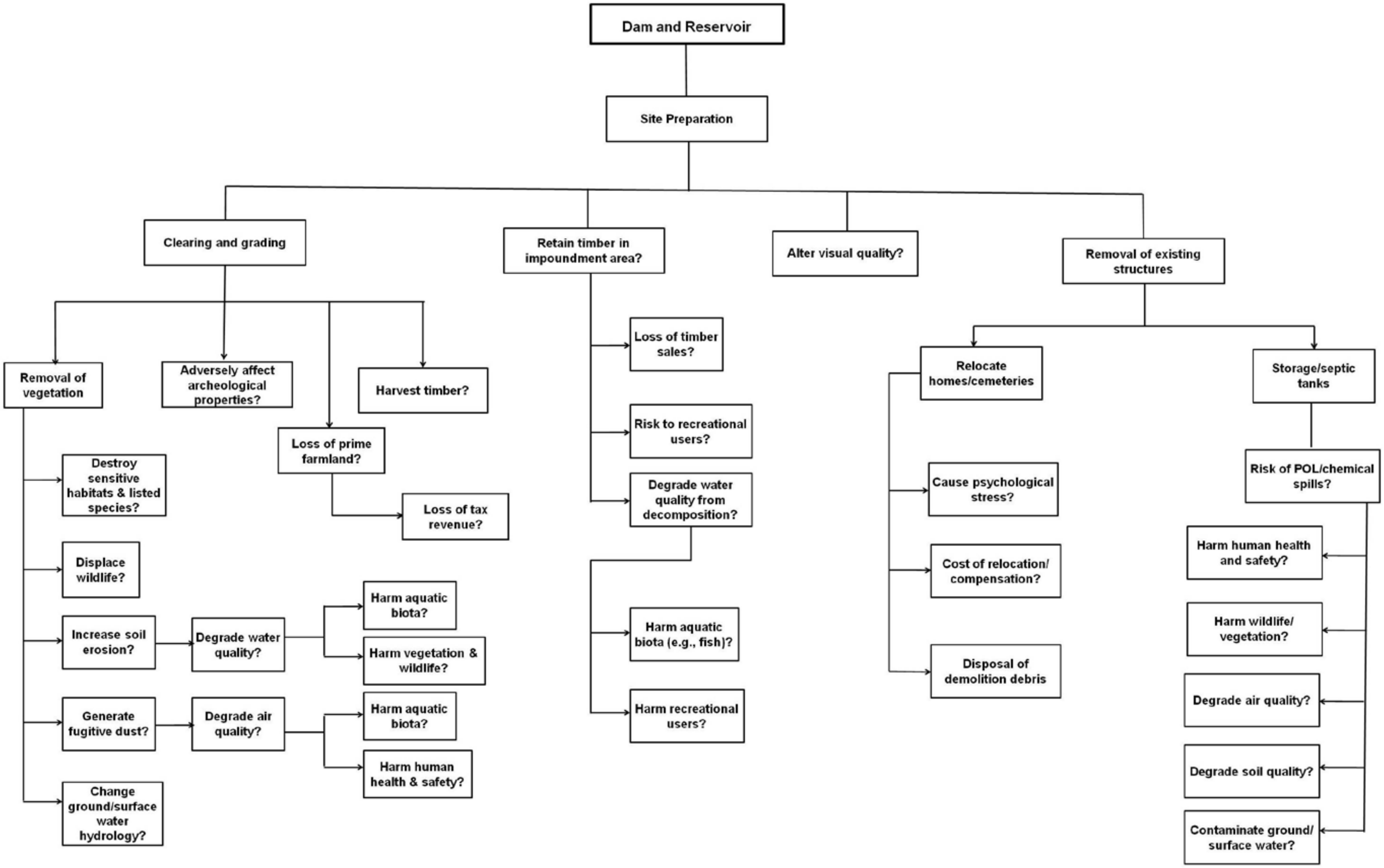


Figure 4-1c. Preliminary Causes-Effects-Questions (C-E-Q) for LBCR (cont.)

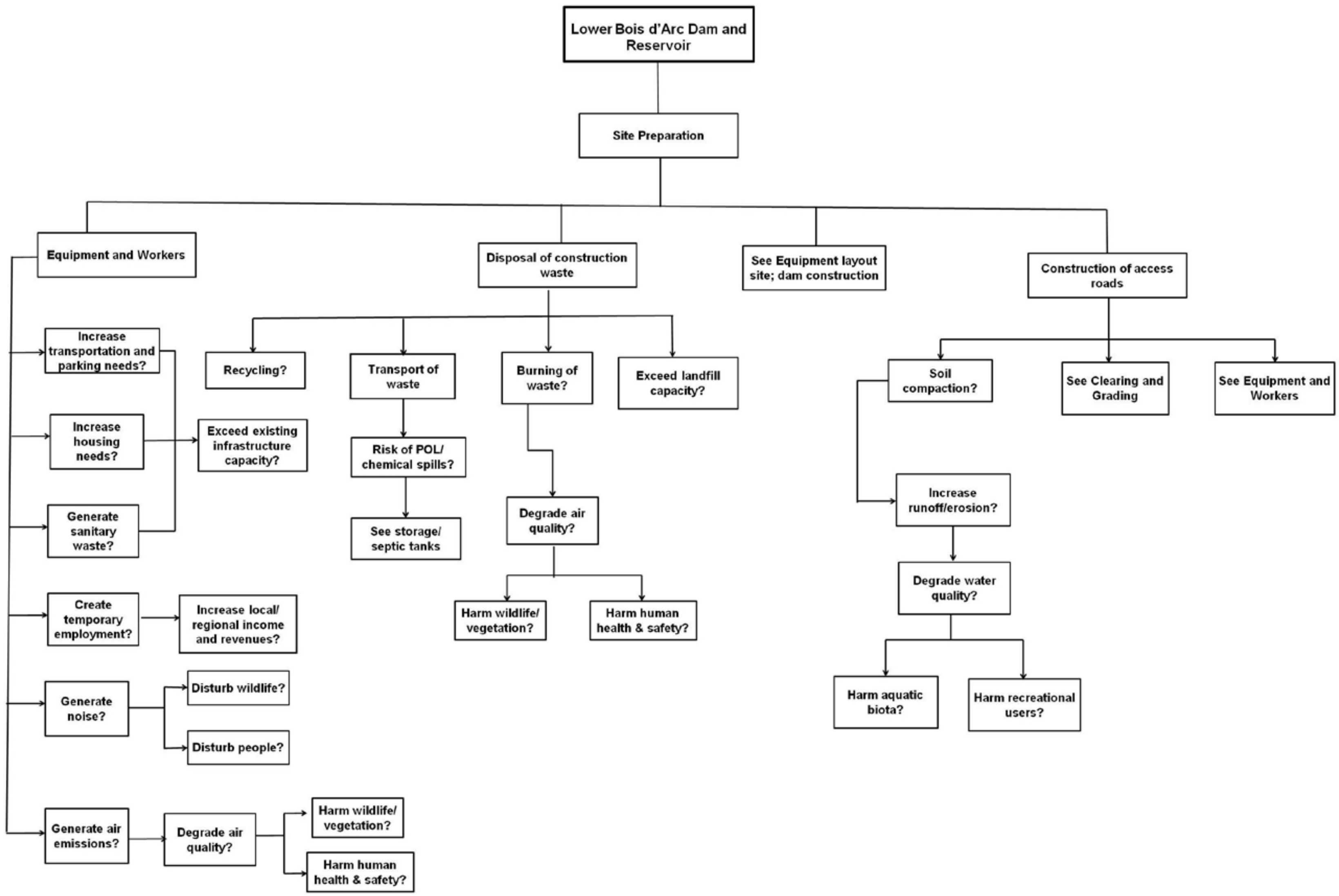


Figure 4-1d. Preliminary Causes-Effects-Questions (C-E-Q) for LBCR (cont.)

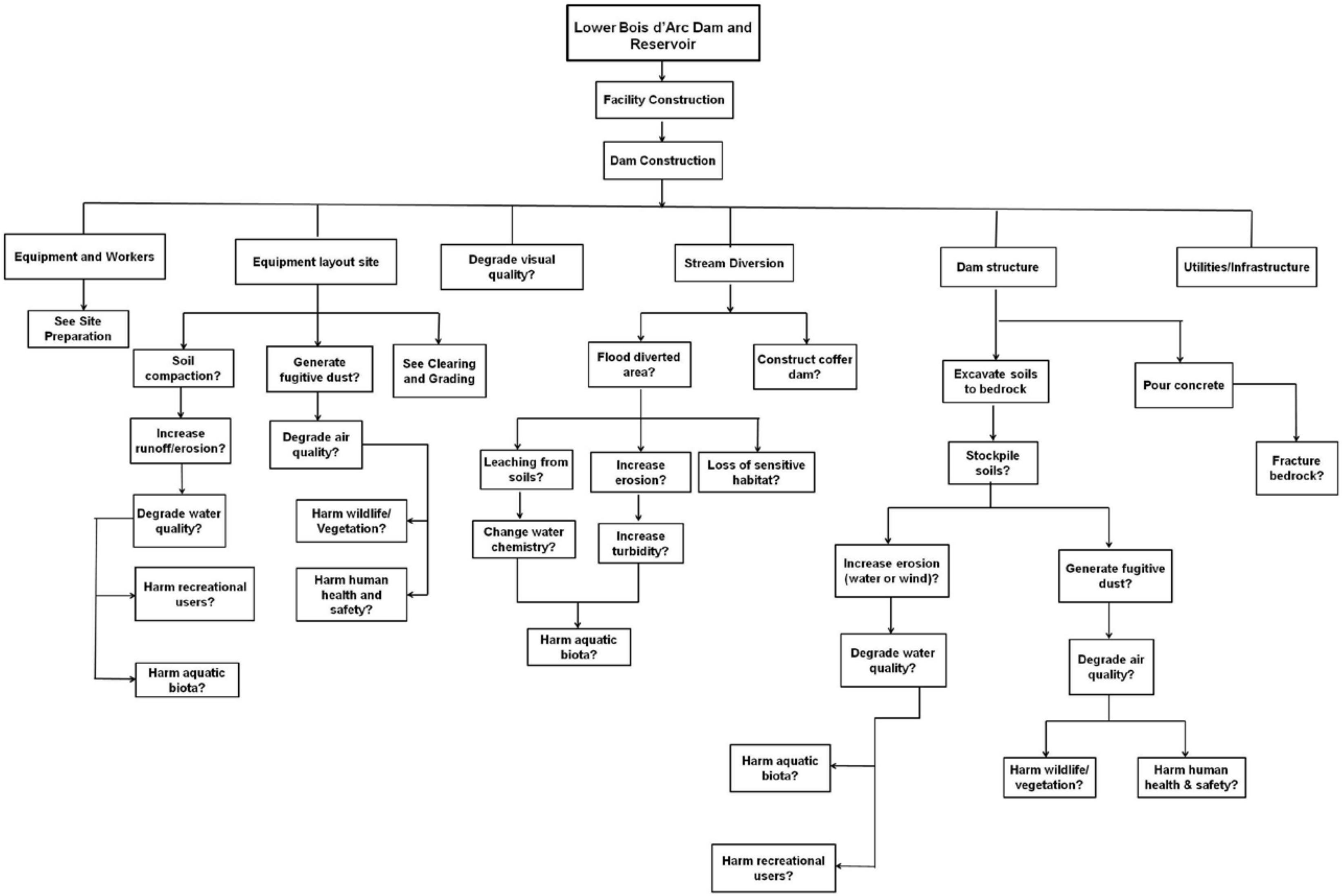
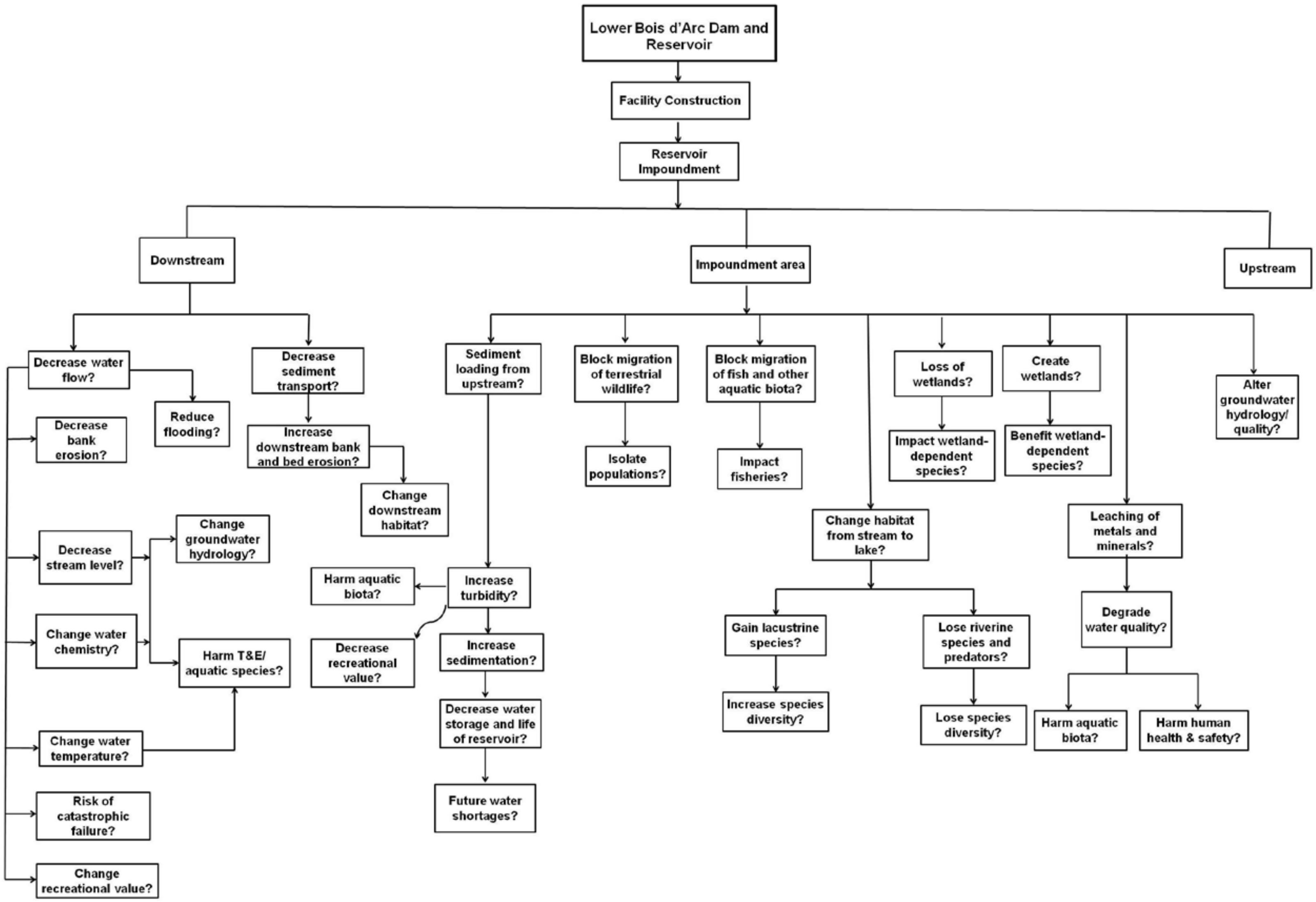


Figure 4-1e. Preliminary Causes-Effects-Questions (C-E-Q) for LBCR (cont.)



During the planning stage of the EIS study, the study team reviewed similar projects and documentation to ascertain the activities associated with the proposed action, and the types of impacts they could cause. Research was supplemented by professional judgment concerning impacts of typical concern for any large construction project. A preliminary environmental evaluation diagram (i.e., the C-E-Q diagram, Figure 4-1) which lists the potential impacts for that activity, was developed for each activity associated with the proposed action.

The study team then identified the following major factors that influence the significance of most types of impacts:

- Magnitude of the impact (how much);
- Duration or frequency of the impact (how long or how often);
- Extent of the impact (how far);
- Likelihood of the impact occurring (probability); and
- Precedence and uniqueness of the impact (e.g., unique setting, unprecedented impacts, uncertain impacts, and controversiality).

For each of these factors, the team identified several levels of that factor, as shown below:

Magnitude:
- major
- moderate
- minor

Duration:
- long term
- medium term (intermittent)
- short term

Extent:
- large
- medium (localized)
- small (limited)

Likelihood:
- probable
- possible
- unlikely

Precedence and Uniqueness:
- severe
- moderate
- slight

The team then identified which combinations of these factors would constitute various overall ratings of significance, as shown in Table 4-1 below. Given this general structure, applied to all types of impacts on all environmental resources, each member of the study team then developed his or her own definitions of these levels for each resource area. That is, biologists formulated a definition of what would constitute an impact of major magnitude on biological resources, what would be an impact of moderate magnitude, and so on. Archeologists/cultural resources specialists similarly defined what constituted an impact of major magnitude on cultural resources, and so on, through all the levels of each of the significance factors.

For the fifth major factor presented above – Precedence and Uniqueness – the study team developed a set of definitions, based on intensifying factors, for each level that are applicable to impacts in essentially all resources areas. In other words, no resource-specific definitions are needed for intensity. These definitions are as follows:

- **Severe**:

  Impacts occur in such close proximity to National Parks, National Register of Historic Places, or National Historic Landmark sites, or other especially valued, unique, or protected sites, that the valued features of those nearby sites are severely jeopardized;
  OR
  Impacts are completely unprecedented; no similar impacts have ever been known to occur;
  OR
  The types, extent, or probability of the impacts cannot be reasonably predicted;
  OR
  There is substantial and sustained dispute among subject matter experts, agencies, organizations, and/or citizens about the nature or importance of the impacts.

- **Moderate**:

  Impacts would occur at sufficient distance from any protected site that the valued features would be perceptibly altered but not severely compromised or jeopardized;
  OR
  There is moderate confidence in the accuracy of the predictions as to types, extent, and likelihood of the impacts;
  OR
  There is moderate dispute among subject matter experts, agencies, organizations, and/or citizens about the nature or importance of the impacts.

- **Slight**:

  Impacts would occur at sufficient distance from any protected site that the valued features would be imperceptibly altered;
  OR
  The types, extent, or probability of the impacts can be reasonably predicted with only slight uncertainty;
  OR
  There is very limited dispute among subject matter experts, agencies, organizations, and/or citizens about the nature or importance of the impacts.

CEQ Regulations on Significance
(40 CFR 1508.27)

The rating of an impact as "significant" in NEPA requires consideration of both the context and intensity of the impact.

- **Context:** The significance of an action must be analyzed in several contexts, including society as a whole, the affected region, the affected interests, and the locality. Both short- and long-term effects on an action should be analyzed.

- **Intensity:** Intensity refers to the severity of an impact. In evaluating the intensity of an impact of the proposed action, the following should be considered:

  - Impacts that may be both beneficial and adverse;
  - Effects on human health and safety;
  - Unique characteristics of the geographic area;
  - Highly controversial effects;
  - Highly uncertain or risky effects;
  - Potential for the action to set a precedence for future actions with significant effects;
  - Cumulative effects;
  - Adverse effects on significant scientific, cultural, or historic resources;
  - Adverse effects on a Threatened or Endangered species or its habitat; and
  - Whether the action violates or threatens a Federal, State, or local law or requirement.

Table 4-1. Criteria for rating impacts

Levels of Impact					Impact Rating
Magnitude	**Duration**	**Extent**	**Likelihood**	**Precedence and Uniqueness**	
Major	Any Level	Large or Medium	Probable	Any Level	**Significant**
Major	Long-term	Large or Medium	Possible	Any Level	
Major	Medium-term, intermittent, or short-term	Any Level	Possible	Severe	
Moderate	Any Level	Large or Medium	Probable	Severe	
Minor	Long-term	Large	Probable	Severe	
Major	Medium-term, intermittent, or short-term	Any Level	Possible	Moderate or Slight	**Less Than Significant**
Moderate	Any Level	Large or Medium	Probable	Moderate or Slight	
Major	Any Level	Small	Probable	Any Level	
Major	Long-term	Small	Possible	Any Level	
Moderate	Any Level	Large	Possible	Any Level	
Moderate	Any Level	Medium or Small	Possible	Any Level	
Moderate	Any Level	Small	Probable	Any Level	
Major	Any Level	Large	Unlikely	Any Level	
Major	Long-term	Medium or Small	Unlikely	Any Level	
Minor	Any Level	Large	Probable	Any Level	
Minor	Long-term	Medium or Small	Probable	Any Level	
Major	Medium-term, intermittent, or short-term	Medium or Small	Unlikely	Any Level	
Minor	Medium-term or intermittent	Medium	Probable	Moderate or Slight	**Insignificant**
Minor	Any Level	Large	Possible	Moderate or Slight	
Minor	Long-term	Medium or Small	Possible	Moderate or Slight	
Moderate to Minor	Any Level	Any Level	Unlikely	Moderate or Slight	
Minor	Short-term	Medium	Probable	Moderate or Slight	
Minor	Medium-term, intermittent, or short-term	Small	Probable	Moderate or Slight	
Minor	Medium-term, intermittent, or short-term	Medium or Small	Possible	Any	

With this structure established for this study, the team then conducted the EIS study. When the study team obtained the information needed to predict the magnitude, duration, extent, likelihood, and any precedence and uniqueness factors associated with the impacts for each of the resource areas, it compared its predictions to these pre-established criteria to determine the levels of significance of the impacts they had predicted. Through the use of this approach, diverse impacts will be assessed on a common footing. If a biological impact is rated by the study team as "significant," the team intends that rating to have essentially the same meaning as a "significant" impact rating in any other resource area.

As indicated above, assessing significance does involve discretion and professional judgment, as well as some degree of subjectivity as to what to value and how much to value it, and this approach does not remove that element from the process. What this method does is organize the analysts' judgment, and make the basis for their judgment more explicit and more uniform. Accordingly, the study team does not present their assessments as indisputable facts, but rather as the considered judgments of the professional team based on the explicit factors and considerations as described here.

Impacts determined to be "less than significant" or "insignificant" are not dismissed as unimportant or non-existent. Rather, these impacts, while adverse (or beneficial, as the case may be) are not considered to have crossed the threshold of significance as defined by Table 4-1.

4.2.2 Definitions

Discussions of environmental consequences in the following sections will utilize a general vocabulary consisting of the 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.

Duration of Impact:

Long-term – Impact would likely last more than two years, or over the lifetime of the project and possibly longer, exceeding the project lifetime.
Medium-term – Impact would extend past the transition phase, or construction phase for future developments, but would not last more than two years, at most.
Intermittent – Impact would not be constant or continuous but may last indefinitely.
Short-term – Impact would occur during a transition phase only, or in the case of potential future developments, during the site preparation and construction phases only. Once these phases have ended, resource conditions are likely to return to pre-transition/construction conditions.

Extent of Impact:

Large – Impacts would affect the resource on a regional level, extending well past the immediate project site.

Medium or Localized – Impacts would affect the resource only on the project site or its immediate surroundings, and would not extend into the region.
Small or Limited – Impacts would affect the resource over a fraction of the project site.

Magnitude of Impact:
Major – Substantial impact or change in a resource area 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.
Minor – Change in a resource area occurs, but no substantial resource impact results.
Negligible – The impact is at the lowest levels of detection – barely measurable and with no perceptible consequences.

Likelihood of Impact:
Probable – More likely to occur than not, i.e., approximately 50% likelihood or higher.
Possible – Some chance of occurring, but probably below 50%.
Unlikely – A non-zero but very small likelihood of occurrence.

Other Terms:
Region of Influence (ROI) – the region over which direct and indirect effects may be experienced; also the region of analysis for the EIS topic in question.
Area of Potential Effect (APE) – similar to ROI, this term and acronym are used exclusively in the context of the analysis cultural and historic effects.

4.3 TOPOGRAPHY, GEOLOGY, AND SOILS

For topography, geology and soils, the Region of Influence (ROI) is the project footprint itself, including connected actions such as the raw water pipeline, terminal storage reservoir, FM 1396 relocation/new bridge, and new treatment plant.

4.3.1 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 neither be built nor operated. Under this scenario, over the short term, topographic features, geological formations, and soils on the reservoir site and other related sites would all remain essentially in their present condition. Over the long term, if these lands continued to be used for agriculture or grazing, rather than being restored to a more natural and thicker vegetative cover, soil erosion would be expected to occur on the steeper sites, gradually reducing soil depth. 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, localized, and minor to moderate in magnitude, but less than significant.

4.3.2 Proposed Action

4.3.2.1 Construction of the LBCR Dam and Reservoir

The impacts of dam and reservoir construction to topography and geology would be expected to be moderate in magnitude, both short-term and long-term, medium in extent, probable, and slight in precedence and uniqueness. 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 above mean sea level. Viewshed topography would be altered by dam construction, though these impacts would be localized to the immediate viewing area.

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 (east) 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 in magnitude, both short-term and long-term, medium or localized in extent, probable, and slight in precedence and uniqueness. Soil disturbing activities from use of heavy construction equipment often result 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 Action are clayey with a low erosional potential. Soil compaction is not expected to significantly change the character of the existing soils. Mitigation measures such as standard Best Management Practices (BMPs) can reduce these impacts to soil resources.

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, as prepared by the applicant, guides the process of vegetation removal within the footprint of the reservoir. Reservoir 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 can be minimized by considering the specific character of the soils, slope, and underlying strata at a particular location.

Overall, using the impacts rating criteria in Table 4-1, the effects on topography, geology, and soils of constructing the LBCR would be adverse but less than significant.

4.3.2.2 Operation of the LBCR Dam and Reservoir

With regard to topography, impacts from operation of the proposed LBCR would be moderate in magnitude, long- term, medium in extent, and moderate in precedence and uniqueness. The dam would operate as a structure 10,400 ft in length at the terminus of the reservoir, which would have a total footprint of 17,068 acres (including the dam). Operations are not anticipated to impact geological resources unless slope stability was 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. However, in most places bank slopes would be relatively low, given the relatively gentle topography of the area. Best management practices and monitoring would be implemented to decrease the potential of these impacts. Impacts from operations on geology would thus be considered minor in magnitude, long-term, medium or localized in extent, and slight in precedence and uniqueness.

Impact to soils from the operation of the dam and reservoir are expected to be moderate in magnitude, long-term, localized in extent, probable, and moderate in precedence and uniqueness. 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. Because sediment would be withheld behind the dam (contained and deposited within the reservoir), the sediment load of the discharge water would be decreased, thus increasing the potential for bank erosion downstream of the dam.

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 action 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 takes place. However, the NRCS considers Prime Farmland soils found in areas of proposed water supply reservoirs to be exempt from restrictions. While the total Prime Farmland would not be available for agriculture, impacts from the Proposed Action are exempt from consideration and protection under the Farmland Protection Policy Act (FPPA). The NRCS office in Temple, TX reviewed information concerning the Proposed Action and completed Farmland Conversion Impact Rating Form (AD-1006). The combined score for the LBCR site was 115; sites with a rating of less than 160 are not subject to the FPPA (Figure 4-2).

Overall, using the impacts rating criteria in Table 4-1, the effects on topography, geology, and soils of operations at the LBCR would be adverse but less than significant.

4.3.2.3 Raw Water Pipeline

Under the Proposed Action, 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 3.1.2.2 the main soil groups crossed by the pipeline route include the Fairlie-Dalco complex, Houston Black clay, and Howe-Whitewright complex. The former two complexes 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.

The Proposed Action would temporarily impact these soils by the use of heavy machinery, excavating a trench, and laying the pipeline. These impacts would be adverse, of minor magnitude, short-term duration, medium extent, probable likelihood, and slight precedence. Overall, impacts of the Proposed Action on soils along the proposed raw water pipeline route would be insignificant.

4.3.2.4 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 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

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

101 S. Main Street
Temple, TX 76501-6624
Phone: 254-742-9861
FAX: 254-742-9859

August 24, 2011

Mangi Environmental Group
7927 Jones Branch Drive, Suite 150
McLean, VA 22102

Attention: Erica M. Earhart, Environmental Analyst

Subject: Land Use (LNU)--Farmland Protection
Proposed Lower Bois d' Arc Reservoir
Fannin County, Texas

We have reviewed the information provided concerning the proposed Lower Bois d' Arc Reservoir in Fannin County, Texas, in correspondence dated May 2, 2011. This is part of the National Environmental Policy Act (NEPA) evaluation for the US Army Corps of Engineers. We have evaluated the proposed area as required by the Farmland Protection Policy Act (FPPA).

The proposed project does contain soils classified as Important Farmland. We have completed Parts II, IV, V and VI of the Farmland Conversion Impact Rating form (AD-1006) sent to us. The combined rating of the proposed site is 115. The FPPA states that sites with a rating less than 160 will need no further consideration for protection and thus are not subject to the FPPA. During the work on this project we would encourage you to use accepted erosion control methods.

We have attached the completed AD-1006 form. Thank you for the resource materials you submitted to help in our evaluation. If you have any questions please call Laurie Kiniry at (254) 742-9861, Fax (254)-742-9859.

Sincerely,

Laurie Kiniry

Laurie N. Kiniry
Soil Scientist

Attachment

Figure 4-2. Evaluation of the proposed LBCR by the NRCS

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 5/2/11
Name Of Project Proposed Lower Bois d'Arc Reservior	Federal Agency Involved U.S. Army Corps of Engineers
Proposed Land Use reservoir	County And State Fannin County, TX
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 7/18/11

Does the site contain prime, unique, statewide or local important farmland? *(If no, the FPPA does not apply -- do not complete additional parts of this form).*	Yes ☑	No ☐	Acres Irrigated 7379	Average Farm Size 245
Major Crop(s) wheat	Farmable Land In Govt. Jurisdiction Acres: 424,393 % 74		Amount Of Farmland As Defined in FPPA Acres: 405,687 % 71	
Name Of Land Evaluation System Used LESA	Name Of Local Site Assessment System N/A		Date Land Evaluation Returned By NRCS 8/24/2011	

		Alternative Site Rating			
PART III *(To be completed by Federal Agency)*		Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly		17,068.0			
B. Total Acres To Be Converted Indirectly					
C. Total Acres In Site		17,068.0	0.0	0.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information					
A. Total Acres Prime And Unique Farmland		5,711			
B. Total Acres Statewide And Local Important Farmland		1,713			
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted		2%			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value		74%			
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*		~~0~~ 14	0	0	0
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*	Maximum Points				
1. Area In Nonurban Use	15	15			
2. Perimeter In Nonurban Use	10	10			
3. Percent Of Site Being Farmed	20	7			
4. Protection Provided By State And Local Government	20	20			
5. Distance From Urban Builtup Area	15	15			
6. Distance To Urban Support Services	15	10			
7. Size Of Present Farm Unit Compared To Average	10	5			
8. Creation Of Nonfarmable Farmland	10	10			
9. Availability Of Farm Support Services	5	0			
10. On-Farm Investments	20	4			
11. Effects Of Conversion On Farm Support Services	10	0			
12. Compatibility With Existing Agricultural Use	10	5			
TOTAL SITE ASSESSMENT POINTS	160	101	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	100	~~0~~ 14	0	0	0
Total Site Assessment *(From Part VI above or a local site assessment)*	160	101	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	~~101~~ 115	0	0	0

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? Yes ☐ No ☐

Reason For Selection:

Figure 4-2. Evaluation of the proposed LBCR by the NRCS (cont.)

predominant soil type at this site is the Fairlie-Dalco complex, the soils of which are deep, moderately alkaline, clayey soils on low slopes of 3-5%.

These impacts on soils would be adverse, of minor to moderate magnitude, long-term duration, small to medium extent, probable likelihood, and slight precedence. Overall, developing the proposed water treatment plant would have less than significant effects on soils.

4.3.2.5 FM 1396 Relocation and New Bridge Construction

As described in Section 3.10 of this EIS, FM 1396 is an existing two-lane, TxDOT asphalt road situated within the proposed reservoir. Construction of the 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 route 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 on the northern and southern sides of 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, localized impact of slight precedence.

4.4 WATER RESOURCES

The following sections address the potential effects of construction and operation of the proposed LBCR project on the available water resources and wetlands located within the study area. Discussion of the environmental consequences of the No Action Alternative and the proposed Lower Bois d'Arc Creek Reservoir project site and pipeline route will include issues related to effects on surface water resources, including waters of the U.S. and wetlands, groundwater resources, and existing water rights and inter-basin water transfers.

4.4.1 No Action Alternative

The primary ROI for water resources is the Bois d'Arc Creek watershed.

4.4.1.1 Surface Water Resources

The No Action Alternative is expected to result in continuing minor to moderate 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 by Freese and Nichols for NTMWD also discusses potential impacts that could result from increased runoff from development and urbanization, particularly in the nearby City of Bonham (Freese and Nichols, 2008a). As the most serious flooding in the watershed is currently caused by constrictions due to two bridge crossings, the greatest hydrologic impact expected to result from the No Action Alternative would be the potential for continued and perhaps worsened flooding caused by the construction of new roads and bridges, perhaps exacerbated by general development in the county and an associated increase in erosion (initially) and runoff from impervious surfaces (permanently).

Surface water quality is expected to remain similar to the existing conditions under the No Action Alternative, although increases in turbidity could result from development and/or increased channelization. Bois d'Arc Creek water quality should continue to support all of its current instream uses under this alternative.

As the waters of the U.S., including wetlands, located at the project site would remain intact and unchanged, the No Action Alternative would not cause any significant changes to the current conditions and function of the wetlands. If the reservoir were not to be built, then those lands within the proposed reservoir footprint could once again be subject to timber harvest, clearing of wetlands (bottomland hardwood forests), and construction of new stock ponds, though not by NTMWD.

Overall, using the criteria at the start of this chapter, the direct and indirect impacts on surface water resources from the No Action Alternative would be of minor magnitude, long term duration, medium or localized extent, probable likelihood, and slight precedence. In sum, the No Action Alternative's effects on surface water resources would be insignificant.

4.4.1.2 Groundwater Resources

The No Action Alternative would potentially have a moderate impact on groundwater supply, since groundwater withdrawals from the local aquifers would likely increase as a result of increasing water demand in the area. Given that population and water demand are projected to steadily increase in Fannin County over the next several decades (Region C Water Planning Group, 2010), the No Action Alternative could potentially increase the pumping of groundwater from the major aquifers in the region, including the Woodbine and Northern Trinity, thereby decreasing water levels in these aquifers. As such, areas of the 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. In sum, the No Action Alternative's effects on groundwater resources would be a moderate and potentially significant adverse impact on local aquifers.

4.4.2 Proposed Action

4.4.2.1 Impact Area

The proposed Lower Bois d'Arc Creek Reservoir project would impact approximately 17,068 acres of bottomland and adjacent upland habitat along Bois d'Arc Creek in north central Fannin County, including 5,874 acres of wetlands, 219 acres of streams, and 87 acres of open water (Freese and Nichols, 2008a). The constructed dam and spillways would impact 427 acres while the reservoir itself would inundate approximately 16,641 acres. The proposed reservoir has a total drainage area of 327 square miles. Upon construction of the proposed Lower Bois d'Arc Creek Reservoir project, areas within the project site would be inundated to an elevation of 534 feet above mean sea level under normal operating conditions. Approximately 123.3 miles of perennial and intermittent streams located within the proposed project site would be lost to inundation.

The primary purpose of the 16,641-acre proposed reservoir is to provide water supplies for customers in the NTMWD's service area within Collin, Dallas, Rockwall, Hunt, Hopkins, Kaufman, Denton, Rains, and Fannin counties. As such, a raw water transmission pipeline would be required to convey and deliver water from the proposed reservoir diversion to a proposed new water treatment plant – the "North Water Treatment Plant" – near the City of Leonard in southwest Fannin County (as shown on Figures 2-8 through 2-13). The proposed water delivery project includes approximately 35 miles of pipeline right-of-way. In selecting an alignment for this pipeline, planners attempted to avoid jurisdictional waters and wetlands as much as possible. A Preliminary Jurisdictional Determination (PJD) was conducted in the fall 2013 of the pipeline route and the proposed sites of connected facilities near Leonard (i.e., the terminal storage reservoir and the water treatment plant). The alignment chosen crosses 39 waters of the U.S., of which 36 are streams (one perennial, seven intermittent, and 28 ephemeral). In addition, there is one on-channel impoundment and two upland/off-channel stock ponds. No jurisdictional wetlands would be crossed by the proposed pipeline.

A number of stream crossings were avoided altogether because the pipeline alignment follows high ground (upland) along the divide between the Sulphur River basin and the Red River basin over roughly half of its length. Temporary impacts to Ward, Honey Grove and Bullard Creeks would be avoided by using tunneling rather than trenching at these stream crossings. At those crossings of smaller streams, where the open-trench construction method is proposed for use, all exposed slopes and stream banks would be stabilized and pre-construction contours would be restored afterwards. These techniques would serve to limit both the areal extent and the duration of impacts. The areal extent of impacts would likely be limited or localized at most, while the duration of impact would be short-term or medium-term at most. Overall impact from pipeline construction to waters of the U.S. would be negligible to minor.

The proposed new water treatment plant and terminal storage reservoir near the City of Leonard occupy a site to the west-northwest of town (as shown on Figure 2-8). The project site for the WTP and TSR are used primarily for livestock grazing and hay production. Within the area investigated in a 2010 PJD of Waters of the United States on the project site, the tracts mostly consist of areas containing upland herbaceous vegetation. Wooded areas do occur along riparian corridors and along fence lines (Alan Plummer Associates, 2010).

The PJD conducted in fall 2013 determined that there are no jurisdictional waters or wetlands present within the footprint of either the North WTP or its associated TSR. Planners were able to select upland areas on which to site these two facilities that entirely avoided permanent impacts to waters of the U.S. including wetlands.

The acreages directly impacted by the footprints of the two main parts of the Proposed Action are shown in Table 4-2.

Table 4-2. Combined project impact area (acreage) within footprints of the Proposed Action

Facility and water resource	Temporary Impact (linear feet)	Permanent Impact (linear feet)	Temporary Impact (acres)	Permanent Impact (acres)
Dam and reservoir				
Wetlands	--	--	--	5,874
Streams	--	651,024	--	219
Open waters	--	--	--	87
Raw water pipeline, WTP & TSR				
Wetlands	--	0	0	0
Streams	4,355	0	0.44	0
Open waters	--	0	0.1	0
Combined distance/acreage	**4,355**	**651,024**	**0.54**	**6,180**

Table 4-3 displays the percentages of total impacts to waters and wetlands impacted by the two main parts of the Proposed Action. In sum, construction of the dam and reservoir is responsible for all of the permanent impacts while construction of the raw water pipeline, water treatment plant and terminal storage reservoir is responsible for all of the temporary impacts.

Table 4-3. Impacts of each facility component as a percentage of entire project impact

Facility and water resource	Temporary Impact (linear feet)	Permanent Impact (linear feet)	Temporary Impact (acres)	Permanent Impact (acres)
Dam and reservoir				
Wetlands	--	--	--	100%
Streams	--	100%	0%	100%
Open waters	--	--	--	100%
Raw water pipeline, WTP & TSR				
Wetlands	--	--	0	0%
Streams	100%	0%	100%	0%
Open waters	--	--	100%	0%

4.4.2.2 Reservoir Storage

The 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 (Figure 4-3). The profile also indicates that water depth would be 19 feet by reservoir mile 12, and 11 feet by reservoir mile 13, under normal pool conditions (Freese and Nichols, 2011a). Water depth would be approximately four feet by reservoir mile 15, and that 4-foot water depth 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 from the normal pool elevation). At 50 percent capacity, the reservoir pool elevation would be at 520.3 feet (-13.7 feet from the normal pool elevation).

Figure 4-4 presents a plan view map of the fill levels of the proposed LBCR based on the elevation profile discussed above. This map 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 above mean sea level), at 75 percent capacity, at 50 percent capacity and at the flood easement elevation (545.0 feet msl).

Reservoir storage capacity can 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 streambeds. Erosion and sedimentation rates vary throughout the year as well as from year to year. 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 sediment discharge rating curves using measured sediment concentrations in stream water, estimation of watershed sediment yields using available erosion prediction equations such as the Modified Universal Soil Loss Equation, and comparison to measured sedimentation rates in existing reservoirs with similar climate, soils, land use/land cover and topography (Coffman, 2013).

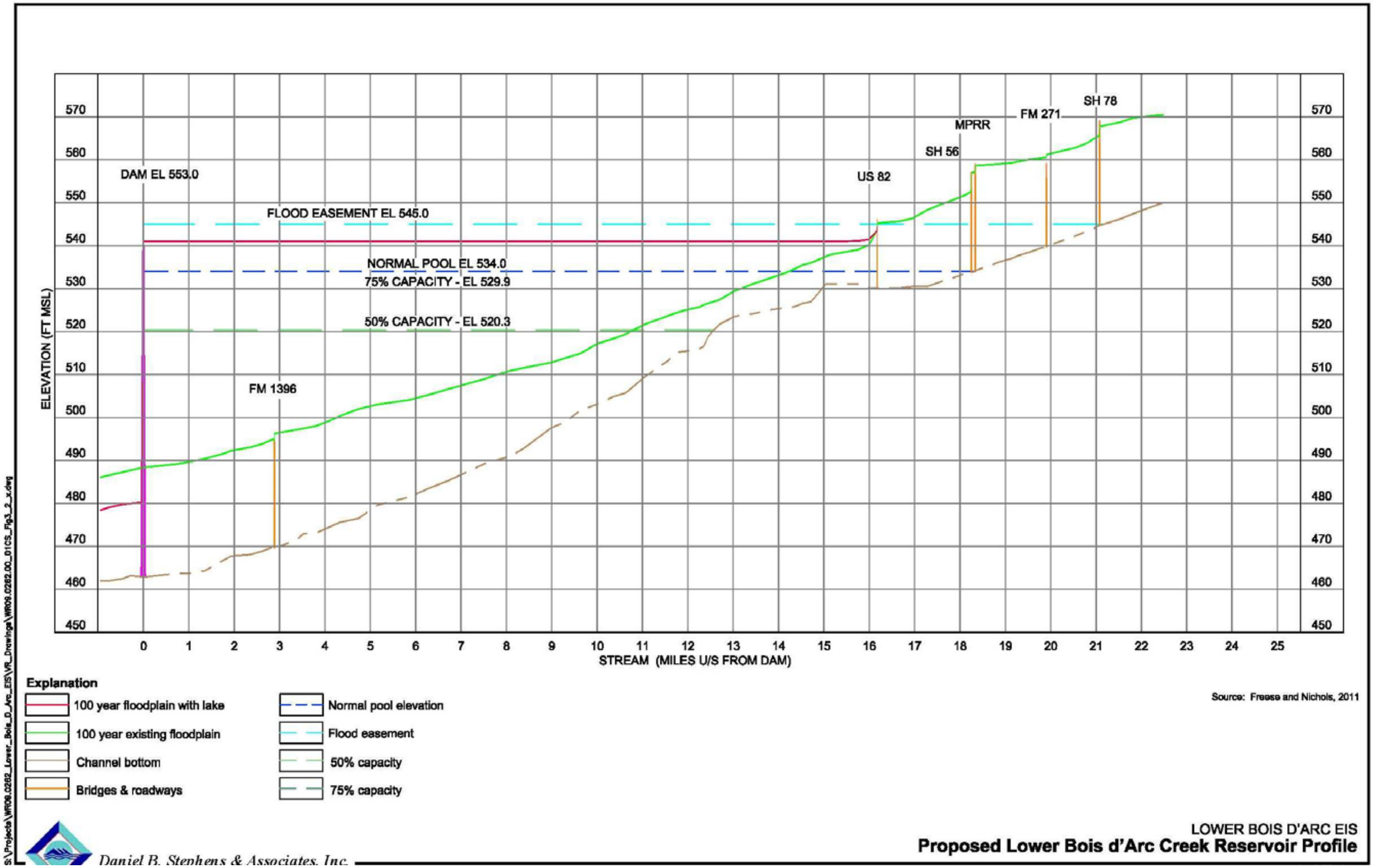


Figure 4-3. Profile of proposed LBCR

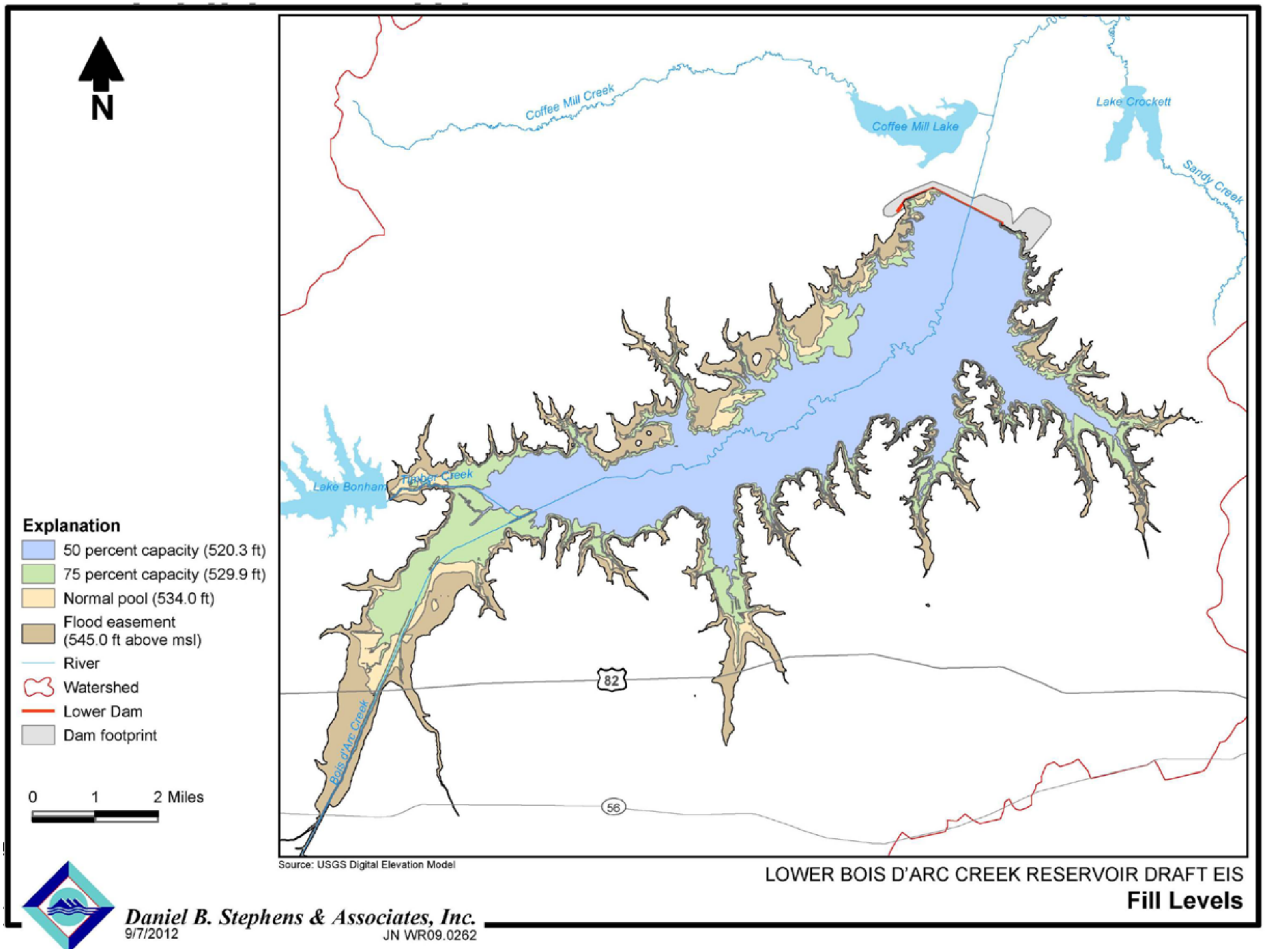


Figure 4-4. LBCR fill levels

Table 4-4, 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 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 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 LBCR, and the USACE concurs. 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).

Table 4-4. 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

*acre-feet per square mile per year **acre-feet per year
Source: Coffman, 2013

Assuming a sedimentation rate of 0.94 AF/mi^2/year (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% 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 submerged so that they 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.

4.4.2.3 Downstream Impacts on Flows and Navigation in Red River

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 not a 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 values 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 on 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 volume caused by a diversion of up to 175,000 acre-feet of water annually (less during periods of low flow) from one of its tributaries, Bois d'Arc Creek, is not expected to significantly impact water supply or flows in the Red River. No or negligible adverse water supply impacts are predicted to occur at the "Red River near De Kalb, Texas" or "Red River near Hosston, Louisiana" gages, even under low flow conditions.

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 hydropower and can vary substantially on any given day. In recent years, on average, approximately 3-4 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 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.

Table 4-5. Daily average flows at selected gages in the Bois d'Arc Creek and Red River area, July 2006 to June 2014[1]

Statistic	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

[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.

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 from the LBCR project would have only a minor effect on downstream flows in the Red River.

The U.S. Army Corps of Engineers lists navigable waters for the Red River 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 boundaries (northern edges) 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 cubic feet per second (cfs) (USACE, 1989).

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'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 two gages' data that were analyzed are one Red River gage located in Texas and another Red River gage located near Shreveport, Louisiana. These gages (Red River near De Kalb, Texas, and Red River near Hosston, Louisiana), 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.

Minimum daily mean discharge values were summed for the Red River near the DeKalb, Texas gage, located in Bowie County near the state line, for its period of record (1969 to 2010), yielding a minimum annual discharge of 900,000 acre-feet (USGS, 2011b). Data were also evaluated for the Red River near Hosston, Louisiana stream gage, located approximately 110 miles downstream of the Texas state line and 30 miles north of Shreveport, Louisiana. Minimum daily mean discharge values were summed for the period of record on this gage (1957-1994, although records for this gage are discontinuous), yielding a minimum average annual discharge of 1.6 million acre-feet (USGS, 2011a).

Since navigability is dependent on daily flows and not annual discharge, the minimum of daily mean discharges were also evaluated for these three stream gages. The minimum of daily mean discharge measurements at the Red River near DeKalb, Texas gage was 254 cfs for 1969 to 2010, with the minimum of 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). Evaluating the 10th percentile of daily mean values instead of the minimum of daily mean discharges 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). This stream gage is located in Bowie County near the state line, in a section that is not defined as navigable.

The minimum of 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 of daily mean discharges 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 impact 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 of daily mean discharge values at the Red River near DeKalb, Texas gage were 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 of daily mean discharge values at the Red River near Hosston, Louisiana stream gage exceeds the minimum navigability flow requirement for 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.

A 175,000 AFY withdrawal at the LBCR is equivalent to 242 cfs (if the flows and diversions were constant through the year, which they are decidedly not), and 242 cfs seems to be a sizeable share of the minimum flow 1,200 cfs flow required to maintain navigability in the navigable reaches of the Red River.

Water supply demand varies through the year, and the highest amount taken from the reservoir would be in late summer and early fall. However, the withdrawals from the Bois d'Acr Creek/Red River system to meet customer demand 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, there would be no effect on navigability. As stated elsewhere in this section, during low flow times, there would actually be more flow in Bois d'Arc Creek with reservoir present compared to existing flows without the project.

The bottom line is that the proposed action (LBCR) would not impact navigability on navigable reaches of the Red River downstream. Reinforcing this conclusion is the fact that the Red River Authority has never expressed concern to NTMWD or the TWDB about the effect of the proposed project on Red River flows.

4.4.2.4 Surface Water Quality Impacts

With regard to surface water quality in the reservoir, the expected result is similar or even lower average dissolved mineral concentrations than in existing stream flow as a result of the proposed reservoir project, due to most of the inflows resulting from high-flow events (Freese and Nichols, 2008a). Historical water quality data for the 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 of water quality 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 a reduction in the variability of 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 in order to estimate concentrations of chloride, sulfate, and total dissolved solids in the proposed reservoir (Freese and Nichols, 2006). Limited water quality and USGS gage data were available for Texas tributaries downstream of Lake Texoma when this analysis was performed. 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 (Freese and Nichols, 2006).

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 are completely mixed in the reservoir, and a monthly time-step was used to evaluate lake level and parameter concentration for the period of 1940 through 1986. Values used for the natural inflow water quality are presented in Table 4-6. The water model predictions may include a significant margin of error due to how little water quality data were available for Bois d'Arc Creek at the time of the analysis.

Table 4-6. 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: Freese and Nichols, 2006

The estimated water quality for the proposed Lower Bois d'Arc Creek Reservoir that resulted from the water-balance model is shown in Table 4-7.

Table 4-7. 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

Source: Freese and Nichols, 2006
[a] = Total concentration is a maximum 1-year running average

The 2006 water quality analysis concluded that the primary impact on water quality that would result from building the proposed reservoir would be to decrease the variability of water quality in the reach downstream of the reservoir (Freese and Nichols, 2006). This assessment concurs with that conclusion. The expected chloride, sulfate, and total dissolved solids concentrations in the LBCR are not elevated and 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 is amenable to the standardized, widely-used water treatment processes and technologies employed by NTMWD, which include flocculation/ coagulation, sedimentation, disinfection (three times), filtration, and pH adjustment.

As a part of the 2010 Instream Flow Study, Freese and Nichols performed an analysis of the impact of the reservoir on dissolved oxygen (DO) downstream of the proposed reservoir. Their modeling used an existing Qual-TX model developed by TCEQ to evaluate waste loads in Bois d' Arc Creek, restricting the analysis to below the proposed reservoir dam. As described in the Draft Operation Plan (NTMWD, 2014; Appendix F 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 the depth in a manner that would minimize impacts to DO concentrations downstream.

Freese and Nichols reviewed DO and temperature data from other North Texas lakes and used these data in the Qual-TX model. Jim Chapman (Cooper) 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) (Freese and Nichols, 2010a).

Freese and Nichols modeled flow regimes 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 (Freese and Nichols, 2010a). 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 DO standards (Table 3-6). The TCEQ freshwater criteria for a High Aquatic Life Use Subcategory (which is where Bois d'Arc Creek falls) 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 levels would be expected to be slightly higher than at present, which may be a beneficial impact for the creek. Results of the water quality modeling predicting water quality in Bois d' Arc Creek downstream of the proposed dam are summarized in Table 4-8.

Table 4-8. Bois d'Arc Creek water quality modeling results for the proposed flow regimes

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 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

Source: Freese and Nichols, 2010a

The 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) in order to monitor the proposed reservoir's impact on water quality below the dam after it is built.

Water Quality Impacts on Red River Downstream of Bois d'Arc Creek Confluence

As stated earlier in this document, 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. Because water in Lake Texoma is relatively salty, hydroelectric and other releases from Denison Dam largely determine salinity levels below Lake Texoma. As one proceeds 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).

Salinity is typically measured by the water quality parameter called Total Dissolved Solids (TDS). As the name suggests, TDS is a measure of the concentration of dissolved solids in a known volume of water, typically milligrams per liter (mg/L), and it can only be measured in discrete, field-collected samples that are analyzed in a lab. USGS reports daily specific conductance measurements for certain stream gages. Generally there is a fairly consistent relationship between TDS concentration and specific conductance, so specific conductance measurements are often used as a proxy for daily or monthly TDS concentrations (Albright and Coffman, 2014).

USGS reports daily specific conductance data for two stream gages in the vicinity of Lower Bois d'Arc Creek Reservoir:

- Red River at Arthur City, TX (07335500) - 3/2007 to 9/2008
- Bois d'Arc Creek at FM 1396 near Honey Grove, TX (07332620) – 6/2006 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 showed that if the LBCR had been present during this 14-month period, TDS concentrations would have increased by 1.2-1.4%. This is a minor impact.

Golden Algae

Golden algae (*Prymnesium parvum*) is a toxic algal species that can cause extensive fish kills, and rivers, ponds, and reservoirs in north-central Texas have been susceptible to these events (TPWD, 2011). Four Texas river systems (Brazos, Canadian, Colorado, and Red) and at least 29 Texas reservoirs have been affected by golden algae since 2001 (TPWD, 2011). 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 reservoirs (TPWD, 2007c).

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 a plan be in place prior to any introduction taking place (TPWD, 2011).

The following are some of the risk factors that can be used to determine if a waterbody is in a high risk area for golden algae toxic events (TPWD, 2011) (answers for LBCR in italics):

- Have previous toxic golden algae events taken place? *N/A*
- Is golden algae known to be present in the waterbody? *N/A*
- 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 soils and high pH (>7.0) waters conditions present for the waterbody in question? *Yes*.
- Does the waterbody have fairly salty water (high conductivity)? *Not considered excessive. Salinity (chloride) predicted in LBCR is below favorable range for golden algae.*

Based on these risk factors, the golden algae is 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) and ultraviolet light and ozonation for small volumes of water (TPWD, 2011).

The TPWD monitors for algal blooms and provides golden algae bloom status reports on their web site. 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, 2011). 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, 2011), and so equipment cleaning could be important to keep from introducing this alga and other invasive species into the new reservoir.

4.4.2.5 Flooding Impacts

The inundated project area would increase to approximately 541 feet under the 100-year floodplain with the reservoir (as shown on Figure 4-3) (Freese and Nichols, 2011a). The NTMWD plans to acquire ownership of property within the 541.0 foot elevation contour and flowage easements between 541.0 and 545.0 feet as a part of this project. Construction of the proposed reservoir would not increase flooding either upstream or downstream of the project site.

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 floodplain covers approximately 43 percent and the 100-year floodplain covers approximately 55 percent of the proposed Lower Bois d'Arc Creek Reservoir project site (Figure 4-5). Figure 4-6 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 the 10-, 50-, 100-, and 500-year floods were developed using the USACE HEC-RAS model in order 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 flood plain 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 4-3, the profile of the proposed LBCR, shows US 82 and SH 56 in relation to the existing 100-year flood plain and the 100-year floodplain after the lake is in place if the project were built.

4.4.2.6 Impacts to Lake Bonham Dam

Lake Bonham is located immediately upstream of the proposed Lower Bois d'Arc Creek Reservoir on Timber Creek (shown on Figure 4-4 and Figure 4-7). 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 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, 2011). The normal pool elevation for the proposed Lower Bois d'Arc Creek Reservoir is 534 feet above mean sea level. This elevation corresponds to 50 feet below the top of the Lake Bonham dam, so 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 potential impact issues 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, including the following:

- Impacts on dam stability due to the wetting front on either side of the Lake Bonham dam, underflow, and wave action;
- Impacts to the emergency spillway (cut bank type located to the right of the dam, crest elevation is 571.0 ft);
- Impacts to the service spillway (drop inlet type to pilot channel below the dam, crest elevation is 565.0 ft);
- Impacts on the Lake Bonham outlet works (diversion is directly pumped from the lake; discharge is to the service spillway);
- Potential for a dam safety inspection to be required; and how pass-through will be handled (during high flow events).

Protection of the Lake Bonham Dam would be provided as a part of the LBCR project. The preliminary design and cost estimate assume protection of the front side of the dam and appurtenant facilities with rip rap.

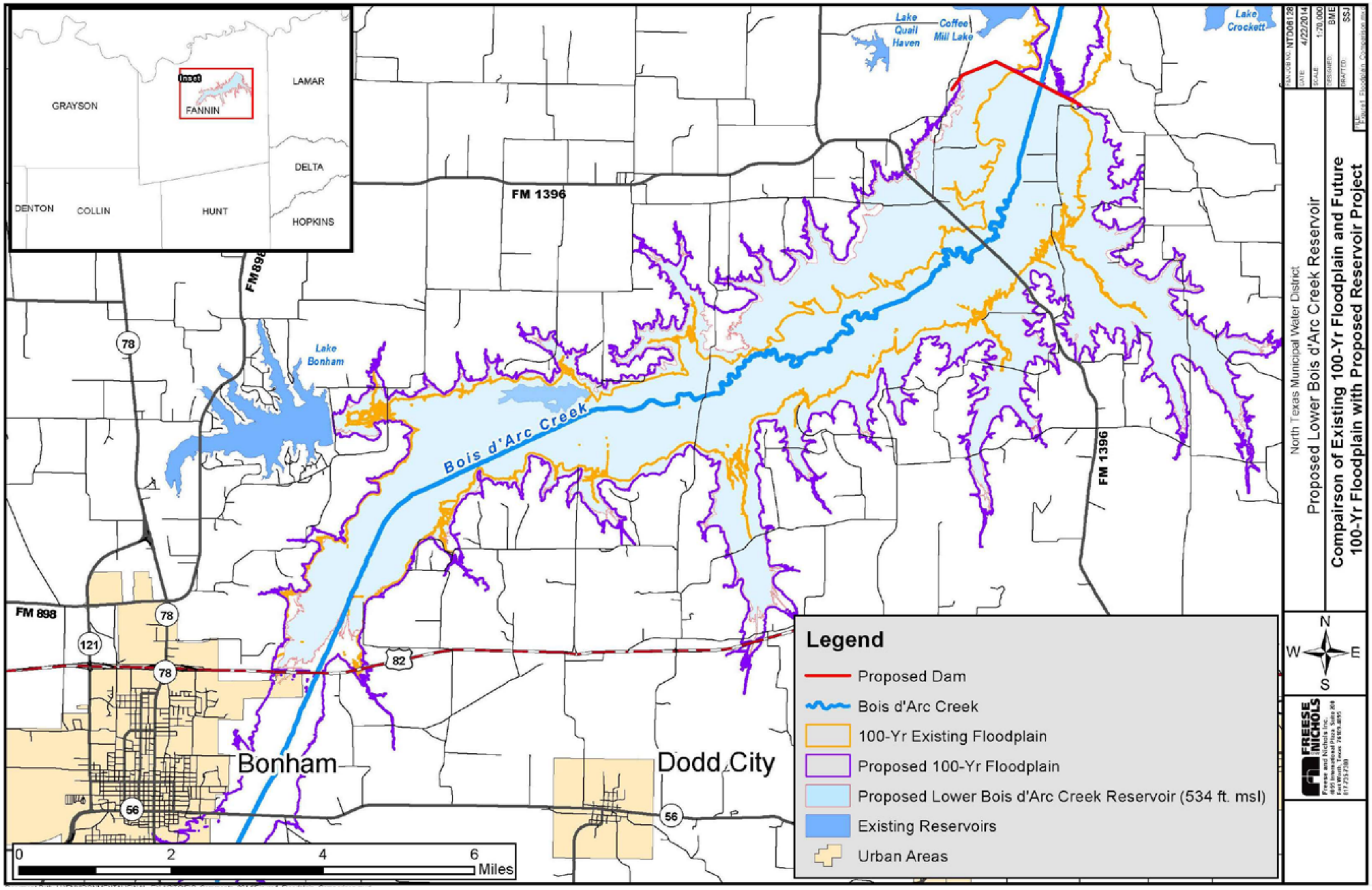
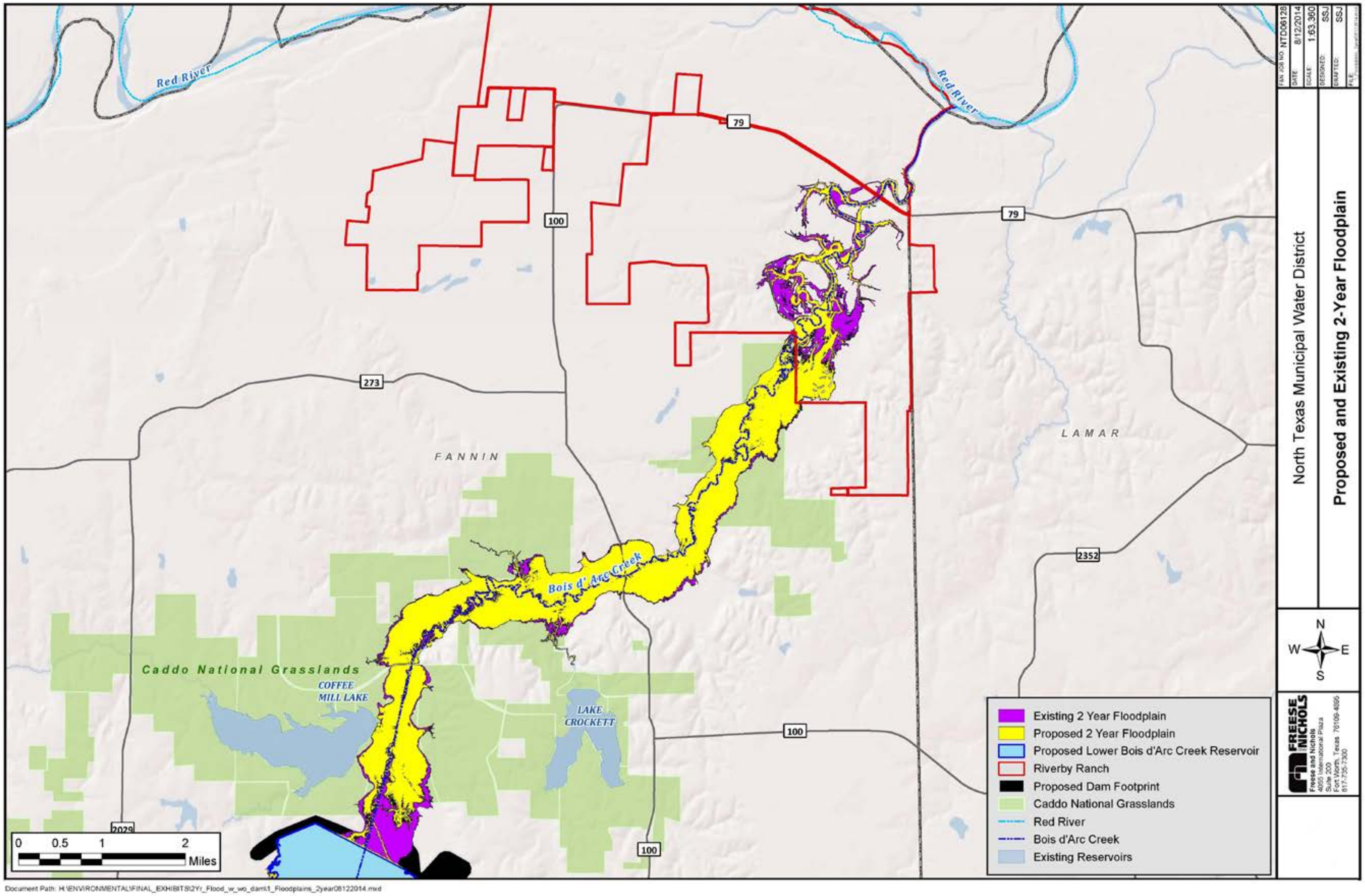


Figure 4-5. Existing and proposed 100-year floodplains at the Lower Bois d'Arc Creek Reservoir site



1 **Figure 4-6. Existing and proposed two-year floodplains on Bois d'Arc Creek downstream of the LBCR dam site**

Figure 4-7. Aerial photograph of Lake Bonham Dam with LBCR pool superimposed

The five issues listed above are addressed in turn.

Dam/Embankment Stability Impacts

The downstream toe of Lake Bonham Dam, at approximately 524 feet-msl, would be submerged by LBCR by as much as 10 feet under normal conditions. About 900 feet of the downstream toe would rest at or below 534 ft. msl (LBCR's normal pool). As noted above, there are two potential impacts to embankment stability due to this submergence. First, the embankment could experience erosion damage from wave action and fluctuation in the LBCR water level. Second, there could be impacts to the dam's internal drainage system, impeding this system's ability to safely convey seepage flows through the embankment (Miles, 2014).

Proposed modifications to address these two issues include placing a toe berm on the downstream slope of Lake Bonham Dam to armor and protect it from wave action on the LBCR pool surface and alterations to 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 ft. msl to permit sufficient drainage.

Emergency Spillway Impacts

The emergency spillway is located over 30 feet above the normal pool elevation of the LBCR. At this elevation, the presence of the LBCR pool below would not entail any effects associated with discharge capacity reduction or erosion concerns at the Lake Bonham Dam emergency spillway. Nonetheless, while the emergency spillway would not be affected by the LBCR, the service spillway would experience a reduction in discharge capacity. In order to mitigate the impacts of the reduced discharge capacity of the principal spillway, modifications are proposed to increase the discharge capacity of the emergency spillway pilot channel (Miles, 2014).

Service Spillway Impacts

Lake Bonham Dam's principal spillway stilling basin is at elevation 524 ft. msl, and the main impact of LBCR would be to decrease the discharge capacity through the 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 modifications to the emergency spillway, described above, would aim to mitigate the impacts of this reduced discharge capacity of the service spillway. 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 these modifications, 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 about 200 feet north of the service spillway drop inlet structure at an elevation of 538 ft. msl. Under normal conditions, LBCR would not affect the discharge capacity of these outlet works because they are almost two-and-a-half feet above the proposed normal pool. Thus, no mitigation is proposed for the Lake Bonham Dam outlet works at present.

Dam Safety Inspection Impacts

Regular dam safety inspections are required for Lake Bonham Dam, 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 that they are functioning appropriately (Miles, 2014).

Flood routing through Lake Bonham Dam during high flow events would occur largely as at present, except with 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 similar flood events for LBCR, and thus there would be no significant impact to operations during high flow events.

Overall impacts to Lake Bonham Dam from the Proposed Action would be adverse, direct, localized and long-term, and minor. However, these impacts can be mitigated to an acceptable level.

4.4.2.7 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 by Freese and Nichols in the 2006 *Report Supporting an Application for a Texas Water Right for Lower Bois d'Arc Creek Reservoir*. By comparing the standard reliability measurements for existing water rights, the impact evaluation determined that "the proposed reservoir causes no injury to existing water rights" (Freese and Nichols, 2006). This is a reasonable conclusion.

The 2006 *Report Supporting an Application for a Texas Water Right for Lower Bois d'Arc Creek Reservoir* also identified "no impacts associated with the interbasin transfer to water rights in the Trinity or Sabine River Basins." The current request would only transfer water to the Trinity and Sulphur River Basin. Proposed Lower Bois d'Arc Creek Reservoir water would be delivered to the proposed new water treatment plant near Leonard, located in southwest Fannin County, which is located in the Trinity River Basin and would have no impacts on Trinity River Basin Water Rights.

4.4.2.8 Impacts to Waters of the U.S., Including Wetlands

A jurisdictional determination was performed for the proposed project area to identify the waters of the United States that would be impacted by the proposed Lower Bois d'Arc Creek Reservoir project. The study concluded that potential waters of the United States do exist within the proposed project area, including 5,874 acres of wetlands, 219 acres of streams, and 87 acres of open water; and that these waters of the U.S. are subject to USACE jurisdiction under Section 404 of the Clean Water Act (Freese and Nichols, 2008a). Approximately 123.3 miles of perennial and intermittent streams located within the proposed project site will be lost to inundation (Freese and Nichols, 2008a).

The proposed Lower Bois d'Arc Creek Reservoir Project 404 Permit Application outlines the impacts to wetlands and the waters of the United States that would result from the proposed project, including inundation of streams and wetlands, as shown in Table 4-9.

Table 4-9. Impacts to Wetlands and Waters of the United States – estimates of inundation to be caused by the LBCR dam and reservoir

Type of water/wetland	Area (acres)
Perennial streams	120
Intermittent streams	99
Open waters	87
Forested wetlands	4,602
Herbaceous wetlands	1,223
Shrub wetlands	49
Total	6,180

Source: Freese and Nichols, 2008b

The final environmental report in support of the project's 404 permit application estimates that 2,150 acres of emergent wetlands would potentially be created around the perimeter of the reservoir between the elevations of 529 and 534 feet msl as a result of the project (Freese and Nichols, 2008a). The NTMWD proposes to include credit for 1,402 acres of emergent wetlands at the lake as part of its mitigation for the project (Votaw, 2014).

In May 2014, the margins of five reservoirs located in Northeast Texas were surveyed, including Cooper Reservoir, Pat Mayse Reservoir, Lake Bonham, Coffee Mill Lake, and Davy Crockett Reservoir. All were chosen based on their proximity to the proposed LBCR. The purpose of the pedestrian survey was to document plant species that occur within the littoral zone/fringe wetlands along the edges of these reservoirs to better predict the species that may develop within the littoral zone/fringe wetland of the proposed LBCR. All five of the reservoirs had functioning littoral zone/fringe wetlands along their shorelines and these wetlands extended for some distance into the reservoir pool. Over 49 different species of plants were identified (Votaw, 2014). It is reasonable to predict that the LBCR would develop overall ecological conditions and vegetative diversity within the littoral zone/fringe similar to those observed at the five reservoirs in this survey.

As described and quantified in Section 4.4.2.1, no waters (including wetlands) of the United States would be affected permanently by the proposed 35-mile raw water pipeline, the proposed North WTP, and the terminal storage reservoir (TSR) associated with the WTP. The TSR and WTP have been sited entirely on uplands, avoiding waters and wetlands altogether. The pipeline would tunnel beneath the three largest water courses it would cross, avoiding direct impacts. It would have short-term effects during and immediately after construction on those smaller, generally intermittent streams it would intersect, across which a trench would be excavated and the pipeline laid.

In view of the nation's policy of "no net loss" of wetlands, without the mitigation plan discussed in Section 4.4.3, a conversion at the reservoir footprint of forested wetlands (and the other types) of this magnitude, to open water, lacustrine waters of the U.S. would be considered a significant, long-term, adverse impact.

4.4.2.9 Groundwater Resources

The proposed LBCR project is not located directly over the recharge zone for any major or minor groundwater aquifer in Texas. Additionally, the Woodbine and Northern Trinity aquifers "are confined and separated by relatively impermeable clay and carbonate units" (Freese and Nichols, 2008a). 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 due to the fact that 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, 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 all 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 groundwater wells appear to be located within the actual 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 lessen the amount of groundwater pumping in the area and reduce declining groundwater levels, thereby allowing for increased aquifer recharge, storage and production. Therefore, the proposed project is not expected to have any significant adverse impact on local groundwater resources and may even have a beneficial impact.

4.4.3 Aquatic Resources Mitigation Plan

4.4.3.1 Overview

As mentioned in Chapter 1, with the assistance of Freese and Nichols, Inc., the North Texas Municipal Water District has developed and submitted for the USACE Tulsa District's consideration a mitigation plan to compensate for impacts of the proposed LBCR project to waters of the United States, including wetlands and other aquatic and terrestrial resources (Freese and Nichols, 2012; Freese and Nichols, 2014). This plan is included in Appendix E of this EIS.

The mitigation plan for impacts to waters, wetland, and other aquatic resources was prepared following pertinent federal rules, regulations, and guidelines. Comments from the public, state, and federal resource agencies on the Section 404 permit application for the Proposed Action and comments made during the EIS scoping process were also considered in developing the mitigation plan. Moreover, extensive coordination has taken place with appropriate state and federal resource agencies during the permitting process. Interagency teams from both the federal and state governments participated in the collection and analysis of data from the proposed reservoir site as well as the proposed mitigation site.

The aquatic resources mitigation plan was prepared 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 U.S. that would be impacted by construction of the proposed reservoir. Proposed compensatory mitigation for waters of the U.S. would be provided through in-kind mitigation that would occur through on-site or near-site mitigation strategies. On-site mitigation would be provided at the proposed reservoir site and near-site mitigation would be provided on an approximately 14,960-acre parcel of land known as the Riverby Ranch (Figure 4-8 and Figure 4-9). 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.

Existing habitat at the proposed mitigation site consists largely of biologically degraded ranch and farmland, providing the opportunity for mitigation actions to result in considerable gains in "ecological uplift" (increase over time in ecological values and functions). Another advantage of the proposed mitigation site is that it consists of one large, contiguous tract of land, thus avoiding the ecological and logistical problems associated with disconnected fragments of mitigation lands. Furthermore, the proposed site is located adjacent to the USFS-managed Caddo National Grasslands and beside other privately-owned lands that are already protected in perpetuity by easement through the Wetlands Reserve Program (WRP); this could provide synergistic uplift to the resources at the mitigation site and to these other federally protected lands.

NTMWD proposes that the mitigation site be protected in perpetuity by a conservation easement and be transferred to a third party following fulfillment of mitigation requirements. The Tulsa District concurs that existing site conditions at the Riverby Ranch, including surrounding land uses, its soils, climate, and hydrology, make the site suitable for restoring waters of the U.S. Mitigation and habitat restoration/enhancement could begin prior to or concurrent with impacts at the reservoir site, thereby minimizing temporal losses of waters, wetlands, and aquatic resources. However, the Tulsa District has communicated to NTMWD that pre-purchasing lands for mitigation is purely speculative on their part and only after the Least Environmentally Damaging Practical Alternative (LEDPA) is identified can mitigation be fully evaluated.

4.4.3.2 Methodology

The interagency team assessed the existing conditions at the proposed project site (i.e., footprint of the conservation pool area at 534 ft. msl and the footprint of the dam and spillways) and proposed mitigation site using the Habitat Evaluation Procedures (HEP) described in Chapter 1 and Chapter 3. The HEP methodology has been developed and used by the USFWS as its basic tool or method for evaluating project impacts on habitats and crafting mitigation recommendations. Both impacts and mitigation credits are measured using Habitat Units (HUs), a metric specific to the HEP methodology.

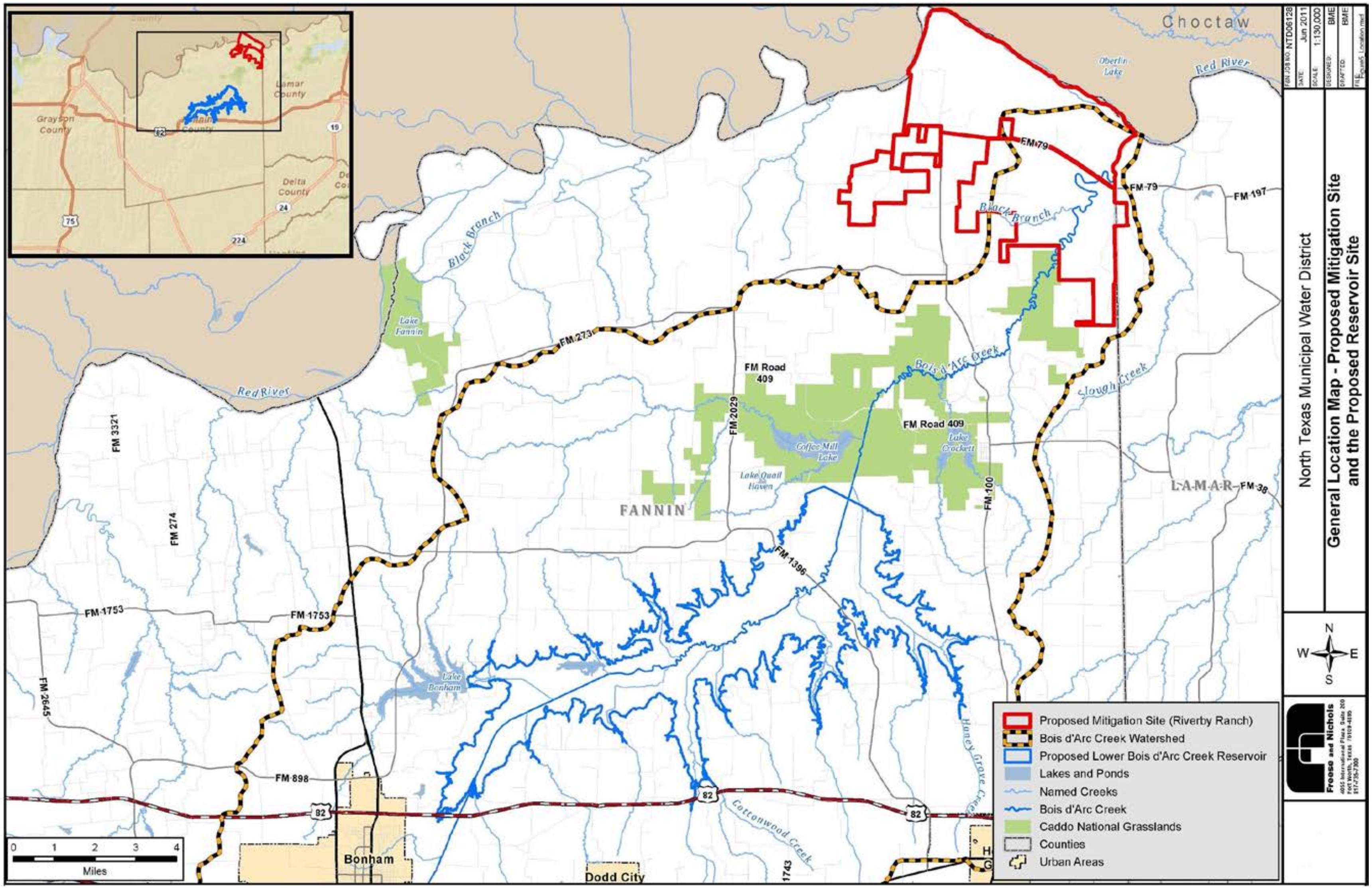


Figure 4-8. Lower Bois d'Arc Creek Reservoir site, Caddo Grasslands, and Riverby Ranch mitigation site, Fannin Co., TX

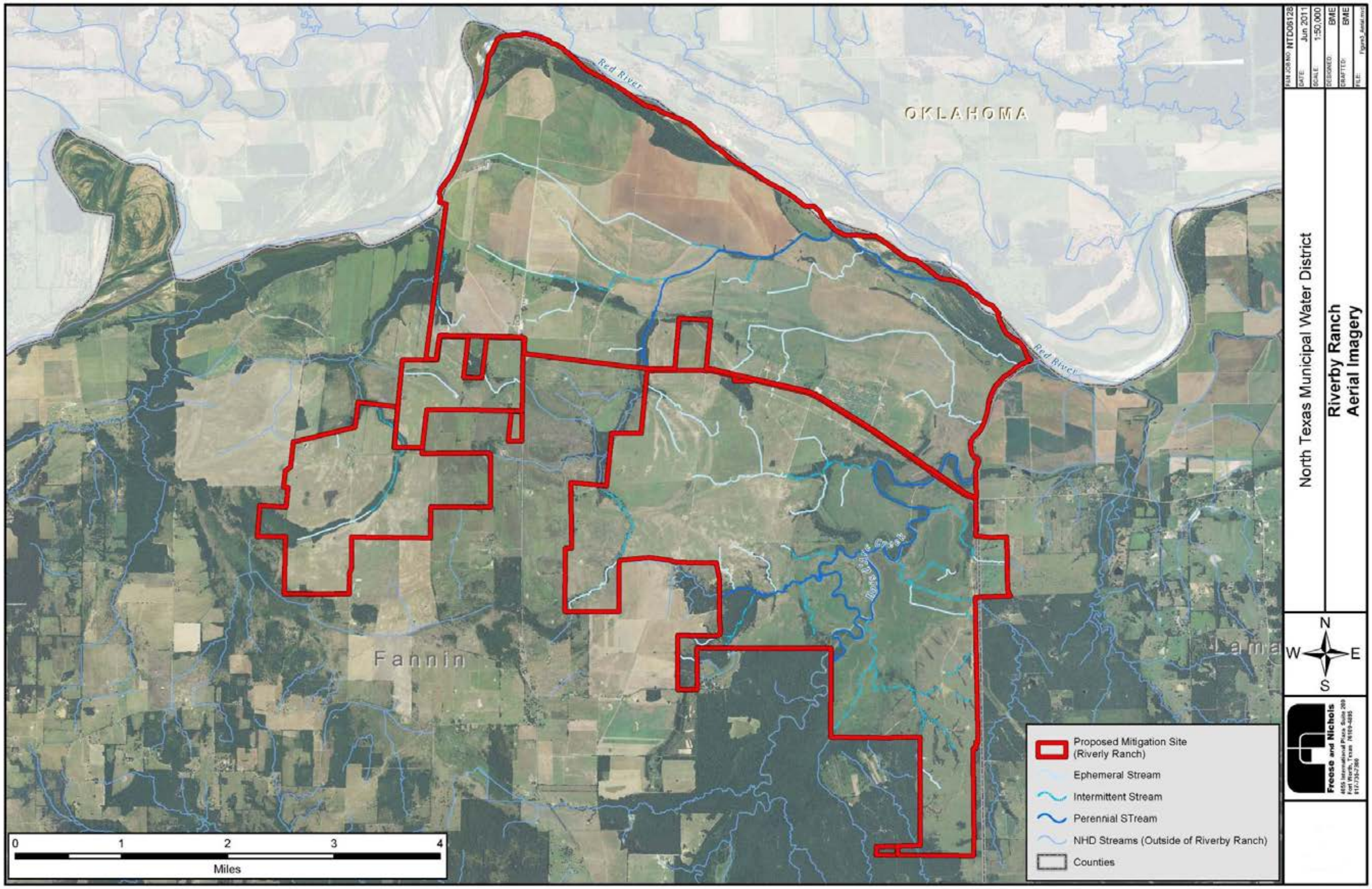


Figure 4-9. Aerial photo of land cover at proposed Riverby Ranch mitigation site

Rapid Geomorphic Assessment (RGA) methodology was used to assess existing conditions of streams within the proposed reservoir footprint, including tributaries to the proposed littoral zone wetlands around the reservoir perimeter, Bois d'Arc Creek downstream of the proposed dam, and streams at the proposed Riverby Ranch mitigation site. The RGA method is similar to other geomorphic assessment methodologies applied in various regions of the U.S. In general, these methods use measures of erosion channel stability, riparian habitats, instream habitats and other visual attributes of stream channels to evaluate and measure stream conditions. The RGA method integrates data both from field and desktop sources into a quantitative and qualitative description of the features that affect stream stability and the potential for developing aquatic habitat features. Impacts and mitigation credits are both measured using Stream Quality Units (SQUs), a metric developed for this assessment to assign a value to stream reaches that can be used to measure baseline conditions, assess impacts from the proposed action, and measure "uplift" at the mitigation site (Freese and Nichols, 2014).

During the preparation of this aquatic resources mitigation plan, the applicant has taken a number of steps to avoid and/or minimize, to the extent practicable, potential impacts to waters of the U.S. These steps include locating the proposed intake pump station and electrical substation within the grading limits of the proposed dam and spillways, siting the proposed terminal storage reservoir and north water treatment plant entirely within upland areas, minimizing impacts to streams, waters, and wetlands that would be crossed by the proposed raw water pipeline by restoring preconstruction contours and stabilizing exposed slopes and stream banks, tunneling beneath larger stream crossings (including Ward, Honey Grove, and Bullard Creeks), removing 14.4 miles of proposed pipeline from the proposed water treatment plant site to a discharge location on Pilot Grove Creek in the Trinity River Basin, purchasing additional lands and a flowage easement around the proposed reservoir, and coordinating with local authorities to implement water quality protection measures in the vicinity of the proposed reservoir.

A summary of potential impacts to waters of the U.S. and proposed compensatory mitigation for unavoidable impacts to waters of the U.S. is shown in Table 4-10. As proposed by NTMWD, this mitigation plan would provide:

- Enhancement and/or protection for 452 acres of forested wetlands, 1,377 acres of emergent wetlands, 98 acres of shrub wetlands, 34 acres of open water, and 375,076 linear feet of streams;

- Restoration of 3,500 acres of forested wetlands, 1,100 acres of emergent wetlands, 325 acres of shrub wetland, and 209,437 feet of riparian corridors;

Table 4-10. Summary of impacts to waters of the U.S. and proposed mitigation

Type of Water of the U.S.	Amount Impacted		Amount of Mitigation		Net Gain (+) / Net Loss (-)	
	Acres	HUs	Acres	HUs	Acres	HUs
Forested Wetland	(-)4,602	(-)1,150.5	(+)3,952	(+)2,266.1	(-)650	(+)1,115.6
Emergent Wetland	(-)1,223	(-)514	(+)3,879	(+)1,276.2	(+)2,656	(+)762.2
Shrub Wetland	(-)49	(-)23	(+)423	(+)224.3	(+)374	(+)201.3
Open Waters	(-)87	N/A	(+)15,273[1]	N/A	(+)15,186	N/A
	Linear feet	**SQU's**	**Linear feet**	**SQU's**	**Linear feet**	**SQU's**
Streams	(-)651,024	(-)229,054	(+)404,979	(+)193,334	(-)246,045	(-)35,720

Source: Freese and Nichols, 2014
[1]This represents the offset of open waters by the creation of the lake, less the acreage identified for littoral wetlands.

- Creation of 1,402 acres of littoral zone wetlands, creation of approximately 30,084 linear feet of stream, and an offset to open water losses through the creation of abundant open water areas in the proposed reservoir; and

- A net gain of 1,115.6 HUs of forested wetlands, 762.2 HUs of emergent wetlands, and 201.3 HUs of shrub wetlands (Freese and Nichols, 2014).

The proposed mitigation plan is described in greater detail in Freese and Nichols (2014) and is included in this EIS as Appendix E.

Taking into account the proposed mitigation plan for wetlands and waters of the United States, environmental consequences associated with the Proposed Action can be divided temporally into 1) short-term and medium-term impacts, and 2) long-term impacts. In the short term and medium term (when habitat restoration and enhancement at the mitigation site is just getting underway), impacts from the Proposed Action would be of major magnitude (primarily from the permanent loss of more than 4,600 acres of forested wetlands), medium extent, probable likelihood, and moderate precedence/uniqueness. Over the long term (measured in decades), as habitat development at the Riverby Ranch mitigation site continues, net impacts from the Proposed Action (including mitigation) would be beneficial rather than adverse. These net beneficial impacts would be of moderate to major magnitude, long-term duration (permanent), medium extent, probable likelihood, and moderate precedence.

In conclusion, the net impacts of the Proposed Action on Waters of the United States would be adverse in the short and medium term and beneficial over the long term. The significant impacts of the project on Waters of the U.S. would be substantially mitigated following implementation of the proposed mitigation plan.

4.4.3.3 Impacts Downstream on Bois d'Arc Creek

As part of the 2010 Instream Flow Study, and as noted in Chapter 3, a RiverWare model was developed to predict the response of the watershed to changing stream conditions over an extensive time period. RiverWare is a hydrologic model designed to simulate management of reservoir and stream segments.

RiverWare was used to assess baseline conditions of the watershed as well as future conditions with the dam and reservoir in operation. It includes explicit modeling of Lake Bonham, the FM 1396 gage (USGS 07332620), the proposed reservoir dam site, Lake Crockett, the FM 409 gage, Coffee Mill Lake, the FM 100 crossing and the reach from FM 100 to the Red River. Flows for the RiverWare model are based on data from the North Sulphur River near Cooper gage (USGS 07343000) and the TCEQ Red River Basin Water Availability Model (TCEQ WAM). The model uses a daily time step and covers the period from 1948 to 1998.

Mesohabitat, mesohabitat generalists, and fluvial specialists

Mesohabitats refer to the basic structural elements of a river or stream, such as pools, backwaters, runs, glides, and riffles.

A mesohabitat is a given area of stream with relatively similar characteristics of depth, velocity, slope, substrate (bottom materials, such as sand, gravel, or mud), and cover, for example, pools with a maximum depth of less than 5 ft., high gradient, swift riffles, or side channel backwaters.

Mesohabitat generalists are those aquatic species that can be found in many or most of the different mesohabitats found along a stream.

In contrast, a fluvial specialist is an aquatic species that occupies a narrow habitat range of water depth and velocity; these species are most likely to be affected by changes in instream flow.

As noted in the 2010 Instream Flow Study (Freese and Nichols, 2010a; 2010b), the flow regime downstream of a dam and reservoir would be markedly different than before the reservoir was established and the subject stream's waters impounded. It is, however, possible to mitigate adverse effects, or even obtain beneficial effects, by establishing release criteria from a reservoir.

Hypothetically, the altered flow regime downstream of the proposed reservoir could negatively affect fish species with narrow habitat requirements, such as those sensitive to particular temperature regimes or flow rates for reproductive cues. Other potential adverse impacts related to aquatic biota include limitation of nutrients and loss of stream connectivity. In warm water aquatic systems such as Bois d'Arc Creek, cold-water releases from the bottom of a reservoir could impact native fish species diversity below a dam, since reproduction and growth of some warm water species are temperature-dependent. The impact can be mitigated by releasing water from the upper portion of the reservoir using a multi-level intake structure. As would be expected, fish species that are habitat generalists tend to fare better in the altered aquatic environments downstream of dams than those species that are habitat specialists (Freese and Nichols, 2010a). In contrast, studies elsewhere have shown that "fluvial specialists" downstream of water supply reservoirs tend to be negatively affected by impoundments and water withdrawal, with one outcome being reduced species richness, i.e., fewer species or less biodiversity (Freeman and Marcinek, 2006).

Given that most of the fish species documented at Bois d'Arc Creek during the instream flow study are what aquatic ecologists call "mesohabitat generalists," then it is considered likely that there would be a limited adverse effect on the downstream fish community and biodiversity as long as water continues to flow in the creek. It would thus be reasonable to conclude that providing a generally higher flow (while still intermittent, and not perennial) in Bois d'Arc Creek, especially during the months in which most species spawn and reproduce, could potentially increase fish abundance and/or species diversity by increasing the populations of "fluvial specialists." Providing a steadier flow, when one is now lacking, could also provide better habitat for those species of fish that are habitat generalists.

The Texas Legislature and the Texas Instream Flow Program (TIFP) have prescribed the ultimate goal of the instream flow assessment and instream flow regime development process as that of "creating and maintaining a sound ecological environment." Given that the Bois d'Arc Creek watershed has been greatly modified by stream channelization and other actions since the early 1920s to reduce flooding so as to facilitate agricultural development, the existing ecological environment of Bois d'Arc Creek is quite distinct from original pre-settlement conditions. Based on the current conditions and history of Bois d'Arc Creek, the objectives of the TIFP, and input from the interagency team that participated in the instream flow assessment, NTMWD proposed that the following attributes represent a sound ecological environment for Bois d'Arc Creek downstream of the proposed Lower Bois d'Arc Creek Reservoir:

1. Geomorphology:
   a. Stream power that provides for reworking of sediment (depositional features) but not stream bed and bank erosion (downcutting and widening).
   b. Spectrum of mesohabitats – pools, runs, structures (snags, large woody debris, brush piles, other), and "riffle-like" shallows

2. Hydrology and Hydraulics:
   a. Seasonally varying flows.
   b. Flow regime to support targeted geomorphic processes identified above, meet water quality goals, and maintain or improve existing biological communities.
   c. Hydraulic connectivity to support biological communities.

3. Water Quality:
    a. Maintain existing water quality standards as established in 30 TAC 307, including:
        i. High aquatic life use
        ii. Contact recreation – fully supporting

4. Biology:
    a. Maintain or improve existing fish and macroinvertebrate communities and biodiversity as measured by Index of Biological Integrity (IBI) and Rapid Bioassessment (RBA) metrics.
        i. Fish IBI= High
        ii. Macroinvertebrate RBA = Intermediate
        (Freese and Nichols, 2010a)

The TIFP divides flows into four components or classifications (TCEQ, 2008):

- Subsistence flow – minimum streamflow during extreme drought conditions. During times of subsistence flow one would expect elevated temperatures, increased concentrations of dissolved material in water, and sediment deposition. For Bois d'Arc Creek, a subsistence flow criteria should be designed to maintain minimal water quality levels to limit impacts on aquatic organisms.

- Base flow – "normal" flow conditions found between storm events. For Bois d'Arc Creek, base flow criteria should be designed to maintain connectivity between a variety of habitats to support the natural community, maintain soil moisture, and provide suitable water quality.

- High flow pulses – short-duration, high flows within the stream channel resulting from a storm event. For Bois d'Arc Creek, high flow pulse criteria should be designed to maintain channel characteristics, move sediments to maintain habitats and restore water quality after periods of low-flow.

- Overbank flows – high-flow events that cause flow beyond the riverbanks. Currently overbanking flows are relatively frequent on the Bois d'Arc Creek watershed and follow and precede channel-degrading bank-full flows. The instream flow assessment did not develop overbank flow criteria for Bois d'Arc Creek in order to minimize potential bed and bank erosion and to limit property damage.

Based on the instream flow needs analysis and subsequent discussions with the TCEQ, the following environmental flow releases have been proposed for the Lower Bois d'Arc Creek Reservoir:

- During normal and wet conditions, release of a base flow of 10 cfs during the months of March, April, May and June and 3 cfs during the rest of the year as measured at the FM 409 USGS gage (see Table 4-11).

- During normal and wet conditions if pulse flow events as shown in Table 4-11 do not occur at FM 409 USGS gage and a pulse event is captured by the reservoir, the pulse will be released in compliance with the corresponding season. Pulse events will vary in magnitude and duration by season. A total of five pulse events per year may be passed through the reservoir.

- Release of a subsistence flow of 1 cfs during extreme, prolonged drought. Pulse releases are not required or proposed during subsistence periods. Extreme drought can be identified using reservoir storage. At this time it is proposed that subsistence flows be released when the reservoir content is less than 40 percent of the conservation storage. If it is found that subsistence conditions occur more than 10 percent of the time, then the storage trigger may be adjusted.

Table 4-11. Proposed instream flow regime for Bois d'Arc Creek downstream of the LBCR

Pulse Flows (a total of 5 pulse events per year may be passed through reservoir)

Months	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Season	Spring				Summer				Fall-Winter			
Flow (cfs)	500				100				150			
Volume (ac-ft)	3,540				500				1,000			
Frequency (per season)	2				1				2			
Duration (days)	10				5				7			

Subsistence Flows

Months	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Season	Spring				Summer				Fall-Winter			
Subsistence (cfs)	1				1				1			

Base Flows (measured at FM 409 USGS gage)

Months	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Season	Spring				Summer				Fall-Winter			
Base (cfs)	10				3				3			

Notes:

1. A qualifying pulse flow must meet the peak flow and the volume or duration.
2. Subsistence conditions occur when the reservoir is at 40% capacity or less.

Consistent with discussion of the interagency team, the proposed criteria do not include deliberate overbanking flows. Channelization and straightening have so thoroughly modified the original hydrologic regime of Bois d'Arc Creek, resulting in channel downcutting and increased erosion, that high pulse flow releases would be counterproductive to maintaining a sound ecological environment. In addition, there would be liability issues associated with deliberate flood releases. For these reasons, TCEQ has stated that the State of Texas will not issue water rights permits with deliberate overbank release requirements.

The proposed flow regime with the proposed reservoir project is substantially different from the current flow regime in Bois d'Arc Creek. Specifically, large flow events would become substantially less frequent. For example, at present, flow events that overtop stream banks occur on the average of more than once a year (Freese and Nichols, 2010a). Under the proposed regime bank overtopping would occur approximately once every 25 years.

Due to the altered hydrology and degraded current condition of Bois d'Arc Creek, a flow regime that perpetuates or mimic current conditions would only exacerbate the on-going erosion and frequent habitat destruction currently observed in the watershed and, therefore, would not be supportive of developing a sound ecological environment. NTMWD's proposed flow regime would be expected to stabilize Bois d'Arc Creek downstream of the reservoir so it can reach equilibrium, and thus a sound ecological environment. As part of the water rights permitting process, TCEQ reviewed the instream flow studies and found that the proposed instream flow regime would provide a sound ecological environment for Bois d'Arc Creek. This flow regime will be included in the draft water right permit (Burt, 2012).

The Draft Operation Plan (Appendix F) details a number of management actions and activities for the proposed LBCR, including storage, diversions, pass-through flows, and monitoring and compliance. Many of these actions are oriented toward management of the hydrology, water quality and biology of Bois d'Arc Creek downstream of the LBCR dam (NTMWD, 2014).

Based on the instream flow assessment and proposed water releases and flow regime downstream of the LBCR, overall impacts on the existing downstream aquatic environment would likely be beneficial. These beneficial impacts would be of moderate magnitude, long-term duration, medium extent, probable likelihood, and moderate precedence.

4.4.3.4 Mitigation for Linear Impacts to Streams

One unavoidable direct effect of the proposed LBCR would be impacts to approximately 651,024 linear feet (123.3 miles) of streams due to their permanent inundation upstream of the dam within the reservoir footprint. The USACE and the EPA acknowledged in the 2008 Final Mitigation Rule that some types of aquatic resources are difficult to replace, streams among them. Recognizing this, the USACE and EPA require that compensatory mitigation be provided through in-kind preservation, rehabilitation, or enhancement to the extent practical.

NTMWD submitted its Section 404 permit application for LBCR prior to implementation of the 2008 Final Mitigation Rule. However, it is working to accommodate the rule by compensating for unavoidable impacts to streams. NTMWD is proposing to restore and enhance approximately 181,000 linear feet (34.3 miles) of existing streams (not including streams located within the Wetlands Reserve Program area) at the Riverby Ranch mitigation site by placing them in a conservation easement, removing cattle, and establishing riparian corridors and buffers (Figure 4-10). Additionally, NTMWD is proposing to restore meanders to several first and second-order streams located on the ranch that have been

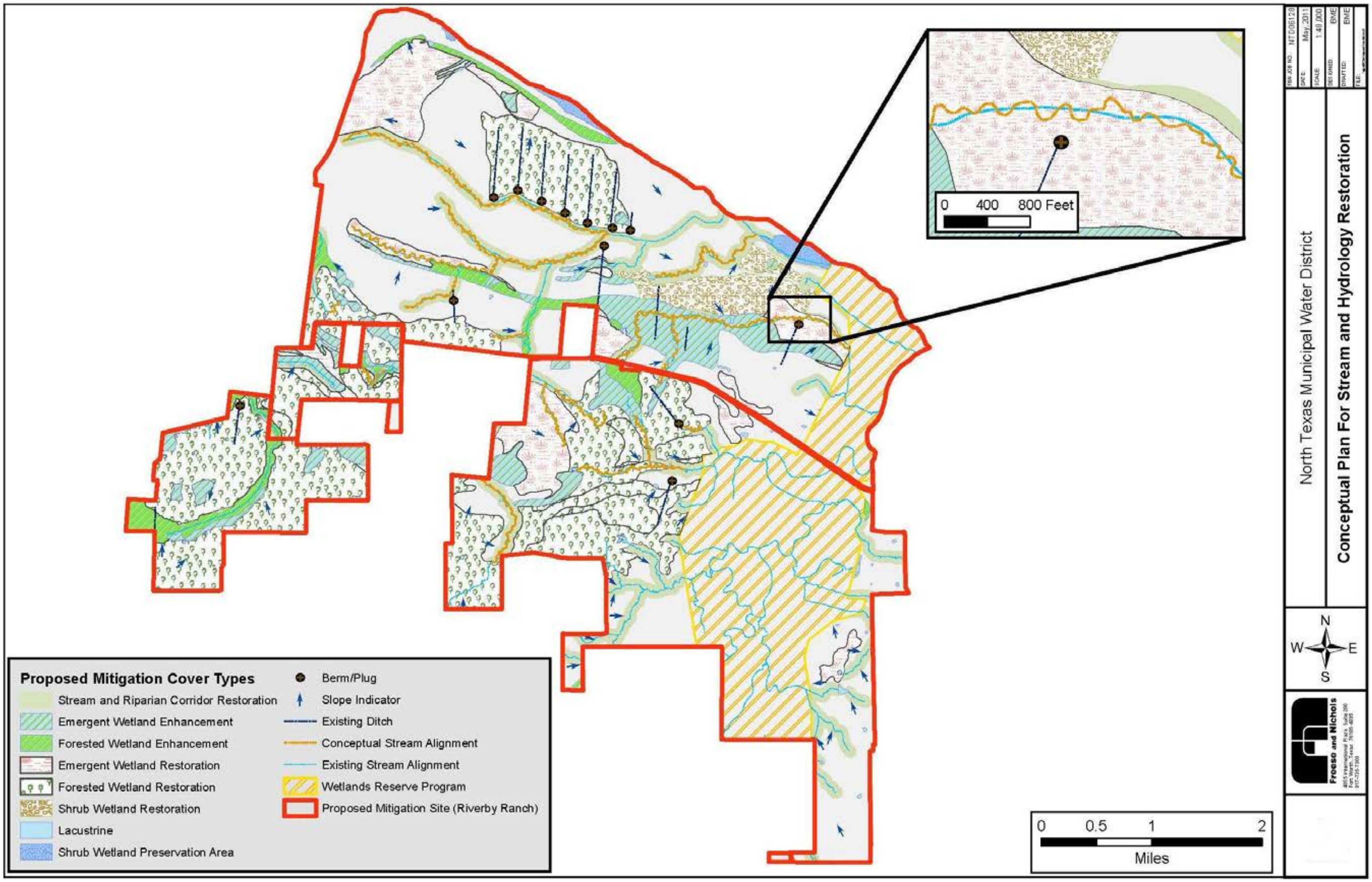


Figure 4-10. Concept plan for stream and hydrology restoration at proposed Riverby Ranch mitigation site

straightened to expedite runoff . This would add approximately 42,000 linear feet (8 miles) of additional stream length to the mitigation site, bringing the stream length total to approximately 222,000 linear feet (42 miles).

In order to provide a basis for calculating mitigation credits, NTMWD has performed an RGA on the degraded streams on the mitigation site. The USACE Tulsa District was in support of this so that the stream mitigation would be both qualitative and quantitative. As noted earlier, a RGA had previously been conducted along Bois d'Arc Creek and four of its principal tributaries within the footprint of the proposed LBCR site to provide estimated measures of baseline stream conditions. The RGA method integrates field data and desktop sources to quantify the features that affect stream stability and aquatic habitat potential.

The RGA method is based on a rapid field assessment of stream properties and characteristics at representative sites along stream reaches under evaluation. In general, the types of data collected include observations of channel size and location, bank geometry, information describing riparian vegetation and rooting depths, general bank armoring characteristics, as well as conditions of the upper slopes, lower slopes, and channel bed. Morphological variables for channel stability were documented using the techniques described in publications on the EPA's technical tools website. For each data collection point, six stream characteristics (evidence of bank erosion, bank root zone, vegetative bank cover, bank angle, sediment transport, and channel alteration) were assessed, scored, and then summed to calculate a final RGA score ranging from 0 - 60. Then, as part of developing this mitigation plan, these scores were normalized by dividing the score by 60 to produce a Stream Quality Factor (SQF) ranging between zero and one, where zero represents poorest stream conditions and one represents optimum stream conditions (Freese and Nichols, 2014).

The calculated SQF score for a given study reach was then multiplied by its length to calculate Stream Quality Units (SQUs) contributed by that reach. This process was repeated for all study reaches within the footprint of the proposed Lower Bois d'Arc Creek Reservoir site to establish baseline SQUs that would require mitigation.

In 2014, FNI biologists and technicians completed field investigations to establish baseline stream conditions at the proposed Riverby Ranch mitigation site using the same RGA method. Using the same method to evaluate stream conditions at both the impacted site (reservoir footprint) and mitigation site (Riverby Ranch) furnishes a consistent comparison of impacts to mitigation as well as a scientifically supportable, quantitative estimate of potential "ecological uplift" (habitat improvement and enhancement) anticipated to occur at the mitigation site.

During the RGA study of Riverby Ranch, 36 data collection points were evaluated to quantify the characteristics of the existing streams on the ranch outside the WRP area. The streams were divided into reaches based on morphological characteristics, cover types, stream order, tributary confluences, and field point RGA score. The same methodology that was used with stream in the reservoir footprint was then applied to obtain a total baseline SQU value for all streams on the Riverby Ranch, excluding those within the WRP area. The sum total of the SQUs in each reach was calculated to be 64,140. The existing SQUs for the tributaries within the WRP total 28,561. However, NTMWD is not claiming compensatory mitigation credit for streams within the WRP, even though it is evident that improvements to watersheds and stream reaches upstream of the WRP area would have a beneficial effect on those reaches within the WRP.

Streams located at the Riverby Ranch mitigation site are generally in poor condition due to longstanding agricultural practices. Widespread cattle grazing has resulted in the destruction of stream bank vegetation, increased erosion, and down-cutting of the channels (Figure 4-11). Other existing impacts to

Figure 4-11. Degraded stream at Riverby Ranch from widespread cattle grazing

Figure 4-12. Cleared and degraded riparian corridor at Riverby Ranch

the streams from historical land practices at the mitigation site include the straightening of channels and clearing of trees and other vegetation in former riparian areas to open them up for crop production and/or grazing (Figure 4-12).

The proposed stream mitigation considers existing drainage contours, meander sinuosity of unaltered streams in the watershed, soils, and existing land cover. Stream restoration activities at the mitigation site would be designed to site-specific conditions and would include restoration measures such as:

- Conservation easements
- Removal of cattle and protection from livestock grazing
- Laying back stream banks to reduce erosion and allow for tree and shrub plantings
- Restoration of riparian corridors through tree and shrub plantings
- Plugging and/or diverting drainage ditches; and
- Restoring meanders to straightened portions of stream channels.

It is expected that these activities would result in ecological uplift and enhancement of streams that would provide a variety of ecological benefits including:

- Decreased erosion and down-cutting of stream channels and increasing bank stability;
- Reductions in sediment, fecal coliform bacteria, and nutrient loading downstream from currently degraded areas;
- Improvements in water quality from the cessation of farming practices such as the application of fertilizers, pesticides, herbicides, etc., as well as from restoring a vegetated buffer in riparian corridors; and
- Increasing the quality and quantity of available habitat for aquatic and terrestrial wildlife species.

Overall, creation of new stream length and enhancement and restoration of existing stream length) at the Riverby Ranch is expected to generate a total of 158,065 SQUs.

Many of the streams that would be protected, restored, and enhanced on the mitigation site (outside of the Wetlands Reserve Program boundary at Riverby Ranch) flow directly into the WRP area. Benefits to the upstream, headwater sections of these streams and their watersheds would be anticipated to extend downstream and provide ecological uplift to these already protected streams as well.

Linear impacts from the Proposed Action would also be mitigated on Bois d'Arc Creek itself downstream of the LBCR dam by planned water releases from the reservoir. As described in Chapter 3 of this EIS, these reaches of Bois d'arc Creek had already been significantly impacted by channelization beginning as far back as the 1920s and continuing into the 1970s. Because of this channelization, the stream has not been in equilibrium for many decades. Downcutting and stream bank erosion increased, and lateral migration of the stream (i.e., meander migration) slowed. It is also likely that channelization increased the "flashy" nature of flows in the watershed, that is, the rapid rise and fall in flow in response to rainfall events. If channelization had never occurred, there would have been greater connectivity to the adjacent floodplain, flows would have been slower and the probability of connectivity through the stream system would have been greater, resulting possibly in perennial flows, rather than today's intermittent condition.

NTMWD's proposed instream flow regime for Bois d'Arc Creek downstream of the LBCR dam is predicted to enhance the creek's future condition of by reducing the frequency and magnitude of high flows which perpetuate and aggravate the degrading, ongoing cycle of channel bed erosion, followed by slumping and sloughing of the resulting steepened channel banks and the subsequent erosion and transport of the bank material downstream (shown graphically in Figure 3-13). It is anticipated that reducing the frequency and magnitude of high flows would allow the existing channel to reach an equilibrium condition with less steep and vegetated banks and a stable meandering low flow channel within the existing deep and incised channel. This equilibrium condition is expected to support improved habitat downstream of the dam to maintain the healthy biological community.

The proposed flow regime would restore stream connectivity and enhance aquatic habitat for a distance of approximately 78,977 linear feet (15 miles) downstream of the dam. Finally, 89,465 linear feet (17 miles) of perennial and intermittent tributaries of the proposed LBCR above the 534 ft. msl conservation pool but on land owned by NTMWD out to 541 ft. msl would be protected by conservation easement.

4.4.4 Impacts from Raw Water Pipeline, Water Treatment Plant, Terminal Storage Reservoir, FM 1396 Relocation and New Bridge Construction

Based on a PJD conducted in 2013 (Freese and Nichols, 2013), none of these connected actions would cause additional long-term or permanent impacts to waters of the United States including wetlands. There would be temporary impacts as a result of stream crossings. In the case of FM 1396 relocation and new bridge construction over the reservoir, impacts are either avoided or are already accounted for within the reservoir footprint.

The proposed raw water pipeline would cross 39 waters of the U.S., including 36 streams, one on-channel impoundment, and two upland/off-channel stock ponds. No wetlands would be crossed by the proposed pipeline. All crossings of streams and open waters would be carried out using open trench construction methods, excluding the crossings of Ward, Bullard, and Honey Grove Creeks, which would be tunneled (Freese and Nichols, 2013). Effects on streams and the on-channel impoundment that would be crossed by the proposed raw water pipeline using open trench construction methods would be mitigated and minimized by restoring pre-construction contours, stabilizing exposed slopes and stream banks, as well as revegetating disturbed areas immediately following construction. Consequently, there would be no permanent impacts to streams or open waters.

No impacts to waters of the U.S. would occur from construction of the proposed water treatment plant near Leonard. This particular WTP site was selected because it is located on uplands and avoids waters altogether (except for two non-jurisdictional and off-channel stock ponds). Similarly, no impacts to waters of the U.S. would occur as a result of constructing the proposed terminal storage reservoir because no waters of the U.S. are found within its footprint. The terminal storage reservoir site was selected due to its proximity to the WTP and because it is located entirely upon an upland site, thus avoiding potential impacts to waters of the U.S., including wetlands.

4.5 AIR QUALITY AND CLIMATE

The ROI for the air quality analysis in this EIS is the 19-county Air Quality Control Region (AQCR) 215, and those portions of Fannin County where the Proposed Action would occur.

4.5.1 No Action Alternative

The No Action Alternative would have no impacts to air quality because no installation of dam, water treatment plant, or pipeline would occur. Air quality would remain unchanged when compared to existing conditions, discussed under the Affected Environment.

4.5.2 Proposed Action

4.5.2.1 Estimated Emissions and General Conformity

The general conformity rules require federal agencies to determine whether their action(s) would increase emissions of criteria pollutants above preset threshold levels (40 CFR 93.153(b)). These *de minimis* (of minimal importance) rates vary depending on the severity of the non-attainment and geographic location. Because Air Quality Control Region (AQCR) 215, and therefore the entire project, is in attainment, the general conformity regulations do not apply. However, all direct and indirect emissions of criteria pollutants were estimated and compared to applicability threshold levels of 100 tons (91,000 kg) per year (tpy) to determine whether implementation of the Proposed Action would cause significant impacts. The total direct and indirect emissions associated with the Proposed Action would not exceed applicability threshold levels (Table 4-12). These effects would be minor.

In addition, the permitting portions of the activities proposed under the project would not be expected to exceed *de minimis* levels of direct emissions of a criteria pollutant or its precursors and are exempted by 40 CFR Part 93.153. Any later indirect emissions would not be within the USACE's continuing program responsibility, and the USACE cannot practicably control them. For those reasons, a formal conformity determination would not be required for this project.

Table 4-12. Proposed Action emissions compared to applicability thresholds

	Annual emissions (Short Tons Per Year)		*De minimis* threshold (Short Tons Per Year)	Would emissions exceed applicability thresholds? [Yes/No]
Activity	CO	NO_x		
Site Preparation and Construction	1.8	5.8	100	No

Source: Freese and Nichols, 2011b
Notes: Emissions of all other criteria pollutants and their precursors would be appreciably lower than those of CO and NO_x.

4.5.2.2 Regulatory Review

The CAA, as amended in 1990, mandates that state agencies adopt State Implementation Plans that target the elimination or reduction of the severity and number of violations of the NAAQS. State Implementation Plans set forth policies to expeditiously achieve and maintain attainment of the NAAQS. Since 2004, Texas has developed a core of air quality regulations that USEPA approved. These approvals signified the development of the general requirements of the State Implementation Plan. The Texas program for regulating air emissions affects 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 with applicable requirements.

As part of these requirements, TCEQ oversees programs for permitting the construction and operation of new or modified stationary source air emissions in Texas. TCEQ air permitting is required for many industries and facilities that emit regulated pollutants. These requirements include Title V permitting of major sources, New Source Review, Prevention of Significant Deterioration, New Source Performance Standards for selected categories of industrial sources, and the National Emission Standards for Hazardous Air Pollutants. TCEQ air permitting regulations do not apply to mobile sources, such as trucks. An overview of these regulations applicability to the project is outlined in Table 4-13.

Table 4-13. Air quality regulatory review for proposed stationary sources

Regulation	Project status
New Source Review	The potential emissions would not exceed New Source Review threshold and would be exempt from New Source Review permitting requirements. It is possible that a state operating permit would be required for emergency back-up generators if they became part of the project.
Prevention of Significant Deterioration	Potential emissions would not exceed the 250-tons-per-year Prevention of Significant Deterioration threshold. Therefore, the project would not be subject to Prevention of Significant Deterioration review.
Title V Permitting Requirements	The facilities potential to emit would be below the Title V major source threshold and would not require a Title V permit.
National Emission Standards for Hazardous Air Pollutants	Potential HAP emissions would not exceed National Emission Standards for Hazardous Air Pollutants thresholds. Therefore, the use of Maximum Available Control Technology would not be required.
New Source Performance Standards	Both emergency generators and boilers would be subject to New Source Performance Standards if they became part of the project.

Source: Texas Administrative Code, 2011

Other non-permitting requirements may be required through the use of compliant practices or products. 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)
- Air pollution from VOCs (Chapter 30 TAC 1.101)

Fugitive Dust Control
The grading and site-preparation phases would generate fugitive dust emissions. Texas's Administrative Code (Chapter 30 TAC 1.111.A) does require 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 for conveying or transporting material likely to create objectionable air pollution when airborne
- 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/or 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 where required. The model ordinance includes, but is not limited to, the following:

- All reasonable efforts shall be made to minimize the amount of material burned, with the number and size of the debris piles;
- The material to be burned shall consist of brush, stumps and similar debris waste and lean burning demolition material;
- The burning shall be at least 500 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 built-up area.

4.5.2.3 Reservoir and Dam

Construction
Short-term minor adverse effects from construction would primarily be due to the use of heavy construction equipment, deliveries to the site, and fugitive dust. All emission of criteria pollutants from construction of the reservoir and dam are included in Table 4-12, and would not exceed applicability threshold levels. These effects would be minor and end upon completion of the construction phase.

Operations
Long-term negligible adverse effects from the proposed reservoir and dam would primarily be due to potential small sources of air emissions such as recreational visitors, and increased development around the lake, and generators. These small sources are not expected to generate appreciable amounts of emissions and would be permitted as outlined in Table 4-13.

4.5.2.4 Raw Water Transport Pipeline

Construction
Short-term minor adverse effects from construction would primarily be due to the use of heavy construction equipment, deliveries to the site, and fugitive dust. All emission of criteria pollutants from construction of the pump station and pipeline are included in Table 4-12, and would not exceed applicability threshold levels. These effects would be minor and end upon completion of the construction phase.

Operations
Operation of the proposed pipeline would have long-term negligible effects, as there would be no ongoing sources of air emissions associated with this part of the project.

4.5.2.5 Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

Construction
Short-term minor adverse effects from construction would primarily be due to the use of heavy construction equipment, deliveries to the site, and fugitive dust. All emission of criteria pollutants from construction of the water treatment plant (WTP) are included in Table 4-12, and would not exceed applicability threshold levels. These effects would be minor and end upon completion of the construction phase.

Operation
Long-term minor adverse effects from operation of the proposed WTP would primarily be due to potential small sources of air emissions such as worker commutes, delivery of equipment and supplies, generators. These small sources are not expected to generate appreciable amounts of emissions and would be permitted as outlined in Table 4-13.

4.5.2.6 FM 1396 Relocation and New Bridge Construction

Construction
Short-term minor adverse effects from construction would primarily be due to the use of heavy construction equipment, deliveries to the site, and fugitive dust. All emission of criteria pollutants from road and bridge are included in Table 4-12, and would not exceed applicability threshold levels. These effects would be minor and end upon completion of the construction phase.

Operation
Long-term effects on air quality from using the new road and bridge would be negligible.

4.5.2.7 Conclusion

Overall, the Proposed Action's impacts on air quality would be adverse, and generally of negligible to minor magnitude, both short-term (construction) and long term (operation) duration, small or limited extent, probable likelihood, and slight precedence. Short-term minor adverse and long-term minor beneficial impacts to air quality would be expected with the implementation of the Proposed Action. Short-term emissions would be limited to fugitive dust and diesel emissions from construction equipment during dam, water treatment plant, and pipeline development. Direct and indirect air emissions would not be expected to exceed applicability thresholds or contribute to a violation of any federal, state, or local air regulation. Long-term effects would be primarily due to the elimination of existing sources of air emissions within the project area.

4.5.3 Climate

4.5.3.1 No Action Alternative

Long-term moderate adverse effects would be expected. 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 global warming. 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 conditions associated with climate when compared to the Proposed Action.

Future Precipitation and Water Management
The No Action Alternative would not have any direct or indirect effects on the regional climate, and would not contribute to changes in precipitation. Although there would be no direct effects, the effects of a given set of operating rules may vary depending on the basin's weather patterns. Therefore, a discussion of the No Action Alternative within the framework of future precipitation scenarios is contained herein.

Although the dry weather patterns that Texas has experienced in recent years are not outside the historical norm, the total available precipitation will likely decrease over the next 40 years (Ward, 2011). 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. Changes in available precipitation are a result both of changing precipitation and of changing potential evapotranspiration (PET). For counties within the vicinity of the general project area, the summer deficit is expected to increase from 2005 to 2050 (Table 4-14). Table 4-14 lists the expected changes in summer deficits from 2005 to projected 2050 for Fannin, Hunt, Lamar, Delta, Hopkins, and Collin counties.

As the total available precipitation decreases, the summer deficit may increase. The projected (2050) average summer deficits range from 13.1 inches in Lamar County to 20.5 inches for Fannin County. This constitutes a 13% increase in the summer deficit for Fannin County when compared to historical conditions.

Table 4-14. Changes in available precipitation for neighboring counties

County	Summer deficit in 2005 (inches)	Summer deficit in 2050 (inches)
Collin	-15.09	-16.30
Delta	-12.45	-14.48
Fannin	-15.48	-20.53
Hopkins	-12.13	-16.38
Hunt	-13.78	-16.46
Lamar	-11.82	-13.09

Source: Tetra Tech, 2010

4.5.3.2 Proposed Action

Short-term minor adverse effects and long-term minor beneficial effects would be expected. The Proposed Action would generate a relatively small amount of GHG emissions, and in the short term it would represent an incremental, but overall negligible, contribution to global warming. Although there would be an incremental increase in greenhouse gases, the Proposed Action 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 drier and hotter (Anon., 2011; NRC, 2011), having more water storage capacity to take advantage of heavy precipitation and runoff storm events grows more important.

GHG emissions in the vicinity of the future lake would likely increase due to long-term changes nearby population centers (i.e., 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 the Proposed Action.

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 equivalents. Equivalent CO_2 emissions are the amount of CO_2 emissions that would cause the same amount of "climate forcing" as another GHG such as methane (CH_4). Table 4-15 outlines 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, the Proposed Action would have a relatively small carbon footprint, and would have an incremental, but overall negligible, contribution to global warming.

Table 4-15. Carbon equivalent emissions during the 100-year life of the project

Total Carbon Dioxide Equivalents (total tons)				
Lake Inundation	**Construction**	**Embodied in Fabrication Materials**	**Power Use**	**Total**
10,180	50	1,880	33,055	45,170

Source: Freese and Nichols, 2011b.

Long-term minor beneficial effects from augmenting water storage capacity in North Texas would be expected. Although there would be negligible direct effects from the emissions on global warming, the Proposed Action 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 minor adverse effects from GHG emissions associated with the proposed reservoir. Lake inundation, that is, initial impoundment of the water in Bois d'Arc Creek, would account for approximately 10,180 tpy of CO_2 equivalents, much of which would take place in the first five to ten years after the dam was built. GHG from the lake inundation includes the GHG that are currently being removed or sequestered by existing vegetation within the reservoir site, and the GHG emitted by the reservoir surface. For the first 10 years after the reservoir is created, the GHG would be from the biomass that would decompose after flooding as a result of conversion to permanently flooded land. This would constitute the vast majority of emissions during the first 10 years of the project. After that, any additional

GHG emissions from the reservoir would be from organic material that would have decomposed with or without the project (Freese and Nichols, 2011b).

Raw Water Pipeline and Pump Station
Small amounts of GHG emissions associated with the proposed transport pipeline would have an incremental, but overall negligible, contribution to global warming. All emissions of GHG from construction and operation of the pipeline are included in Table 4-15. The largest component of ongoing GHG 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 supping water to the region such as piping it in from a remote location or desalination would have a much larger carbon footprint (Freese and Nichols, 2011b). These effects would be minor.

Water Treatment Plant, Terminal Storage Reservoir and Related Facilities
Small amounts of GHG emissions associated with the proposed WTP would have an incremental, but overall negligible, contribution to global warming. All emissions of GHG from construction and operation of the WTP are included in Table 4-15. The largest component of ongoing GHG 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. 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 (Freese and Nichols, 2011b).

FM 1396 Relocation and New Bridge Construction
As in the case of other connected actions, small amounts of GHG emissions would be associated with construction and use of these facilities.

4.6 ACOUSTIC ENVIRONMENT (NOISE)

The noise ROI for the project encompasses the footprints of the proposed reservoir, dam, new bridge for FM 1396 and treatment plant footprint, plus the pipeline route, out to a distance of one-half mile from construction activities.

4.6.1 No Action Alternative

The No Action Alternative would have no impacts to noise because there would be no installation of the dam, WTP, or pipeline. Noise levels would remain unchanged when compared to existing conditions described in Section 3-4.

4.6.2 Proposed Action

Implementation of the Proposed Action would have short-term minor adverse and long-term minor beneficial effects on the noise environment. Short-term minor increases in noise would result from the temporary use of heavy equipment during land clearing and construction. Long-term effects would likely be mixed. While most existing sources of noise within the reservoir footprint such as agricultural activities, automobile traffic, and lawn maintenance equipment would end, there is likely to be noise associated with long-term recreational and real estate development at and in the vicinity of the reservoir. Increases in noise would not create areas of incompatible land use or violate any federal, state, or local noise ordinance.

4.6.2.1 Reservoir and Dam

Construction

Construction of the dam and clearing of the reservoir area would have short-term minor adverse effects on the noise environment. These effects would be primarily due to noise 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. Individual pieces of construction equipment typically generate noise levels of 80 to 90 A-weighted decibels (dBA) at a distance of 50 feet (Table 4-16). With multiple items 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. Given the temporary nature of proposed construction activities, these effects would be minor.

Table 4-16. 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

Source: USEPA, 1974.
dBA = A-weighted decibel
L_{eq} = equivalent sound level

Operations

There are no sources of noise associated with the proposed reservoir and dam; therefore, its operation would have negligible effects to the existing noise environment. Upon the initial acquisition of land most existing sources of noise on newly acquired land such as agricultural activities, automobile traffic, and lawn maintenance equipment would end. This return to natural quiet and absence of manmade noise would have a minor beneficial effect on the noise environment.

However, if recreational and real estate development occur at the LBCR, as they do at virtually every other reservoir in the region, then there would be noise associated with these activities, such as using motor boats. However, such noise would be compatible with the end use of the property. For example, noise from motor boats is typical for lakes and lakeside areas.

4.6.2.2 Raw Water Pipeline

Construction

Construction of the pipeline would have short-term minor adverse effects on the noise 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 as heavy equipment noise described under the dam and reservoir above, though on a smaller scale. Heavy equipment would not be fixed in one location but would progress along the pipeline as construction progressed. Construction noise would be temporary and would subside at any particular location as activities progressed. There are some nearby residents who may experience annoying levels of noise; however, given the temporary nature of proposed construction activities, these effects would be minor.

Operations
Pipeline operation would have long-term minor adverse effects on the noise environment. All equipment would be enclosed at the pumping stations, but some mechanical noise may be audible at close range. Some noise due to the use of backup generators may be present during power outages. Noise from the generators expected to attenuate to less than 50 dBA within several hundred feet of each station. These events would be both intermittent and temporary in nature lasting only as long as the power outage itself. These effects would be minor.

4.6.2.3 Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

Construction
Construction of the WTP and TSR would have a short-term minor adverse effect. As noted above, individual pieces of construction equipment typically generate noise levels of 80 to 90 A-weighted decibels (dBA) at a distance of 50 feet (Table 4-16). Given the temporary nature of proposed construction activities, these effects would be minor.

Although construction-related noise impacts would be minor, the following BMPs would be performed to reduce further any realized noise impacts:

- Construction would primarily occur during normal weekday business hours in areas adjacent to noise sensitive land uses such as residential areas, 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, and particularly equipment operators, would don adequate personal hearing protection to limit exposure and ensure compliance with federal health and safety regulations.

Operations
There are no appreciable sources of noise associated with the operation of the proposed WTP; therefore, it would have negligible effects to the existing acoustic environment.

4.6.2.4 FM 1396 Relocation and New Bridge Construction

Construction
Construction of the new road and bridge would have a short-term minor adverse effect. As with the other connected actions listed above, individual pieces of construction equipment typically generate noise levels of 80 to 90 A-weighted decibels (dBA) at a distance of 50 feet (Table 4-16). Given the temporary nature of proposed construction activities, these effects would be minor.

Operations
A relatively low volume of traffic along the relocated FM 1396 would have adverse effects on the nearby acoustic environment comparable to those of FM 1396 at present. Traffic over the bridge might cause minor adverse acoustic impacts for recreationists on the future lake surface.

4.7 BIOLOGICAL RESOURCES

The ROI for biological resources includes the proposed reservoir site, pipeline, water treatment facility, and mitigation site, all of which are located in Fannin County.

4.7.1 No Action Alternative

4.7.1.1 Vegetation

Under the No Action Alternative, effects to the vegetation communities or habitat of the affected environment described in Chapter 3 would likely be a mixture of minor adverse and minor beneficial; it is not possible to foresee which of these might predominate, and thus whether the net effect would be adverse or beneficial. None of the direct effects to vegetation that would occur at the proposed reservoir, dam, pipeline, and the water treatment plant sites due to the Proposed Action would take place under the No Action Alternative. No direct removal of vegetation and inundation of vegetation would occur to clear the site for a dam and reservoir that would not be built, although ongoing silviculture, forestry/ logging and some land clearing for agricultural purposes would still take place, as would natural succession on old fields that are abandoned. Any substantive change to vegetation in the area would come from other projects distinct from the proposed reservoir, dam, WTP and pipeline.

Without the Proposed Action, continuing slow population growth in Fannin County is expected in the coming decades. The area could experience changes in vegetative cover primarily related to agricultural practices and perhaps residential development. In areas where agriculture is abandoned, natural succession of plant communities would occur, leading eventually to climax communities of either upland or bottomland woodlands in most instances. Under the No Action Alternative, adverse effects to the vegetation communities or habitat of the proposed project site and surrounding area would be at most minor; historic trends in the area would be expected to continue for decades into the future.

4.7.1.2 Terrestrial Wildlife

Under the No Action Alternative, adverse effects to wildlife in the footprint of the Proposed Action would likely be minor and adverse, although, as in the case of vegetation, there could possibly be a net increase in wildlife abundance and diversity in the area associated with broader regional trends. No direct effects to wildlife would occur in the area of the proposed reservoir, dam, pipeline, 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 and slow rate. Any substantive change to wildlife in the area would come from projects distinct from the Proposed Action, such as additional rural houses, timber harvest, an increase or intensification of agriculture practices, and reversion of agricultural fields to old fields, grass fields, or eventually, woody habitat (Freese and Nichols, 2008a). There could also be changes in hunting intensity (up or down) as population grows and increases in competing invasive species, like feral hogs.

4.7.1.3 Aquatic Life

Under the No Action Alternative, overall effects to aquatic life would be minor to moderate, adverse, and long term. No direct effects to aquatic species would occur in the area of the proposed reservoir, dam, and pipeline because the Proposed Action would not take place. Terrestrial habitat would not be converted to lacustrine habitat at the proposed reservoir site. Any substantive change to aquatic life would come from projects distinct from the Proposed Project. Additional effects to aquatic species would come from changes in agricultural practices and development that would occur near or within the surface waters of the area.

In spite of avoiding the direct adverse effects on aquatic fauna associated with reservoir construction, the long-term effects of the No Action Alternative on aquatic fauna, that is, on the existing communities and populations of fish and aquatic invertebrates within Bois d'Arc Creek, would nevertheless be minor and adverse because the degraded condition and modified hydrology of this creek would continue into the indefinite future. These existing conditions, which include both very high, erosive flows during storm events, as well as long periods of little or no flow, are not conducive to maintaining an abundant and diverse stream fauna.

4.7.1.4 Threatened and Endangered Species

Under the No Action Alternative, effects to both federal and state-listed threatened and endangered species would be minor and associated with independent projects in the area. Any effects are expected to be gradual and result over time from an increase in population, development, or agricultural fields. Because of the small number of potential threatened or endangered species in Fannin County and lack of suitable habitat within the proposed reservoir and dam site, effects to threatened and endangered species under the No Action alternative would likely be no more than minor adverse.

4.7.2 Proposed Action

4.7.2.1 Vegetation

Dam and Reservoir Construction

The effects of dam and reservoir construction to vegetation would be expected to be adverse, moderate in magnitude, short-term and long-term in duration, medium in extent, probable, and moderate in precedence and uniqueness. Construction of the proposed LBCR dam, and associated structures would result in elimination of a variety of vegetation cover types and wildlife habitat (see section 3.5) 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 (see Figure 2-7 in Chapter 2); 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, with the preferred method being mechanical clearing by sheer-blading during the dry season. This is preferred because stumps and all other types of vegetation can be sheared off at ground level. Machine clearing also accumulates most of the loose and dead woody debris on the forest floor. Cleared materials would be placed in windrows or piles and left to dry and eventually burned depending on fire danger conditions.

To provide recreational enjoyment and for emergency purposes, vegetation would be removed for user access to the reservoir area. A number of landing sites would be identified along the future reservoir shoreline. Clearing at these sites may 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, within the reservoir itself, large woody debris would be removed as necessary.

Adverse effects to terrestrial vegetation would occur from construction, clearing, and direct inundation of approximately 16,641 acres by the proposed reservoir and effects to 427 acres from the construction of the dam and spillways. Of this total approximately 16,762 acres are vegetated by terrestrial vegetation, which excludes 219 acres of riverine and 87 acres of lacustrine habitat. Vegetation cover types in this area includes evergreen forests, upland/deciduous forests, riparian woodland/bottomland hardwood/ forested wetlands, shrublands, shrub wetlands, grassland/old fields, emergent/herbaceous wetlands, croplands, tree savannas, and shrub savannas. Much of the proposed site has been altered over the past 100 years due to agricultural practices and stream channelization (Freese and Nichols, 2008a). Vegetation cleared for access roads and associated recreational enhancements would also remove similar vegetation types and increase the overall acres of vegetation removed for the proposed reservoir. Clearing of vegetation for access roads and construction activities that are not permanent would have a short-term adverse effect on vegetation in the area. After construction, recovery of vegetation in these areas would occur in a reasonable time. Inundation of the reservoir site, permanent access sites, and associated recreational facilities would have long-term adverse effects on vegetation in the area.

Approximately 6,330 acres of Riparian Woodland/ Bottomland Hardwood/Forested Wetland would be eliminated – cleared or inundated – by the proposed action. USFWS designated Bois d'Arc Creek bottomland hardwoods as Priority 4 bottomland hardwoods in 1984 – "moderate quality bottomlands with minor waterfowl benefits" (Region C Water Planning Group, 2010) – but nevertheless this type of habitat is scarce or becoming scarce regionally (USACE, 2000). Under the HEP used in the analysis for this EIS, the Habitat Suitability Index for Riparian Woodland/ Bottomland Hardwood is 0.25, a relatively low rating.

Overall, adverse effects to vegetation are expected to be moderate in magnitude. Because 16,762 acres of Fannin County (about 3% of the county's land area) would be converted to a reservoir, the project is expected to be medium in extent.

Besides clearing and direct inundation, potential effects from construction 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. 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 (UMN, 2011). Since vegetation would be cleared two years before inundation, the soil in this area would be exposed and susceptible to soil erosion. Though the proposed dam and reservoir project could result in an increase in soil compaction, erosion, and water runoff a portion (Cropland and Grassland/Old Field) of the proposed site has already experienced soil compaction from agricultural practices. Also, removing vegetation from the reservoir during the dry season will reduce possible impacts of soil compaction because soils are more susceptible to compaction when wet (UMN, 2001). The National Pollutant Discharge Elimination System (NPDES) Stormwater Program requires that all construction projects that exceed 1 acre of disturbance develop storm water pollution prevention plans (SWPPP's) and erosion and sedimentation control plans which minimize the potential for contamination of surface or groundwater resources (USEPA, 2011b). This plan would help control erosion on the reservoir site.

Possible spills of fuels and/or other material could cause shifts in population structure, abundance and diversity, and distribution of plant species. Depending on the type of material spilled, some materials could remain in the environment long after a spill event (USFWS, 2004). Possible spills during construction of the dam and reservoir would be expected to be small, contained, and cleaned up.

During construction adverse effects to local off-site vegetation may occur as a result of fugitive dust emissions from construction machinery and worker traffic along unpaved roads (Ko and Alberico, no date). Dust emission could reduce photosynthesis from reducing the light penetrating through the leaves. Dust emissions could also increase the growth of plant fungal disease (NZME, 2001). 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.

Invasive plant species – especially grasses and forbs – are generally found in disturbed soil conditions. Surface disturbance and construction activities 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, no-date). Effects of invasive plants species would be expected to be moderate in magnitude, long-term in duration, medium in extent, probable, and moderate in precedence and uniqueness.

The reservoir site is adjacent to and upstream of the Bois d'Arc Unit of the Caddo National Grasslands. Possible adverse effects from construction activities are similar to – but of reduced likelihood and magnitude – the adverse effects on vegetation in the proposed reservoir site. Impacts could occur from fugitive dust covering vegetation on the grassland, spills of fuels and/or other materials near the grasslands, soil compaction, and the introduction and spread of invasive species. Because the proposed site is close in proximity to the Caddo National Grasslands adverse effects are expected to be moderate in precedence and uniqueness.

Raw Water Transmission Facilities

The effects of constructing raw water transmission facilities on vegetation would be adverse, minor in magnitude, short-term and long-term in duration, small in extent, probable, and slight in precedence and uniqueness. Raw water transmission facilities include intake pump stations and a 35-mile long, 90-96 inch raw water pipeline. The intake pump station would be built at the edge of the reservoir near the dam (Figure 2-8). The recommended pipeline route occurs mostly across open farmland and completely avoids more valuable natural habitats such as forested wetlands. During construction, a temporary construction easement is proposed for a total width along the alignment of 70 feet. The grading limits for pipeline construction would cover approximately 512 acres. After construction, the permanent easement would be 50 feet wide.

Grassland within the proposed 70-foot wide temporary easement and 50-foot permanent easement would be restored to the same cover type (grassland) through re-vegetation upon completion of construction. Likewise, agricultural activities on cropland would presumably be resumed by land owners. Forest cover types (upland forest, evergreen forest, and riparian woodland/bottomland hardwood) and shrubland within the temporary construction easement would revert to their respective cover types over time. Within the permanent 50-foot easement, however, forest cover types would be converted to grassland following re-vegetation of the easement and would be maintained as such. For all non-reservoir connected actions combined (e.g., pipeline, WTP, and TSR) a total of 16.5 acres of upland deciduous forest (9.7 acres), evergreen forest (2.6 acres), shrubland (0.9 acre), and riparian woodland/bottomland hardwood (3.3 acres) would be permanently converted to grassland.

After construction and placement of the pipeline, the vegetation in this area would be expected to recover in a reasonable time. Long-term impacts would occur from maintaining the permanent pipeline easement. Temporary effects to vegetation from construction of the pipeline would be similar to construction of the dam and reservoir, though much smaller in extent and magnitude. These adverse impacts would be the removal of vegetation, soil compaction, soil erosion, surface water runoff, risk of spills of fuels and/or other material, construction dust, and invasive species. For a further discussion see the above vegetation impacts from construction of the dam and reservoir. As with the construction of the dam, adverse impacts associated with ground disturbances would be mitigated through on-site measures outlined in an approved SWPPP and erosion and sediment control plan. Since most (about 95 percent) of this route occurs on agricultural land (cropland and grassland/old field), impacts of the proposed pipeline on natural vegetation would be expected to be minor in magnitude and medium in extent. The pipeline route would mostly avoid valuable habitats such as forested wetlands, making it slight in precedence.

Proposed Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

The effects of the WTP and TSR construction on vegetation would be adverse, minor in magnitude, long-term in duration, small in extent, probable, and slight in precedence and uniqueness. The proposed WTP and TSR are located on a NTMWD-owned property near the city of Leonard in Fannin County. Within the selected sites, the grading limits of the TSR would be approximately 153.5 acres, while those of the WTP would encompass approximately 186.2 acres. Temporary adverse effects to this area would be similar to effects, but substantially smaller in magnitude, as those occurring during construction of the proposed dam and reservoir. These adverse effects are the removal of vegetation, soil compaction, soil erosion, surface water runoff, possible spills of fuels and/or other material, construction dust, and invasive species. Vegetation removed on the proposed WTP and TSR sites consists primarily of grasslands and old fields and croplands, with some upland herbaceous vegetation with small wooded areas along fence lines. There would be no effects to wetlands vegetation, since the entire construction area is located on upland. Effects to vegetation on this site would be minor in magnitude and small in extent. See the above discussion of construction of the dam and reservoir on vegetation for further details on these effects. To address soil erosion and surface water runoff, mitigation measures would be implemented through a SWPPP.

FM 1396 Relocation and New Bridge Construction

Since the preferred option for locating FM 1396 is along existing transportation right-of-way, impacts to upland native vegetation and habitat are expected to be negligible to minor and localized.

Operations

The effects of dam and reservoir operation to vegetation would be adverse, minor in magnitude, long-term in duration, small to medium in extent, probable, and slight in precedence and uniqueness. Operation of the proposed reservoir could result in indirect adverse effects to vegetation outside of the immediate project area. Potential adverse effects may be brought about by an increase in recreation and residential housing along the shoreline of the proposed reservoir. Both an increase in recreation and residential housing could result in an increase in vegetation removal, soil compaction, soil erosion, surface water runoff, and an increase of the introduction and facilitation of invasive species. Recreation users could trample vegetation, increasing soil compaction, soil erosion along the reservoir shoreline, and surface water runoff. Soil erosion and surface water runoff could degrade nearby water sources, including the proposed reservoir. Recreational users could also increase the facilitation and spread of invasive species into the reservoir area because invasive species can travel from one location to another via vehicles, pets, and people.

Operating the proposed reservoir could affect the vegetation along the channels downstream of the dam, including the Caddo National Grasslands. Vegetation cover in and along channels downstream of dams has been shown to remain the same or increase following the placement of a dam. The vegetation along stream banks downstream of the proposed reservoir would be expected to continue to increase after the dam is built. A reduction in large erosive flow events would be expected and would allow vegetation along banks to become readily 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 adverse effects to this area would be slight in precedence and uniqueness.

Mitigation

In addition to providing compensatory mitigation for potential impacts to waters of the U.S., including wetlands, the proposed mitigation plan would also provide compensatory mitigation for potential impacts to terrestrial and upland flora. The proposed terrestrial mitigation components were developed to support and meet the permitting and mitigation requirements associated with the state of Texas water right permit application for the LBCR submitted by NTMWD to the TCEQ on December 29, 2006 (Freese and Nichols, 2014).

All proposed aquatic and terrestrial mitigation (excluding on-site aquatic mitigation) would occur on the Riverby Ranch, a single tract of land approximately 15,000 acres in size, which is located downstream of the proposed reservoir site (Figures 4-5 and 4-6). The presence of both aquatic and terrestrial mitigation areas in close proximity to each other, within the same watershed as the proposed reservoir (about 10 miles away), and adjacency to the Caddo National Grasslands are considered advantages of this mitigation proposal.

The HEP methodology described earlier was used to evaluate and compare vegetation resources and habitats that would be affected by construction of the proposed reservoir. The USFWS identifies HEP as an appropriate methodology to assess project impacts to vegetation/habitats and make mitigation recommendations; furthermore, it is also considered an appropriate tool by the state of Texas (30 TAC §297.53). Under the HEP, both impacts and mitigation credits are measured using Habitat Units (HUs), a metric specific to the HEP methodology. Potential impacts to terrestrial/upland vegetation resources and proposed compensatory mitigation to offset those impacts are shown in Table 4-17. Table 4-10 provided corresponding figures for wetlands (forested wetland, emergent wetland, shrub wetland).

Proposed techniques and details for restoring and enhancing agricultural and degraded habitats to native vegetation communities are available in the Mitigation Plan.

Table 4-17. Summary of impacts to upland/terrestrial habitats and proposed mitigation

Type of Habitat	Amount Impacted	Amount of Mitigation	Net Gain (+) / Net Loss (-)
Upland Deciduous Forest (HUs)	(-) 1,046	(+) 665	(-) 381
Riparian Woodland / Bottomland Hardwood (HUs)	(-) 433	(+) 855	(+) 422
Grassland / Old Field (HUs)	(-) 2,886	(+) 2,393	(-) 493
Shrubland (acres)	(-) 64	(+) 41	(-) 23

Source: Freese and Nichols, 2014

Conclusion
Taking into account the proposed mitigation plan for upland and terrestrial vegetation, environmental consequences associated with the Proposed Action can be divided temporally into 1) short-term and medium-term impacts, and 2) long-term impacts. In the short term and medium term (when habitat restoration and enhancement at the mitigation site is in its early years), impacts from the Proposed Action would be of moderate magnitude (primarily from the permanent loss of upland deciduous forest and bottomland hardwoods), medium extent, probable likelihood, and moderate precedence/uniqueness. Over the long term (measured in decades), as habitat restoration and enhancement at the Riverby Ranch mitigation site advances, net impacts from the Proposed Action (including mitigation) would continue to be somewhat adverse, due to the time lag and net losses for upland deciduous forest and grasslands/old fields. The projected increase over time in riparian woodlands (bottomland hardwoods) would be beneficial in and of itself, but alone would be insufficient to offset losses to other habitats. These net adverse impacts would be of minor magnitude, long-term duration (permanent), medium extent, probable likelihood, and slight to moderate precedence.

In conclusion, the net impacts of the Proposed Action on upland or terrestrial vegetation would be moderately adverse in the short and medium term and minor adverse over the long term. With mitigation measures implemented, these impacts would be less than significant.

4.7.2.2 Terrestrial Wildlife

Construction of the Dam and Reservoir
Adverse effects from the proposed dam and reservoir construction on wildlife would be expected to be moderate in magnitude, short-term and long-term in duration, medium in extent, probable, and moderate in precedence and uniqueness. 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.

As discussed above, existing habitats at the proposed site would be eliminated by the Proposed Action and replaced by largely open water lacustrine habitat with perhaps some emergent marsh at the upper end of the reservoir and other shallow waters. Generally, according to the HEP evaluation, the habitat quality (HSI) is the highest for cropland, tree savanna, and shrublands. See Table 4-16. 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 incapable of supporting a higher population density, in which case further displacement or mortality would occur. Because of the loss of habitat, effects to wildlife would be moderate in magnitude. 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 losses to these forms of wildlife.

The greatest short-term and long-term adverse effects, both direct (mortality) and indirect (habitat loss) would occur to small mammals, reptiles and amphibians, 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. Its 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. Its effect on shorebirds is likely to be neutral or mixed, but on net 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 songbirds such as warblers and vireos that are forest dependent would be negative due to the disappearance of this habitat 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 facilities could create wildlife barriers and alter migration patterns and species dispersal (Al-jabber, 2003). Effects from habitat fragmentation from road construction and reservoir inundation would be long-term and adverse but of minor magnitude. The project area and surroundings are already quite fragmented, as illustrated by the variety and configuration of existing habitat types.

During construction 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 communication, navigation, 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 (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 generally be localized to the general vicinity of the proposed dam and reservoir during construction.

Injury or mortality of wildlife may also 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).

Raw Water Transmission Facilities

The effects of constructing the raw water transmission facilities on wildlife would be expected to be adverse, minor in magnitude, primarily short-term in duration, small in extent, probable, and slight in precedence and uniqueness. The recommended 35-mile pipeline route is located mostly over open farmland and completely avoids more valuable habitats such as forested wetlands. Though croplands and pasture provide food sources for wildlife species, wildlife species do not typically occur in croplands exclusively. During construction, a total construction easement width of 120 feet is proposed along the alignment. The grading limits for pipeline construction would cover approximately 512 acres. After construction, the permanent easement would be 50 feet wide.

After construction and placement of the pipeline, the habitat in this area would be expected to recover in a reasonable time and wildlife species that were displaced from this area could move back. Wildlife species in this area would temporarily be displaced during construction due to disturbance, human presence, noise and loss of vegetation. Short-term impacts to wildlife from construction of the pipeline would be similar to construction of the dam and reservoir. These adverse effects could be the removal and degradation of habitat, displacement, fragmentation, and noise and light pollution. For a further discussion see the above vegetation effects from construction of the dam and reservoir. All grassland and cropland habitats within the temporary and permanent easements would likely be restored to their pre-pipeline condition; within the permanent easement, forested areas would be converted to grasslands on an area no larger than about 16 acres. Since most of this area occurs on agricultural land the proposed pipeline would be expected to be minor in magnitude and small in extent. The pipeline route would completely avoid valuable habitats such as forested wetlands, making it slight in precedence.

Proposed Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities
The effects of constructing the water treatment plant on wildlife would be adverse, minor in magnitude, long-term, small in extent, probable, and slight in precedence and uniqueness. The proposed WTP and TSR are located on about 340 acres of mostly agricultural properties near the city of Leonard in Fannin County. As discussed under vegetation effects, cropland, grassland/old field, and forest habitat on these 340 acres would be removed. Wildlife species would be displaced permanently from those habitats that are built upon and some fragmentation of wildlife habitat would occur. During construction light and noise pollution could also occur and wildlife mortality could occur from collisions with construction machinery. These effects would be similar to those discussed under wildlife impacts from construction of the dam and reservoir. There would be no effects to wetland habitats for wildlife, because both the WTP and TSR are sited entirely on upland habitats.

FM 1396 Relocation and New Bridge Construction
Since the preferred option for locating FM 1396 is along existing transportation right-of-way, impacts to upland wildlife habitat and wildlife itself are expected to be negligible to minor and localized.

Operations
The effects of dam and reservoir operation to wildlife would be adverse, minor in magnitude, long-term, small to medium in extent, probable, and slight in precedence and uniqueness. Operation of the proposed reservoir could result in indirect adverse effects to wildlife outside of the immediate footprint. Potential adverse effects may be brought about by an increase in recreation and residential housing along the shoreline of the proposed reservoir. An increase in both recreation and residential housing would result in an increase in habitat removal, soil compaction, soil erosion, surface water runoff, and facilitating the introduction of invasive species. Depending on how much recreation and development increases, adverse effects could be small to medium in extent. Recreation users could trample species habitat and food sources. Recreation 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 also increase the facilitation and 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 many wildlife species.

Mitigation
The main long-term adverse impacts to terrestrial wildlife from the Proposed Action would occur indirectly through the loss or conversion of habitats upon which wildlife depend for survival. Thus, mitigation for wildlife would be achieved indirectly by the proposed habitat mitigation for aquatic and

terrestrial habitat discussed in the sections above. This would occur primarily at the Riverby Ranch. In addition, NTMWD has purchased the land to elevation 541 ft. msl and the flood easement out to 545ft msl around the lake perimeter. This would limit impacts to habitat on lands between elevations 545 and 534 ft. msl for wildlife.

Conclusion
Taking into account the proposed mitigation plan, overall impacts to wildlife from the Proposed Action would be both adverse and beneficial as well as short-term and long-term. In the short-term, during the construction phase and for some years thereafter, impacts to most established wildlife species, including both vertebrates and invertebrates, within the project area would be moderately adverse, primarily because of removal and elimination of the habitats upon which these particular organisms and species depend. Few animals would venture onto the cleared, grubbed, and disturbed lands being converted into a reservoir. As water is impounded behind the completed dam, aquatic habitats would gradually develop within the reservoir site itself. With a few notable exceptions, the populations of terrestrial mammals, birds, reptiles and amphibians that existed within the reservoir footprint would cease to be there, because they are dependent upon terrestrial and/or riparian habitats, not open water. A few years after the reservoir and vegetation communities have become established, waterfowl, wading birds, and shorebirds would begin to use different zones.

Prior to or concurrently, wildlife habitats at the Riverby Ranch mitigation site would have begun to be developed, restored, and enhanced from the cropland and pastureland that exist there now. These wildlife habitats gains would gradually begin to offset the losses from reservoir, pipeline, and WTP construction.

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. It should be stressed that it may not be possible to exactly replace or duplicate every species of wildlife in kind that would be impacted within the reservoir footprint. It is possible that some species that resided at the reservoir site prior to construction would not become established on the new Riverby Ranch habitats. However, no species is likely to be eliminated from Fannin County as a result of the Proposed Action. At the same time, the Riverby Ranch mitigation site may well eventually foster certain wildlife species and populations that are not now present along Bois d'Arc Creek within the proposed reservoir footprint.

In conclusion, once proposed mitigation is taken into account, overall impacts to wildlife from the Proposed Action would be both adverse and beneficial, and less than significant.

4.7.2.3 Aquatic Life

Construction of the Dam and Reservoir
The effects of dam and reservoir construction to aquatic life would be both adverse and beneficial. Adverse effects would be minor in magnitude, long-term, medium in extent, probable, and medium in precedence and uniqueness. Within the proposed reservoir site there are 87 acres of lacustrine environment, 219 acres of riverine environment, 49 acres of shrub wetlands, 1,223 acres of emergent wetland, and 4,602 acres of forested wetland habitat. The riverine habitat of the proposed site includes numerous named and unnamed perennial and intermittent streams that are tributaries of Bois d'Arc Creek. Currently there are 24.8 miles of unchannelized perennial streams, 68.5 miles of unchannelized intermittent streams, 25 of channelized perennial streams, and 5 miles of channelized intermittent streams within the proposed reservoir site.

Bois d'Arc Creek has rapid rises and falls in response to rainfall events and extended periods of little or no flow. This extreme flow dynamic is most likely due to the extensive channelization that exists in this watershed. During the 1 and 2-year storm events peak flow is approximately 8,056 cfs and 13,390 cfs, respectively. Inundation for the 1 and 2-year storm events is 3,396 acres and 4,121 acres, respectively, and occurs from the proposed dam location to a point just below the FM 79 bridge. Both of these events cause similar overbank flooding from the proposed dam to a point between the FM 100 and FM 79 crossings. After that point the storm events become more confined, with inundation limited to cutoff channels and gullies. If flows in the Red River are high, there is a potential for additional overbanking in the lower portions of Bois d'Arc Creek. Within the Bois d'Arc Creek watershed, overbanking events are a relatively common occurrence and the floodplains in this area are relatively narrow, occurring along Bois d' Arc Creek (Freese and Nichols, 2010a).

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

Within the reservoir footprint, stream habitat would be inundated by the proposed reservoir and converted to lacustrine (lake-like) habitat. While the total "footprint" of the Proposed Project site is 17,068, the reservoir would occupy 16,641 acres (26 square miles) and impound 367,609 acre-feet of water. The conservation pool or normal water surface of the reservoir is 534.0 ft. msl, but the surface and shoreline would continually fluctuate above and below this level. The amount of shoreline or littoral wetlands that is included in the mitigation plan is 1,402 acres, which represents the acreage from 531 to 534 ft. msl. The maximum depth of the reservoir would be approximately 70 feet. 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 and 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 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. The retention of water in a reservoir influences the types of physical and chemical processes occurring in the reservoir.

The proposed reservoir would be subject to sediment inflow and deposition. Incoming sediment in streams impounded behind a dam sinks to the bottom of the reservoir and the reservoir loses water storage to this sedimentation. Sediment yields and estimates of sedimentation rates are discussed in Section 4.4.2.2.

Because of the proposed reservoir's depth and lack of water movement, the reservoir would be expected to stratify – that is, 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. This thermocline 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. Low DO levels are generally harmful to aquatic life. By October the DO levels are expected to increase from the summer months and exceed the High Aquatic Life criterion of 5.5 mg/L throughout the reservoir pool.

During construction, soil compaction, soil erosion, and surface water runoff would all be expected. Soil erosion and surface water runoff could degrade the water quality of the nearby streams within the watershed. A SWPPP would be prepared to comply with the NPDES Stormwater Program, which is a requirement under the General Construction Permit. Soil erosion and runoff would be managed to reduce adverse effects to water quality.

Fish

After inundation, 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. This would take place through selective clearing of trees and shrubs.

The 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). The magnitude of this change depends upon impoundment size, position of the impoundment along the stream, stream size, and current species composition. Fish species that are found only in rivers and streams would be lost, but the newly created lacustrine habitat would compensate for some of these losses. The loss of riverine habitat and fish found only in rivers and streams would be long-term, minor in magnitude, and medium in extent.

A study conducted in Illinois found that a creek, which documented 48 fish species prior to impoundment, had 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 of 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 composition.

The expected dominant fish in the proposed reservoir are expected to include combinations of longear sunfish, bullhead minnow, freshwater drum, logperch, and orangespotted 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. Table 4-18 is a list of fish species found generally abundant in Texas reservoirs. These fish could also become abundant in the proposed reservoir.

Table 4-18. Common fish species in Texas reservoirs

Scientific name	Common Name
Aplodinotus grunniens	freshwater drum
Dorosoma cepedianum	gizzard shad
Dorosoma petenense	threadfin shad
Gambusia affinis	western mosquitofish
Ictalurus melas	black bullhead
Ictalurus punctatus	channel catfish
Lepomis auritus	redbreast sunfish

Scientific name	Common Name
Lepomis microlophus	redear sunfish
Lepomis cyanellus	green sunfish
Lepomis gulosus	warmouth
Lepomis humilis	orangespotted sunfish
Lepomis macrochirus	bluegill
Lepomis megalotis	longear sunfish
Menidia beryllina	inland silverside
Micropterus salmoides	largemouth bass
Notemigonus crysoleucas	golden shiner
Percina caprodes	logperch
Pimephales vigilax	bullhead minnow
Pomoxis annularis	white crappie
Tilapia aurea	blue tilapia

Source: (Freese and Nichols, 2010a)

Tables 3-22, 3-23, and 3-24 list species that were collected in the Bois d'Arc watershed during four separate studies. To determine if these species would likely be 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. See Table 4-19.

Table 4-19. 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

Scientific Name	Common Name
Lepomis gulosus	warmouth
Lepomis humilis	orangespotted sunfish
Lepomis microlophus	redear sunfish
Micropterus punnctulatus	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
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	

Source: (Freese and Nichols, 2010a; TA&M, no-date)

The loss of fish species not adapted to lacustrine habitats would be minor in magnitude, medium in extent, and adverse. Current aquatic habitat in the proposed site is degraded. Streams have been channelized and stream flows are inconsistent with periods of no flows. The proposed reservoir and dam would create a more stable lacustrine environment. A beneficial effect would occur because of the increase in lacustrine environment, resulting in an increase in some fish populations.

Benthic Macroinvertebrates

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. Most, however, are limited to the limnetic and littoral zones and emergent plants found there. The reservoir habitat created could support a productive invertebrate community, although the overall species composition (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 3-25 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. State-listed rare, threatened, and endangered mussels were not collected at the proposed reservoir site during the 2009-2010 Instream Flow Study (Freese and Nichols, 2010a).

Raw Water Transmission Facilities

The effects of constructing raw water transmission facilities on aquatic life would be adverse, negligible to minor in magnitude, long-term in duration, small in extent, probable, and slight in precedence and uniqueness. Raw water transmission facilities include intake pump stations and a 35-mile long, buried 90 to 96-inch raw water pipeline. The alignment would cross 36 streams, most of which are intermittent or ephemeral. The three largest streams would be tunneled so as to avoid aquatic habitat and wetlands. Since the selected 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 minor in magnitude, short-term, small in extent, probable, and slight in precedence and uniqueness.

Proposed Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

No direct effects and at most negligible to minor indirect effects on aquatic life would be expected at the site of the WTP and TSR, because both are located entirely on upland habitat, completely avoiding open waters and wetlands. If there are any adverse impacts to aquatic species at all at these sites, they would be indirect, and potentially include water quality degradation from soil compaction, soil erosion, and surface water runoff; these impacts would be mitigated by implementing a SWPPP and Construction General Permit.

FM 1396 Relocation and New Bridge Construction

FM 1396 construction would occur primarily on upland sites and construction of the new bridge over the reservoir would occur prior to impoundment, so direct effects on aquatic biota would be avoided. However, the road alignment likely would require fill within waters of the U.S. even if it occurs prior to impoundment. It would not include any additional impacts that are proposed to be impacted by the reservoir impoundment. Indirect effects from erosion would be mitigated by implementing a SWPPP and Construction General Permit.

Long-term Functioning of LBCR

Reservoir Impact Analysis

Effects to the aquatic habitat of the reservoir from operation would be adverse, moderate in magnitude, long-term in duration, medium in extent, probable, and moderate in precedence and uniqueness. Recreation and development is expected to increase surrounding the proposed reservoir site. Increased recreational use of the area could facilitate and spread invasive species as well as increase soil compaction, soil erosion, and surface water runoff. Boat propellers, bilges, and livewells could all introduce invasive plants 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. Were invasive plants to become established and require active maintenance, in all likelihood they could be controlled by mechanical or chemical means (herbicides approved for use in fresh water environments). Such mechanical and/or chemical control occurs regularly at thousands of lakes and reservoirs across the country, especially those in warmer climates. Control of invasives would depend on the extent of the problem and type of invasive species. For some invasives, there are no known acceptable means of mechanical or chemical control. For others, one or more control methods must be practiced at regular intervals, and they are of limited effectiveness or have drawbacks.

Stocking fish for recreation could introduce non-native predators or parasites into the aquatic environment. Invasive plant and animal species in the reservoir could be transported to another location. 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, moderate in magnitude, long-term, medium in extent, and probable. Due to the proximity of the Caddo National Grasslands effects of the reservoir would be moderate in precedence and uniqueness.

Downstream Impact Analysis

Effects to the environment downstream of the dam were also covered under water resources, but will be considered here as well under aquatic life impacts. These effects would be mitigated through environmental flow releases of Bois d'Arc Creek below the dam. These designs are incorporated to compensate for losses of stream function and wildlife habitat, and when completed are expected to enhance instream uses below the dam.

As described in Section 4.4.3.3 and elsewhere in Chapter 3 of this EIS, as part of the 2010 Instream Flow Study, a RiverWare model was developed and modified to predict the long-term response of Bois d'Arc Creek downstream of the proposed dam. RiverWare is a hydrologic model that uses a daily time step and simulates management of reservoir and stream segments. It was first used to assess baseline conditions of the watershed as well as future conditions with the dam and reservoir in place. It explicitly includes modeling of Lake Bonham, the FM 1396 gage (USGS 07332620), the proposed reservoir dam site, Lake Crockett, the FM 409 gage, Coffee Mill Lake, the FM 100 crossing and the reach from FM 100 to the Red River.

Both adverse and beneficial effects would be anticipated for aquatic life downstream of the proposed dam. Adverse effects would be minor in magnitude, medium in extent, long-term in duration, probable, and moderate in precedence and uniqueness. The flow regime downstream of a reservoir can be substantially different than before the reservoir was built. To determine downstream flow conditions after the proposed reservoir is in place, the RiverWare model was used to predict expected downstream conditions with the proposed flow regime. The study included computer simulations of proposed reservoir operation and hydraulic and hydrologic modeling to compare with and without reservoir scenarios. This model was used in the preparation of the Draft Operation Plan (NTMWD, 2014) and the draft water right permit from TCEQ, which stipulate the following conditions for Bois d'Arc Creek downstream of the LBCR dam (also listed in Table 4-11):

- Extended periods of zero flow or periods of low flow would only occur during drought.
- Extreme flood events would occur less frequently, with flows staying within the current banks most of the time. Flows higher than 3 cfs would occur less frequently with the dam in place.
- The median base flow would be slightly higher in the spring and summer months and lower during the rest of the year.

- Lower Bois d'Arc Creek Reservoir is expected to go for long periods of time without spilling. The approved draft environmental flow regime requires up to five pulses per year, which is more than the average number of pulse events (3 pulses) prior to dam construction. Overall, the frequency of overbanking flows would be substantially less than before.
- The number of pulse and overbank events would increase with distance downstream from FM409 to the lower reaches of Bois d'Arc Creek.
- The proposed dam would reduce high flow magnitude and frequency, reducing stream power and the sediment transport capacity of the stream system.
- The ability of the stream to reach equilibrium would be expedited because of the reduction in higher magnitude flows and their frequency.
- Flows greater than 50 cfs would be required to transport materials larger than the median grain size of the subsurface sediment.
- The proposed pulse flow regime is expected to provide sufficient flows to benefit and maintain habitat and not cause erosion and channel degradation.
- During the April through June season, the minimum downstream dissolved oxygen concentration is predicted to be 5.82 mg/L, which meets the 5.5 mg/L criterion for the spring spawning period.
- For the July through October season, the minimum downstream dissolved oxygen concentration is predicted to be 5.75 mg/L, which meets the 5 mg/L criterion for non-spawning periods (Freese and Nichols, 2010a).

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 placement of the proposed dam would effectively cut off the sediment supply from the upstream channel to the lower reaches. A reduced sediment load could increase the tendency of the channel downstream of the reservoir to erode and incise during high flow events. However, with the dam in place, there would be fewer highly erosive flow events. Vegetation along the stream bank would help reduce the amount of erosion. Because of the changed flow rate downstream, vegetation along downstream stream banks is anticipated to be denser than what is currently there, further reducing the amount of erosion. Release criteria in the prescribed environmental flows discussed in Section 4.4.3.3 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.

The change in flow regime downstream from the proposed reservoir could negatively affect 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. Additional adverse effects could include nutrient limitation, water temperature regulation, and loss of stream connectivity. Indirect effects from reduction in habitat diversity could come from predation and altered community structure. Given that most fish species collected from Bois d'Arc Creek during the Instream Flow Study are habitat generalists (with a few exceptions), no adverse effects are expected on downstream fish community 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, barring unforeseen actions by others.

The macroinvertebrate communities downstream of the impoundment should not change greatly, as long as adequate flows are maintained. Due to the probable disappearance of sensitive, narrow-range fish species (fluvial specialists), the lower sediment load, and the potential increase in erosion, adverse effects could be minor in magnitude, medium in extent, long-term, and probable. The Caddo National Grasslands is within the downstream environment of the dam. Adverse effects would be moderate in precedence and uniqueness.

Mitigation
During long-term operations, 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 shown in Table 4-11. These measures have tentatively been approved by TCEQ in the form of special conditions to the draft water use permit sent to NTMWD on November 22 (TCEQ, 2014).

Conclusion
Impacts of the Proposed Action on aquatic species within the reservoir footprint would be both adverse and beneficial, short-term and long-term, of medium extent, probable likelihood, and moderate precedence. It is not possible to predict whether fish species diversity (the number of fish species) 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 the Proposed Action 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 within the creek.

4.7.2.4 Threatened and Endangered Species

Dam and Reservoir Construction
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 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 (Table 3-26). However, the project site contains no nesting sites for the interior least tern and limited foraging habitat for interior least terns and bald eagles, and while potential habitat for black bears does occur within the reservoir footprint, none have ever been documented on site.

Direct adverse impacts to the bald eagle would not be anticipated. The bald eagle prefers to nest in big, exposed trees adjacent to large water bodies. The project site contains no nesting and limited foraging habitat in the proposed reservoir site in Fannin County (Freese and Nichols, 2008a). The reservoir's expected fish population would be a food source and potentially furnish opportunistic foraging opportunities for any bald eagles in the area.

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 construction of the dam and reservoir. While potential habitat is present for the black bear only one siting has occurred in Fannin County, back in 1977. Also preferred habitat of the black bear is consists of expansive forests with escape cover and minimal human disturbance. Though there is little undeveloped 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 site (TPWD, 2014) identifies 18 state threatened and endangered animal species (seven birds, two mammals, five fish, three reptiles, and one insect) as potentially occurring in Fannin County, Texas. See Table 3-27 for a list of these species. Section 3.5.5.2 contains a brief description of the preferred habitats of all state- listed species within Fannin and Lamar Counties.

While the majority of the species do not have suitable habitat on the proposed site, the blackside darter, blue sucker, creek chubsucker, and 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 Texas state threatened blackside darter, blue sucker, creek chubsucker, and 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, the rattlesnake could potentially occur. Potential adverse effects to all these species would be moderate in magnitude, medium in extent, long-term in duration, and unlikely.

Raw Water Transmission Facilities

No adverse impacts to threatened and endangered species would be anticipated from construction of the raw water transmission facilities. The pipeline route would be built primarily across agricultural areas. This area has been previously disturbed and does not have suitable habitat for the interior least tern. This land cover lacks suitable habitat for the state and federal threatened and endangered species.

Proposed Water Treatment Plant and Terminal Storage Reservoir

Similar to the discussion under raw water transmission facilities above, no adverse impacts to threatened and endangered species would be anticipated from construction of the North WTP and TSR near Leonard. Both the project site and surrounding properties are used mostly for livestock grazing and hay production. There were some wooded areas along riparian corridors and fence lines. This area has been previously disturbed and does not have suitable habitat for the interior least tern. This land cover lacks suitable habitat for the state and federal threatened and endangered species.

FM 1396 Relocation and New Bridge Construction

FM 1396 construction would occur on existing road right-of-way on upland sites and construction of the new bridge over the reservoir would occur prior to impoundment, so direct effects on state-threatened fish species and the canebrake rattler would be avoided. Any possible indirect effects on these species from water pollution (turbidity and sedimentation) would be minimized by implementing the SWPPP.

Operation
Direct adverse effects of dam and reservoir operation on threatened and endangered species are not anticipated. As in the case of construction of the proposed dam and reservoir, threatened and endangered species would not occur in the project area as a result of operation of the proposed reservoir. One possible indirect effect could hypothetically occur in the case of federally endangered interior least terns which nest on sandbars in the Red River downstream of the project. However, this effect is considered unlikely because the flow reduction in the Red River from diverting much of the incoming flow of Bois d'Arc Creek would be relatively minor.

Mitigation
No mitigation measures beyond the SWPPP and Construction General Permit are proposed or necessary.

Conclusion
Little or no impacts are anticipated on federal or state-listed species as a result of the Proposed Action and connected actions. While some effects cannot be entirely ruled out, due to tendency of wildlife to move, migrate, and expand ranges over time, or to appear accidentally and unexpectedly at a given site for some time (especially in the case of the most mobile of vertebrates – the birds), any impacts are likely to be of minor magnitude, short-term, and localized.

4.8 RECREATION

4.8.1 No Action Alternative

If the Proposed Action were not enacted, there would be little to no direct impacts on existing recreation facilities, opportunities, types and levels. Private recreation would continue, and public recreation in the Caddo National Grasslands and other nearby public recreation lands would continue in about its current state. There would be no beneficial increase in recreation opportunities. It is likely that as the population of the region grows, demand for recreation would also increase, and this demand would increase pressure on existing recreational facilities and opportunities within the region, which could degrade the quality of the facilities and of the recreation experience. This impact is difficult to predict with any precision, as other reservoirs may be developed in the region to meet growing water needs. Furthermore, without the Proposed Action, the county and regional population may not grow as swiftly as it would with the Proposed Action.

Overall, the impacts on recreation in the No Action Alternative would be minor, slight, medium in extent, long-term and possible. Therefore, these impacts would not be significant.

Conclusion
Under the No Action Alternative, no changes would occur to existing public or private recreation areas in this region. Increased pressure on recreation areas due to a larger population may impact the quality of or access to existing recreation areas in the future.

4.8.2 Proposed Action

4.8.2.1 Construction

The dam and reservoir construction could disturb existing recreational opportunities. During this period of time, between 2-3 years, existing recreation on private land in and near the reservoir footprint, such as hunting, fishing, wildlife viewing, or boating/canoeing, would likely be degraded in quality, safety, and access. Clearing and grading of land as well as the construction of access roads would result in runoff and displacement of wildlife, which could limit hunting and fishing. Facility construction could also result in soil compaction, which could result in runoff and water degradation. Dam structure construction would require excavating soils to bedrock and stockpiling soils which could increase erosion and degrade water quality locally. However, degradation of water quality is not allowed under a storm water permit, which the project is required to have. Compliance with the Construction General Permit, SWPPP, and all local, state and federal permits would limit water degradation.

However, these impacts to recreation from construction can be expected to be temporary or short-term, as the land would be restored and new recreation opportunities are likely to arise after the construction period. Overall, the short-term impacts to existing recreation from construction activities are likely to be adverse, of minor to moderate magnitude, medium (localized) extent, probable, and slight to moderate precedence.

Caddo National Grasslands and its recreation sites (lakes, campgrounds, etc.) are close enough to the reservoir construction site that Caddo visitors and recreational users may experience direct or indirect adverse impacts from noise, air pollution (dust), heavy truck traffic, and other environmental stressors. In addition, a temporary increase in the local population due to the presence of the construction workforce may place additional recreation pressure on the Grasslands.

4.8.2.2 Operations

The Proposed Action would create a new, 16,641-acre water supply reservoir that could also potentially serve as a major new outdoor recreation asset for Fannin County and the region, as do most other water supply reservoirs in Texas and elsewhere. Concerns were raised during EIS scoping about whether the water level and shoreline of the new lake would fluctuate significantly. Since the primary purpose of the reservoir is water supply, not lake-based recreation, maintaining a constant shoreline is not its highest priority and there would be a degree of fluctuation, with shorelines receding most prominently in the late summer and fall as the water level in the reservoir drops below 534 ft msl. The horizontal distance this represents would be greatest towards the upstream end of the reservoir (see Figure 4-4). However, even when filled to only 50 percent of capacity – and it would be at least this full 80-90% of the time – the majority of the lake surface area would still be inundated with water deep enough that it would be usable by fishing boats and other permitted watercraft. Moreover, some facilities such as docks, ramps, small marinas, and any designated swimming areas – the specific locations of which have not yet been sited – likely would be located towards the deeper, downstream end of the lake precisely to avoid the problem of being unusable during times of drought. Therefore, it is unlikely that fluctuation of the water level would substantially compromise recreational facilities and opportunities on the new lake that would result under the Proposed Action.

Water level fluctuation varies at existing lakes/reservoirs in nearby counties. Lakes Texoma, Tawakoni, Lavon and Cooper all experience considerable fluctuation in water level and shoreline. Despite this, each of these lakes supports a robust number of recreationists and recreation developments, such as motels and other accommodations and businesses associated with fishing and boating.

The majority of the other lakes in Table 3-28 experience moderate fluctuation. Other lakes that did not have complete data sets available, such as Bonham City Lake, Big Creek Reservoir, Coffee Mill Lake, Davy Crockett Lake and Lake Crook all experience moderate fluctuation, except for Coffee Mill Lake, which experiences very little. Despite this classification of moderate fluctuation (which is generally defined as 2-4 feet), recreational opportunities exist on each lake and all lakes experience non-local recreational visitors who contribute to the local economy.

While the primary purpose of the Lower Bois d'Arc Creek Reservoir would not be recreation, and the lake would be owned and managed by the NTMWD rather than the Army Corps of Engineers or Texas Parks and Wildlife, recreation opportunities are likely to arise at the lake, based on the experience of nearby reservoirs. At this time, NTMWD has committed to work with Fannin County officials in developing recreation facilities for the proposed reservoir. In particular NTMWD has suggested that the abandoned FM1396 roadway be left in place with the sections adjacent to inundated areas of the reservoir serving as boat ramps. If the reservoir is permitted, additional discussions with Fannin County officials regarding recreation opportunities are expected during the final planning and design stage prior to construction. Based on the available data from nearby lakes, it can be reasonably predicted that if recreation facilities such as boat ramps, fishing docks, picnic areas and campgrounds are developed at the lake, the lake is likely to become a source of recreational activities in the area.

Fishing and hunting are an important aspect of recreational activities in Fannin County. The biological analysis has indicated that the reservoir should be able to support high-quality recreational fishing, including species such as smallmouth buffalo, yellow bullhead, channel catfish, green sunfish, warmouth, bluegill, longear sunfish, redear sunfish, largemouth bass, and white crappie. Additionally, many nearby lakes and reservoirs stock their lakes with game fish. This option could be considered if local or state authorities (TPWD) or NTMWD decide to develop recreational opportunities at the proposed site.

The previous discussion under this section concerns the potential for recreational benefits represented by the Proposed Action. A possible adverse impact, but one which can be mitigated, concerns the Legacy Ridge Country Club in Bonham (Figure 4-13). Its owner has expressed concern that a major flood with the reservoir in place would back up waters along Bois d'Arc Creek at Hwy. 82 and damage the Club's golf course. While partially protected by berms, part of the course is below the 100-year flood plain level (without the reservoir) at 541 ft MSL and the NTMWD easement elevation of 545 ft MSL. Some areas inside the berm along the creek are below elevation 534 ft MSL. Analyses indicate that while parts of the golf course are currently inundated during flood events, the presence of the reservoir may increase the length of time the golf course is flooded. If flood waters were to reach the golf course, this recreational

Figure 4-13. Legacy Ridge Country Club golf course sign

resource could be temporarily damaged. The golf course is concerned with NTMWD buying only to elevation 541 ft MSL as this would leave them owning greens areas that are located above elevation 541 but the lower areas, which would be owned by NTMWD, could be inundated during flood events. This would render the use of several holes useless when flooding occurred. The NTMWD is working with the golf course to mitigate the impacts, if any, to the golf course from the project. Overall, this possible impact to the Legacy Ridge Country Club is possible, minor to moderate in magnitude, long-term, small in extent and minor in precedence.

4.8.2.3 Other Sites

NTMWD has purchased and proposes to restore and enhance natural habitats at the 15,000-acre Riverby Ranch in order to mitigate the impacts to waters of the United States. This land, which is currently used for grazing and crop production (Figure 4-14) and has no public recreation value, is proposed to be transferred to a third party and managed for conservation and recreation. This action would enhance the quality of recreation activities of the Grasslands, potentially including hunting, fishing, hiking, camping, horseback riding, wildlife viewing, photography and mountain biking. Current wildlife include white-tailed deer, small mammals, coyotes, bobcats, red fox, waterfowl, bobwhite quail, turkey and songbirds, all of which are likely to benefit from an increase in more natural habitats. It is likely that as these 15,000 acres of habitat are restored, recreational opportunities, including hunting and wildlife viewing, would all increase.

Figure 4-14. Grazing livestock and degraded water resources at Riverby Ranch

The Lower Bois d'Arc Creek Reservoir is not likely to directly affect the recreational opportunities at lakes within the Caddo Grasslands, because the reservoir is not directly upstream from these lakes. The biological or hydrological characteristics of these lakes or other areas within the Grassland that make it a recreational destination are not predicted to be altered. Stream flow in Bois d'Arc Creek would be altered by the project, both within the reservoir footprint and downstream of the dam. Flooding along the bottomlands of Bois d'Arc Creek through the Grasslands is expected to be less frequent.

Currently, there are a variety of water-related recreational opportunities in the affected environment area, from the lakes listed in Table 3-29, to the Caddo National Grasslands, to other, smaller lakes and private recreation areas. The addition of another reservoir with the potential for recreation could impact recreation in the area by providing more recreational opportunities than there is need or desire for. If recreational facilities are developed at the proposed site, it could possibly draw recreational users away from the Caddo National Grasslands, or other lakes such as Bonham State Park. However, since the purpose of the Proposed Action is to provide water for a regional population that is expected to grow dramatically (see Section1.1), it is also likely that this growing population would have a commensurately growing need for recreational opportunities. Assuming the population of the region continues to grow at the projected rate, it is unlikely that the addition of the LBCR would result in increasing recreation availability beyond the needs of the market.

Overall, it is highly probable that impacts to public recreation after construction of the dam, development of recreation facilities (if appropriate authorities choose to do so) and restoration of habitat in Riverby Ranch would be beneficial. These impacts are likely to be moderate in magnitude and precedence, long-term and medium to large in extent. Overall, these impacts would be moderately significant and beneficial. If authorities chose not to develop recreation facilities, beneficial impacts to public recreation would still exist due to the Riverby Ranch restoration and recreation in the reservoir that does not require facilities. However, it is possible that these impacts would then be minor in magnitude, and small in extent.

4.8.2.4 Conclusion

The Proposed Action would cause a variety of different impacts on recreation in the vicinity. It is probable that construction of the reservoir would have minor to moderate, short-term adverse impacts. These impacts would be limited to a small extent.

Recreational opportunities at the proposed site after construction are likely to be moderately beneficial, long term and medium to large in extent. The likelihood of this kind of impact is possible to probable. Therefore, the impact of this project on recreational opportunities at the site would probably be moderately significant and beneficial.

Infrequent minor to moderate adverse impacts may occur to the golf course at the Legacy Ridge Country Club. Impacts on other public recreational areas are unlikely, but could be minor, long term, of medium extent and slight to moderate precedence. Therefore, impacts to other recreational areas are likely to not be significant.

4.9 VISUAL RESOURCES

The visual resources analysis stage involves determining the significance of the potential visual impacts from the proposed activity. The significance definitions that are used to describe the impacts to the visual setting are described in Table 4-20. The ROI is the viewshed of the proposed LBCR reservoir.

The BLM Visual Resource Management (VRM) process has been completed as it was introduced in the visual resources affected environment Section 3.7. The second step, known as the analysis stage in the VRM is a visual contrast rating process. The visual contrast rating involves comparing the project features with the major features in the existing landscape using the basic design elements of form, line, color, and texture (BLM, no date-b). Table 4-21 outlines the criteria for the contrast rating process which are used in this analysis.

Table 4-20. Significance definitions, impacts to visual resources

Term	Definition
Magnitude	
Major	A modification, which is dominant in the landscape and demands attention.
Moderate	A modification, which attracts attention, but is not dominant.
Minor	A modification, which can be seen, but does not attract attention.
Duration	
Long-term	Alteration lasts 20 years or more
Medium-term (limited or intermittent)	Alteration lasts 5 to 10 years
Short-term	Alteration lasts less than 5 years
Extent	
Large	Visual quality is altered for more than 1,000 people
Medium (localized)	Visual quality is altered for 100 to 1,000 people
Small (limited)	Visual quality is altered for less than 100 people
Likelihood	
Probable	Occurs under typical operating conditions
Possible	Occurs under worst-case operating conditions
Unlikely	Occurs under upset/malfunction conditions

Table 4-21. Significance criteria, impacts to visual resources (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.

4.9.1 No Action Alternative

Under the No Action Alternative, the reservoir and dam would not be constructed. Therefore the visual aesthetics 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 vicinity. However, if population grows and development proceeds in tandem, the Bois d'Arc Valley may lose some of its existing rural appearance, in which open space is dominant.

4.9.2 Proposed Action

4.9.2.1 Construction

The impacts of dam and reservoir construction to visual aesthetics would be expected to be major in magnitude, short term, medium in extent, and probable. The dam would be constructed to a length of 10,400 feet with a maximum height of 90 feet. Due to the height of the dam to be built, the viewshed of visitors to the Caddo National Grasslands and travelers on FM 1396 would be affected during construction of the dam. The tree clearing for the reservoir construction would happen prior to 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; tree clearing would only happen in select areas of the proposed reservoir, mostly along the existing creek. Travelers along County Road 2945 would be most affected by the tree clearing.

4.9.2.2 Operation

The impacts of the dam and reservoir operation would be expected to be major in magnitude, long term, large in extent, and probable. Based on the sheer size of the reservoir (16,641 acres), the size of the dam (10, 400 feet long, and 90 feet high), and the complete change in land use it is evident that the Visual Resource Contrast Rating is 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 significantly due to the proposed action. In Section 3.7.2 the affected environment was described according to VRM as having Class III and IV inventory values. That is to say they are of the least to moderate scenic value.

The reservoir area was broken into three scenic quality rating units (SQRU's). Two of the units had ratings of Class IV, and the unit which included the Lower Bois d'Arc Creek received a rating of Class III primarily due to the presence of water. According to BLM's standards, an area with a Class III rating would be allowed a moderate change to the landscape, and a Class IV rating would be allowed a high level of change to the landscape. Since the area within the Class III zone would still retain the water aspect, the Proposed Action is within the VRM standards of change. The three SQRU's described in Chapter 3, the creek and wetlands, forested area, and cropland/grassland, would all switch to a lentic or lake environment.

An aerial view of the existing landscape is seen in Figure 4-15, and an example of the type of contrast to be expected is shown in Figure 4-16. The second figure is an existing reservoir about 60 miles southwest of the proposed action shown solely for reference purposes of what a Strong contrast rating would potentially look like. Any viewer, whether a local resident looking out his or her back window, or a commuter on a nearby road, would take notice of the new lake environment. Figure 4-17 shows the areas in which the proposed reservoir and associated dam would be visible. This viewshed does not take into account tree or building screening, so it should be interpreted as a maximum viewshed; actual visibility of the reservoir from a given site would depend on the presence or absence of highly site-specific screening.

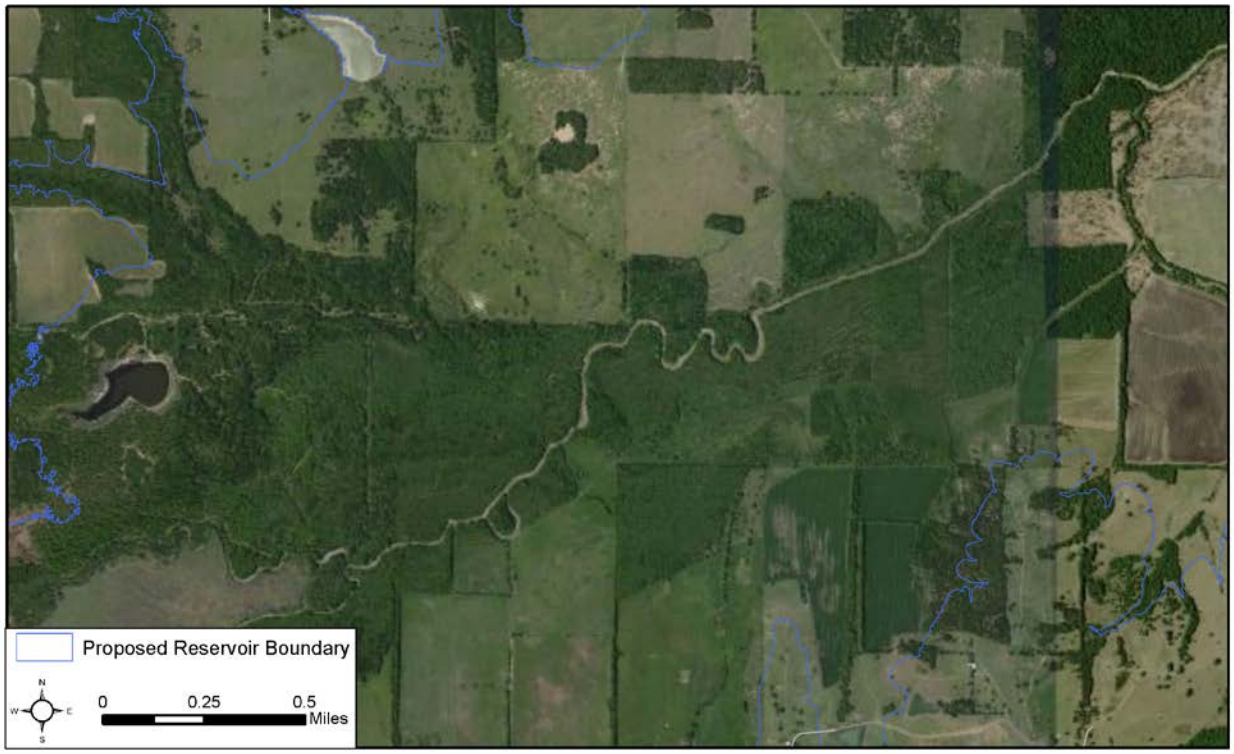


Figure 4-15. Aerial imagery of a portion of the proposed Reservoir (ESRI, 2010)

Figure 4-16. Aerial imagery of a portion of nearby Lake Ray Roberts (ESRI, 2010)

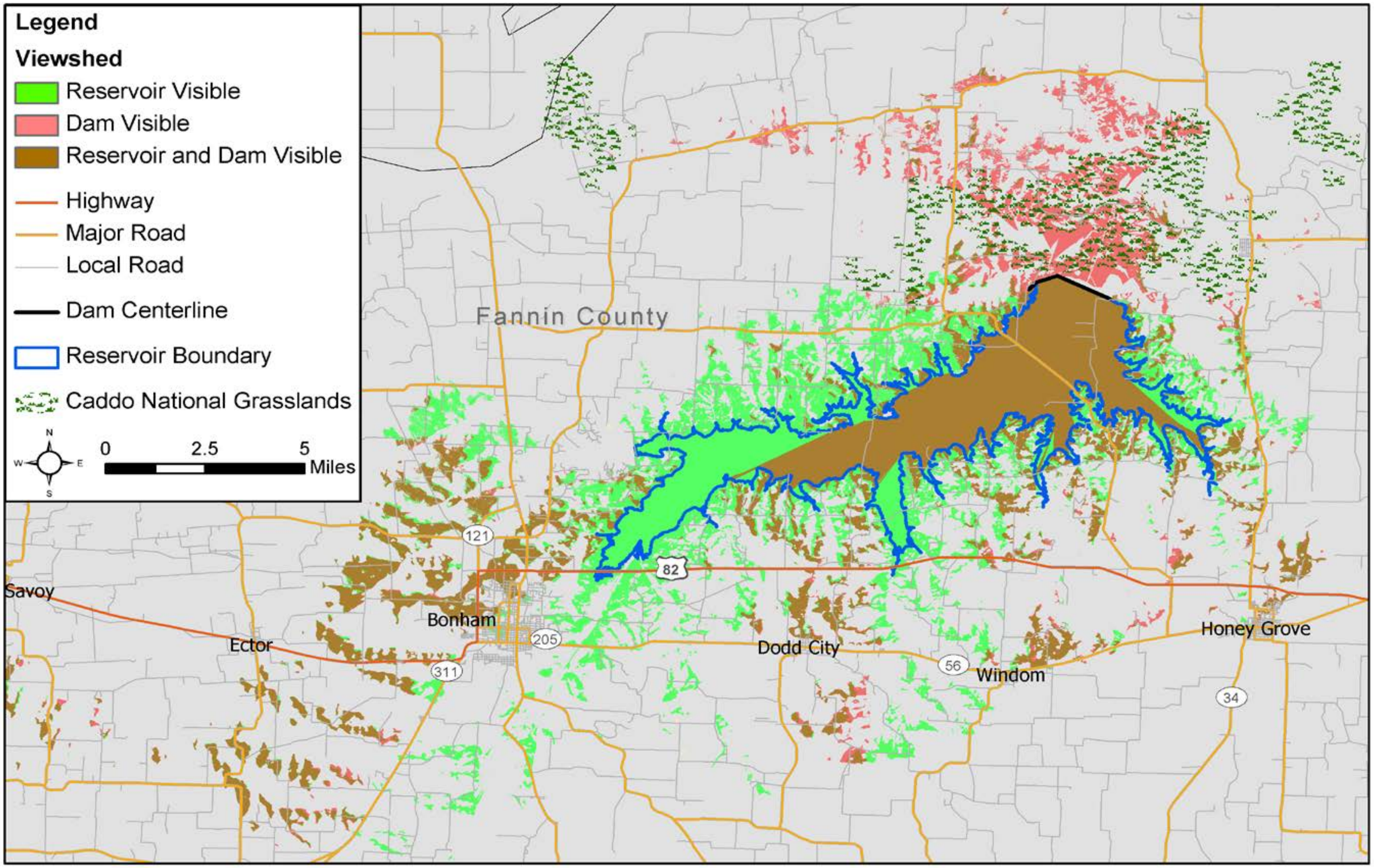


Figure 4-17. Viewshed of the proposed reservoir and dam (ESRI, 2010 and USGS, 2009)

4.9.2.3 Conclusion

Due to its size and salience, the Proposed Action (in particular, dam and reservoir construction and operation) would have a major, long-term impact on visual resources, but 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 in question. Some individuals would regard the permanent elimination of gently rolling pastoral scenery along Lower 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 on the landscape as an aesthetic asset to the community. Many members of the public would appreciate both the aesthetic loss and the aesthetic gain.

4.10 LAND USE

The ROI for land use is Fannin County.

4.10.1 No Action Alternative

The No Action Alternative would consist of not constructing Lower Bois d'Arc Creek Reservoir on the projected site. Under this alternative, the present trends in land use change 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 Metroplex and Fannin County increase over the decades. This 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 would likely occur within and in proximity to the City of Bonham, located approximately one mile to the west-southwest of the upper end of the project site. Land use change in the proximity of the proposed project site is expected to be minimal. There may be some additional development in the projected area as the result of suburban sprawl and 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.

4.10.2 Proposed Action

4.10.2.1 Dam and Reservoir

The LBCR would cover over 16,526 acres of forest, crop, and ranch land. Also, an additional 5,574 acres around the perimeter would be obtained for the flood pool. However, while this additional acreage is permanently "obtained" as a flood easement, it would be only temporarily and infrequently inundated. Thus, only the 16,526 acres would be unusable for terrestrial wildlife. The acreage between 534 and 545 ft. msl would be available for wildlife. In terms of agricultural purposes, most of the 22,100 acres of lands would be rendered unusable for current or future agricultural use. The land that would be inundated also contains about a dozen homes or residential properties. These residential areas are only a minor portion of the proposed reservoir site.

An additional area at the Riverby Ranch would be set aside as mitigation for the impacts caused by the reservoir, changing from ranching agriculture to conservation and habitat restoration. Impacts of the Proposed Action Alternative are thus expected to be major in magnitude, long term, direct, medium in extent, probable, and moderate in precedence and uniqueness. Whether or not these long-term, indeed permanent, changes in land use of major magnitude are considered adverse or beneficial – or both – depends on the particular interests and values of the observer.

4.10.2.2 Raw Water Transmission Facilities

Pipelines associated with the 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. While future construction would be limited within the right-of-way easement, land uses such as farming could continue directly above the buried pipeline itself.

Overall, the effects on land use of the raw water transmission facilities associated with the Proposed Action would be adverse, minor, long-term, of large extent (approximately 35 miles in length), and slight precedence.

4.10.2.3 Water Treatment Plant, Terminal Storage Reservoir, and Related Facilities

The construction and operation of the WTP (including plant access and parking areas) and TSR near Leonard is unlikely to precipitate any further changes in land use in that area.

4.10.2.4 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 LBCR.

4.10.2.5 Reservoir Operations

Effects on land use from the operational phase of the Proposed Action Alternative are expected to be major in magnitude, long term, direct, medium in extent, probable, and slight to moderate in precedence and uniqueness. Once construction of the dam is completed, this alternative could well serve as a catalyst, possibly 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 in turn possibly result in the sale and subdivision of agricultural lands as these are converted 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 and suburban or exurban sprawl as developers begin to move to outlying areas of the county. 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.

It should be stressed that as the 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 Proposed Action, that is, without the new reservoir. However, the presence of the reservoir is likely to accelerate this background trend, especially if and when it is developed for its recreational and amenity potential, which is highly likely.

Recreational land use such as parks and golf courses could result from the construction of the lake due to the resulting scenic and recreational opportunities that the reservoir creates. 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 future 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.

4.10.2.6 Mitigation

Neither the NTMWD nor the USACE have land use planning authority in the vicinity of the proposed LBCR. However, Sentate 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 Reserveroir 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:

1. height, number of stories, and size of buildings & other structures;
2. percentage of a lot that may be occupied;
3. size of yards, courts, & other open spaces;
4. population density;
5. location & use of buildings, other structures, & land for business, industrial, residential, or other purposes;
6. placement of water & sewage facilities, parks, & other public requirements.

When and if the Lower Bois d'Arc Creek Reservoir is constructed, the Fannin County government now possesses the authority to regulate land use in its vicinity (for almost a mile around the reservoir perimeter) in the public interest. To date the County has yet to act on this authority, but it has not yet had reason to.

4.11 UTILITIES

The ROI for utilities is the reservoir footprint itself.

4.11.1 No Action Alternative

The No Action Alternative does not provide the needed water supply for NTMWD's members and customers. The projected shortage by 2060 without any additional water supply projects is about 368,000 acre-feet per year, of which the LBCR would supply more than one-third, or the needs of nearly half a million residential consumers.

Thus, in terms of utilities, the No Action Alternative would be expected to be adverse, major in magnitude, long-term, direct, medium in extent, probable, and slight in precedence and uniqueness to the NTMWD service area.

Under the No Action Alternative, existing power lines would remain in place with no impacts or need for relocation. Their use would continue at current levels.

4.11.2 Proposed Action

The construction of the Lower Bois d'Arc Creek Reservoir is the recommended approach for NTMWD to provide additional mid-term water supply. The NTMWD is projected to have water shortages of 368,000 acre-feet per year by 2060. The growth in the economy would create a demand for new publically-provided services. This in turn would include electrical service and infrastructure, roads, water supply infrastructure and services, public safety, schools, and other municipal services that the local jurisdictions and companies would have to provide.

4.11.2.1 **Construction**

The overhead power lines that run within the vicinity of the proposed reservoir site would have to be raised or removed and relocated before the reservoir is filled. There would also be demolition of infrastructure in the footprint of the reservoir site as well as the construction of related infrastructure within Fannin County. Impact of construction on utilities would be adverse, minor to moderate in magnitude, short term, direct, small to medium in extent, possible, and slight in precedence and uniqueness to the power supply in Fannin County.

4.11.2.2 **Reservoir Operation**

Locally, operation of the reservoir under the Proposed Action would be expected to have a moderately adverse impact on utilities, which would be indirect, long-term in duration, medium in extent, possible in likelihood, and moderate in precedence and uniqueness. As a result of the potential increase in development that could be caused by the reservoir, the demand for publicly-provided utility services would increase. Indirect impacts from the construction of a large reservoir in Fannin County would also possibly include the conversion of adjacent and nearby undeveloped areas to developed areas. Development of these areas would likely include large, single family residential areas, commercial uses such as retail centers to support the single family residential areas and water based land use types such as marinas.

The development of infrastructure to support this increase in population would occur over a 30-year period (NTMWD, 2010a). In addition, recreational areas such as parks and golf courses would likely result from the construction of the lake and the resulting scenic and recreational opportunities created. This development, in turn, would create a demand for increased infrastructure, such as additional improved roads and utilities, schools, churches and other amenities. One of the most critical factors would be the extent to which counties, cities, and towns would adopt well-reasoned development plans to promote quality growth while also ensuring that infrastructure development and publicly-provided services keep pace with new demand.

Regionally, the Proposed Action would be expected to be beneficial, indirect, long-term in duration, medium to large in extent, possible in likelihood, and moderate in precedence and uniqueness. Construction of the Lower Bois d'Arc Creek Reservoir would help ensure that future water needs of the NTMWD region are met. After the reservoir is completed, treated surface water would be provided from the reservoir to present and future NTMWD customers (NTMWD, 2007). NTMWD currently uses multiple sources of water, including Lake Lavon, Lake Texoma, Lake Chapman, Lake Tawakoni, reuse, and interim supplies. NTMWD would optimize its water supplies by operating the Lower Bois d'Arc Creek Reservoir 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 Lower Bois d'Arc Creek Reservoir. However, over time, new electric supply to meet population growth would also be necessary.

4.12 TRANSPORTATION

The ROI for transportation is the reservoir footprint itself and the surrounding areas of Fannin County.

4.12.1 No Action Alternative

Under the No Action Alternative, the acquisition and use of additional land to support the NTMWD Proposed Action would not occur. No impacts to transportation resources would occur as there would be no change in traffic on the roadways, no road closures or reconfigurations.

4.12.2 Proposed Action

The Proposed Action would have short-term minor and long-term moderate to major adverse effects on transportation. This section provides a discussion of the potential environmental impacts to transportation resources that would result from the Proposed Action. Impacts were primarily assessed by reviewing existing traffic conditions of public roadways and the types/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. The Proposed Action would have a no impacts to regional airports and passenger rail services.

4.12.2.1 Reservoir and Dam

Construction
Construction of the dam and clearing of the reservoir area would have short-term minor adverse effects on transportation and traffic. Congestion would increase in the immediate area due to additional vehicles and traffic delays near the site. However, given that roads (in particular FM 1396) would ultimately be closed or rerouted these effects would be minor. The existing transportation infrastructure would be sufficient to support the increase in vehicle traffic and all construction vehicles would be equipped with backup alarms, two-way radios, and Slow Moving Vehicle signs when appropriate.

Operations
The establishment of the reservoir and dam would have significant short-term adverse effects on transportation and traffic. This effect would be due to the permanent closure and rerouting of traffic from some secondary and tertiary roadways in the area. NTMWD has developed a Transportation Plan (Freese and Nichols, 2011c) to provide adequate access to and across the proposed reservoir and surrounding properties; TxDOT and Fannin County authorities have been briefed on the plan and agree in concept. The Transportation Plan examined impacts to the residents while maximizing the transportation and recreational opportunities of the proposed reservoir. Information in the report includes geographic, geological, and cost data with respect to modifying the transportation network located in the proposed Lower Bois d'Arc Creek Reservoir limits. The findings are preliminary in nature and a detailed topographic survey, property survey, geotechnical investigation and design will be required to further define the proposed improvements.

The primary TxDOT road that could be impacted by the proposed reservoir is FM 1396, discussed below. In addition to FM 1396, there are 27 county roads that could be impacted by the proposed reservoir. Most of the county roads located within the reservoir footprint are shorter in length. The Transportation Plan recommends reconstructing nine crossings at a higher elevation, leaving 13 crossings in place, and closing five crossings. After completing the proposed dam, the reservoir would effectively close the secondary roadways, which up until then primarily would have serviced residents who would have relocated (Figures 4-18 and 4-19 and Table 4-22).

Motorists currently using roadways that would be closed by the proposed action would be rerouted in some fashion. Those directly impacted by the reservoir may have relocated to new areas. However, new residents around the lake would use existing roadways. This would constitute an overall increase in vehicle miles traveled in the area. Although these effects would be adverse, there would be an overall net benefit to roadway infrastructure for roads not closed by the Proposed Action. For example, the replacement for FM 1396 would be built to higher speed standards. For roadways being replaced or repaired, the effects would be beneficial when compared to existing conditions, that is, the No Action Alternative.

4.12.2.2 Raw Water Pipeline

Construction

The proposed raw water pipeline would have short-term minor adverse effects to transportation primarily due to open cut installation of segments along the pipeline corridor, workers commutes, and the 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 minor, contractors would route and schedule construction vehicles to avoid conflicts with other traffic, and strategically locate staging areas to minimize traffic impacts.

Operations

The operation of the 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. The overall conditions would remain comparable to the existing conditions. These effects would be negligible.

4.12.2.3 Water Treatment Plant and Terminal Storage Reservoir

Construction

Construction of the WTP and TSR would have short-term minor adverse effects on transportation 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 infrastructure would be sufficient to support the increase in vehicle traffic, and 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 would occur. Upon its completion, small but unnoticeable increases in traffic due to employees at the WTP would be expected.

4.12.2.4 FM 1396 Relocation and New Bridge Construction

Construction

Construction of these connected actions would have the same short-term adverse effects on transportation and traffic discussed for the actions above.

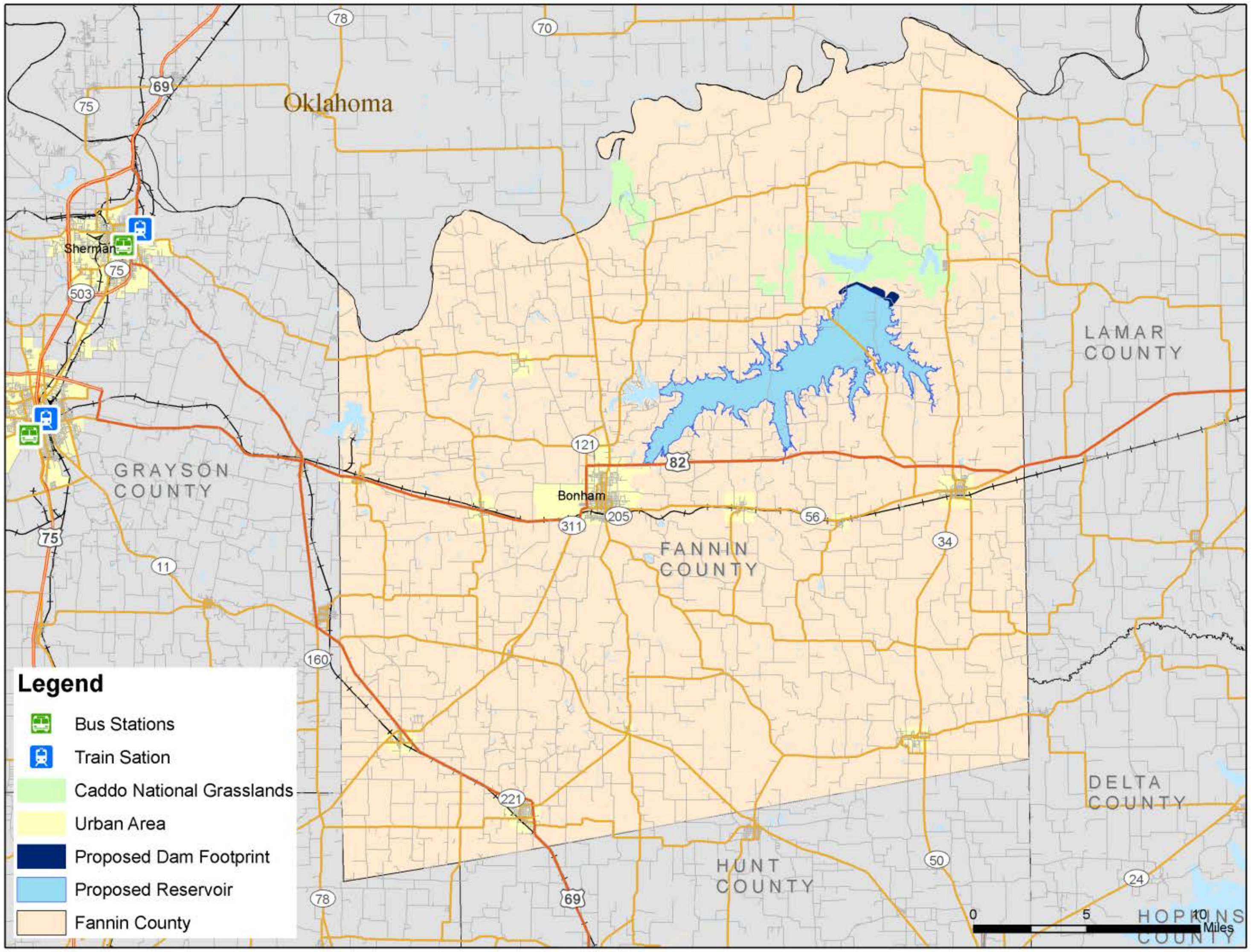
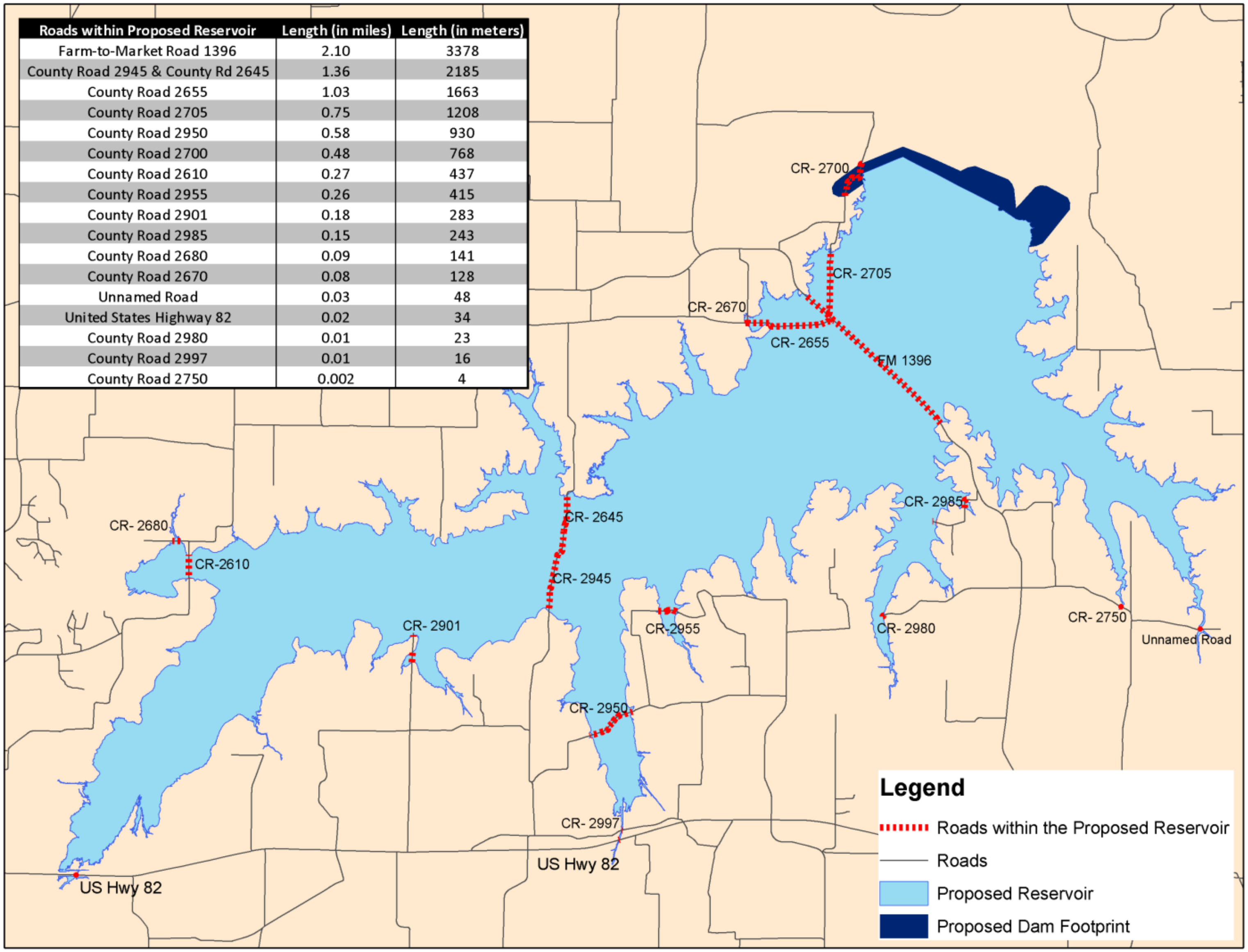


Figure 4-18. Primary roadways affected by the Proposed Action



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 4-19. Secondary roadways affected by the Proposed Action

Table 4-22. Potential effects to roadways affected by the proposed reservoir

Road Name	Crossing Name	Needed?	Crossing Type	Distance (ft)	Detour Distance (ft)	Possible Outcome
CO RD 2980	Ward Creek	Yes	Bridge	1,375	N/A	Replace/Reconstruct
CO RD 2610	Timber Creek	Yes	Bridge	1,971	1,056.00	Replace/Reconstruct
CO RD 2680	Sandy Branch	Yes	Bridge	1,400	N/A	Replace/Reconstruct
CO RD 2770	Honey Grove Creek Tributary	Yes	Bridge is out	626	N/A	Replace/Reconstruct
CO RD 2985	Unknown	Yes	Large CMP	690	N/A	Replace/Reconstruct
CO RD 2980	Yoakum Creek	Yes	Unknown	929	N/A	Replace/Reconstruct
CO RD 2900	Onslott Creek	Yes	Bridge	1,831	N/A	Replace/Reconstruct
CO RD 2610	Bois d'Arc Creek Tributary	Yes	Bridge	495	N/A	Replace/Reconstruct
CO RD 2625	Bois d'Arc Creek Tributary	Yes	2 Large CMP	1,384	N/A	Replace/Reconstruct
CO RD 2655	Edge of Water	No	N/A	852	60	Close Road
CO RD 2670	Unnamed	No	small CMP	1,049	0	Close Road
CO RD 2955	Pettigrew Branch	No	Large CMP	1,847	1553	Close Road
CO RD 2950	Bullard Creek	No	Bridge and CMP	3,538	8492	Close Road
CO RD 2917	Bullard Creek	No	Bridge	2,007	0	Close Road
CO RD 2725	Unnamed	No	bridge	95	3701	Leave in place
CO RD 2730	Honey Grove Creek Tributary	No	small crossing	517	926	Leave in place
CO RD 2745	Honey Grove Creek Tributary	No	Large CMP	540	1180	Leave in place
CO RD 2745	Bois d'Arc Creek Tributary	Yes	small crossing	101	N/A	Leave in place
FM 1396	Bois d'Arc Creek Tributary	Yes	small RCB	441	N/A	Leave in place
CO RD 2955	Unknown	No	Large CMP	1,211	2400	Leave in place
US 82	Cottonwood Creek	Yes	5 multiple RCB	661	N/A	Leave in place
US 82	Bullard Creek	Yes	Bridge	1,901	N/A	Leave in place
CO RD 2900	Burns Branch	No	Bridge	146	882	Leave in place
CO RD 2900	Onslott Creek	Yes	Large RCP	77	N/A	Leave in place
CO RD 2610	Timber Creek	Yes	RCP or CMP	220	N/A	Leave in place
CO RD 2615	Bois d'Arc Creek Tributary	No	Large CMP	376	7826	Leave in place
CO RD 2615	Bois d'Arc Creek Tributary	No	Large CMP	297	7826	Leave in place

Source: Freese and Nichols, 2011c.
Needed? = Is the roadway needed to provide access to homes or businesses? Description of the type of creek crossing
Crossing Type = Description of the type of creek crossing; Project Length = Length of road lower than elevation 542 & between flood easements
Additional Detour Distance = Additional distance driven to avoid the closed creek crossing (if crossing was removed)

Operations
FM 1396 is an existing two-lane TxDOT asphalt road located within the proposed reservoir limits. The affected portion of roadway is located northwest of the community of Honey Grove. The existing roadway and bridge lie within the proposed reservoir boundary and therefore would need to be raised or relocated as part of the proposed reservoir construction. Various options were investigated with respect to landowner impacts, cost, schedule and travel time for the relocation of FM 1396. 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.

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 CR2645. The bridge would have an elevation of 551ft. msl: 15-17 feet above the normal pool elevation of the LBCR. It should be emphasized that at this time these plans are still preliminary; final bridge elevations or lengths have not yet been determined. Safety, recreational purposes, 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).

This is the preferred alignment of FM 1396 by Fannin County, TxDOT, and NTMWD. 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.

TxDOT has requested that the new FM 897 be designed to TxDOT Farm to Market Road Standards with 120 ft. right-of-way ROW and a 70 mph design speed. TxDOT would assume maintenance of the new FM 897 extension as well as the associated bridge after they have been built. It would end maintenance on existing FM 1396 at the intersection with FM 2029 on the north side of the proposed LBCR. Fannin County would be responsible for maintenance from this point to the shoreline. On the south side, TxDOT would end maintenance on existing FM 1396 at crossing #12 and Fannin County would maintain the segment of FM 1396 from this point to the shoreline.

As connected actions to the proposed action, road relocation and bridge construction in and of themselves would entail certain environmental impacts, discussed in other sections of Chapter 4. Given the scale and location of these activities and structures, these impacts would be of short-term duration, localized extent, slight precedence, and minor magnitude.

4.12.2.5 Mitigation

Significant adverse effects to the existing transportation infrastructure would be expected if no relocations or reconstruction of existing roads and bridges were proposed, but this is not the case. By implementing the recommended transportation mitigation measures, while there would still be adverse short-term to medium-term effects, long-term effects would generally be mitigated to below the threshold of significance, if not to neutrality.

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.

4.12.2.6 Conclusion

The Proposed Action would have short-term adverse effects on transportation and traffic, of major magnitude, due to the number and length of roads requiring temporary or permanent closure and relocation. These impacts would be of medium to large extent, probable likelihood, and moderate precedence. These short-term effects would be significant.

Short-term and long-term effects to Fannin County's road network would be mixed. After completing the proposed dam, the reservoir would effectively close the secondary roadways, and motorists would be rerouted in some fashion. Although these effects would be adverse, there would be an overall net benefit to roadway infrastructure for roads not closed by the proposed action. Effects would be of minor magnitude, medium to large extent, probable likelihood, and slight precedence. Given the mitigation measures proposed to ameliorate these impacts, the long-term effects of the Proposed Action on transportation would be less than significant.

4.13 ENVIRONMENTAL CONTAMINANTS AND TOXIC WASTE

The ROI for environmental contaminants and toxic wastes is the reservoir footprint itself and areas immediately adjacent to it.

4.13.1 No Action Alternative

The limited Phase I Environmental Site Assessment described in Section 3.11 did not identify any recognized or potential environmental concerns within the project area (Freese and Nichols, 2010c). There would be no change to this status under the No Action Alternative.

4.13.2 Proposed Action

The limited Phase I ESA did not identify any recognized or potential environmental concerns in the project area. However, subsequently a local resident informed NTMWD of suspected illegal disposal and burning of tires on property already purchased by NTMWD and located within the 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. The next step was to prepare a summary report on the investigation of the site and its cleanup for submittal to TCEQ (Chambers, 2013). This report was submitted to TCEQ on Sept. 16, 2013.

No further action is expected to be necessary to properly address concerns over toxic/hazardous substances or contaminants raised posed by this site.

No adverse effects are expected from the Proposed Action with regard to environmental contaminants and toxic waste. In the future, if the proposed reservoir is constructed and operated, NTMWD, TCEQ, and perhaps other state or federal agencies would be conducting periodic assessments of water quality, so that if a source of contaminants were to become evident, it would be addressed in the appropriate manner.

4.14 SOCIOECONOMICS

This section describes potential beneficial and/or adverse impacts to output, labor income, employment, taxes, homes, and social landscape in a ROI that includes Fannin, Collin, Lamar, Hunt, and Delta counties. Impacts are categorized in terms of magnitude, duration, extent, likelihood, and precedence and uniqueness. Estimates of the economic value of the reservoir are also provided.

4.14.1 No Action Alternative

The No Action Alternative in this EIS consists specifically of not building and operating the reservoir. Since the NTMWD does not have a predictable back-up option to pursue if the Tulsa District denies the Section 404 permit for the Lower Bois d'Arc Creek Reservoir, the water deficits would ultimately remain unaddressed. The NTMWD would continue to plan and implement other strategies to meet the growing water demand, like increasing water conservation efforts and strategies, tapping existing water sources owned by other water purveyors, and expanding the state water reuse program. Conservation is by far the most economical, least expensive, and most feasible water supply strategy identified when compared to all other strategies. However, even if target conservation and reuse goals are successfully met, allowing the NTMWD to extend current water supplies, these strategies alone will not be sufficient to support the expected rapid growth of the NTMWD service area (NTMWD, 2007a).

In the absence of the proposed project, the population projections for the six counties may not materialize to the fullest. 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. The populations of Lamar and Delta are projected to grow by about 50 percent. NTMWD supplied 268 million gallons of water daily (mgd) in 2006 to the region it serves. By 2020, the water demand would increase to an estimated 431 mgd (NTMWD, 2007a). While Grayson and Lamar are included in the defined ROI, the NTMWD does not supply water to these two counties. The No Action Alternative could affect these counties in the form of foregone indirect economic benefits. Neither water supply nor projected population growth would be directly affected under this alternative.

According to the NTMWD "an ample, dependable water supply is essential to economic stability and growth (NTMWD, 2007a)." The Texas Comptroller of Public Accounts, citing the 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 construction and operation of the dam would not take place. Further, the real estate and business development around the reservoir would not occur.

The No Action Alternative would potentially create impacts of moderate magnitude in the short-term since currently the area's water needs are 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. The extent of impacts would be large and reach the nine counties to which the NTMWD supplies water, four of which are contained within the ROI. The likelihood of impacts would be probable, since projected population is based on trends, though these trends could decrease in rate without the ample provision of water. The precedence and uniqueness of the impact would be moderate since the economic impacts would be uncertain and the decision would be controversial.

Over the long term, the No Action Alternative would have adverse socioeconomic impacts of major magnitude, large (multi-county) extent, probable likelihood, and moderate to severe precedence. In sum, these adverse socioeconomic impacts would be significant.

4.14.2 Proposed Action

The primary purpose of the Lower Bois d'Arc Creek Reservoir is drinking water supply. The Lower Bois d'Arc Creek Reservoir would provide a 16,641-acre water supply reservoir for NTMWD and would produce an estimated firm yield of 126,200 acre-feet of water per year. The project has been studied previously for the Red River Authority and the NTMWD (Freese and Nichols, 1984 and 1996). 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 Lower Bois d'Arc Creek Reservoir 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 Lower Bois d'Arc Creek Reservoir" (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).

Dam and reservoir construction expenditures are estimated at $112 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. Additionally, related infrastructure including a water treatment plant, storage reservoirs, transport pipeline, water intake pump station, and other facilities would cost about $293 million. The latter figure would include future planned expansions of the water treatment plant. Total expenditures for the Lower Bois d'Arc Creek Reservoir and related infrastructure would be between $385 and $426 million over a five year period (Table 4-23). These are "one-time" costs without likelihood of persistent economic impacts over the life of the reservoir.

It is anticipated that land acquisition for the reservoir and related mitigation areas would cost about $75.2 million. Property owners in the impoundment area and the additional acreage that may be set aside for flood easements would be compensated. In addition to the inundation area, the Riverby Ranch has been acquired by NTMWD to serve as proposed environmental mitigation for the reservoir. Prior to acquisition, this property had an appraised value of slightly more than $4 million, including improvements, and generated just under $78,000 per year in total property taxes. This estimate represents taxable values and not market values. The assessed values are net of agricultural and homestead exemptions, and it is assumed that any exemptions would continue after the reservoir land purchase (Clower, 2012).

Dam maintenance and operation includes things like controlling vegetation, livestock, and animals; systematic and frequent inspections; repairs as needed; and mechanical and electrical maintenance (TCEQ, 2006). Annual maintenance and operation would cost approximately $3.67 million. Operation and Maintenance (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: 1% of the construction costs for the pipeline; 1.5% for dams; 2.5% 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 $4.57 million annually. Other financial costs like annual debt payments and amortization are discussed in greater detail below in Section 4.14.2.2 on Financing Costs.

Table 4-23. Project cost estimates

Description	Cost
PRE-CONSTRUCTION	
Engineering Fees	$60,415,671
Permitting/Water Right Fees/Notices	$1,803,500
Land Acquisition (not incl. terminal storage)	$69,300,000
Mitigation	$93,155,563
CONSTRUCTION	
Dam and Reservoir Construction Costs	$72,303,400
Conflicts	$47,708,900
North Water Treatment Plant	
TRANSMISSION FACILITIES	
Pipeline	$152,683,500
Intake Pump Station	$42,377,100
Terminal Storage	$12,650,000
TOTAL COST	**$552,397,634**
ANNUAL COSTS*	
Debt Service (6% for 30 years)	$40,131,087
Electricity ($0.09 per kilowatt hour (kWh)	$4,573,000
Operation and Maintenance	$3,670,814
TOTAL ANNUAL COST	**$48,374,901**
UNIT COSTS (Before Amortization)*	
Per Acre-Foot	$347.08
Per 1,000 Gallons	$1.07
UNIT COSTS (After Amortization)*	
Per Acre-Foot	$69*
Per 1,000 Gallons	$0.21*

Source: Freese and Nichols, 2012.
*Figures based on a 126,200 acre-feet/year yield, $328 million balance, 30-year term, and 6% interest rate.

4.14.2.1 Short- and Long-Term Expenditures

Expenditures can be either short-term 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 take three to five years. Short-term expenditures are terminated after the initial outlay or net investment.

Long-term expenditures recur over time and consist primarily of maintenance and operations of those items built with the short-term expenditures. Dam operations and maintenance costs would recur annually and persist over the life of the dam, including storage and treatment facilities. The categories of expenditures and their term are shown in Table 4-24.

Table 4-24. Short- and long-term expenditures

Expenditures	Term
Dam Construction, Pipeline Construction, Pump Station, and Other Infrastructure	4-5 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

4.14.2.2 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 NTMWD.

NTMWD would plan, finance, build, and operate the reservoir coordinating with local, state and federal authorities, including the City of Bonham, Fannin County, Texas Water Development Board, Texas Commission on Environmental Quality, Texas Parks and Wildlife, and the U.S. Army Corps of Engineers, 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 Reservoir (NTMWD, 2009b).

Based on the most recent Freese and Nichols estimated project cost figures, raw water from LBCR would be $1.07 per thousand gallons. The cost per thousand gallons is derived as follows. The probable total cost is $552,397,634. The components of this cost are displayed in Table 4-23. 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 $40.1 million assuming 30 years of payments at six percent interest. This annual debt payment also assumes one bond issuance for $552,397,634. The annual operation and maintenance cost (O&M) is $3,670,814, and the sum of the annual debt payment and O&M is $43,801,901. Based on the reservoir's estimated yield of 126,200 acre-feet per year, the estimated total cost of debt and O&M would be $347.08 per acre-foot of water, which equates to $1.07 per thousand gallons (Table 4-23).

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 $1.07 per thousand gallons. After amortization, water would drop to $0.21 per thousand gallons. 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 6 percent higher than existing rates (NTMWD, 2007a).

Since the NTMWD would be the owner of the reservoir, there would not be a contract price for the water (NTMWD, 2007b). 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 $1.33 per thousand gallons. After amortization, water would drop to $0.21 per thousand gallons (figures based on a yield of 126,000 acre-feet/year instead of the current plan of 126,200 acre-feet/year). 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 6 percent higher than existing rates (NTMWD, 2007a).

The NTMWD 2010-2011 Comprehensive Financial Report indicates that the NTMWD May 2011 Water Rate Projections included funding for a $350 million bond issue in 2014 and a $450 million bond issue in 2019 for construction of the reservoir. Since the bonds are planned to be issued pursuant to two separate bond resolutions, the balance, term, and interest rates can be expected to differ and therefore so can the annual debt payments.

In 2009 Standard & Poor's (S&P) Ratings Services assigned NTMWD an 'AAA' long-term credit rating based on its financial strength, or ability to pay a bond's principal and interest in a timely fashion. S&P's rating indicates that the district's members have strong credit quality. The contracts between the district and its member cities remain in-force unconditionally throughout the final maturity of all parity debt, or debt securities that have an equal and ratable claim on the same underlying asset as collateral. These contracts also essentially create an unlimited step-up provision, so the value of an asset that has appreciated over time can be readjusted for tax purposes upon inheritance. Additionally, the District's strong management at the authority level (as demonstrated by the degree of long-range planning and conservative fiscal policies) was another factor in the evaluation of NTMWD's credit rating.

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 impacts of minor magnitude due to the water price increase for NTMWD customers. The likely extent of impacts are minimal and would be medium (localized) since the project costs are shared by all NTMWD customers The likelihood of rate adjustment is probable, as indicated by the long-term financial plans that have been developed to establish the payment plan. The precedence and uniqueness of the impact would be slight to moderate. Many reservoirs have been constructed in Texas in the last 50 years, so the dam construction project is not unprecedented but still rare. Adverse impacts in the form of more expensive water per thousand gallons would be felt in the short-term until after amortization (30 years). In the long-term, impacts to economic resources would be beneficial since the price will drop drastically once the debt is paid off.

4.14.2.3 Input-Output Model

Estimates of the economic impacts of the reservoir 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 4-24 through Table 4-35 are taken directly from Dr. Clower's 2011 report "Update of the Economic, Fiscal, and Developmental Impacts of the Proposed Lower Bois d'Arc Creek Reservoir Project" prepared for the NTMWD. The economic benefits reported in Dr. Clower's report are likely understated, by the authors' estimates. All results are reported in 2011 dollars.

The modeled impacts include the direct effects (Table 4-25) of spending for construction activities and consumption spending of new recreationists and residents, and construction works; the indirect effects of local vendors providing goods and services to the primary firms; and the induced impacts of employees of these firms spending a portion of their earnings in the local economy. Economic activity is measured in terms of income and employment generated (or lost) due to the proposed action. With increased spending, many different sectors of the economy benefit – not only the directly impacted sector but also many sectors indirectly. The analysis performed by an input-output model helps account for changes that may occur due to construction. There are many costs associated with construction and maintenance. 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 4-25. 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 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.

Construction

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 4-26). 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).

When compared with the construction impacts, the non-recurring impacts of developing the Lower Bois d'Arc Creek Reservoir 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 (Table 4-27).

Table 4-26. Local economic construction impacts in Fannin County

Description	Impact	
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

Sources: North Texas Municipal Water District; Clower, 2012.
* 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.

Table 4-27. Temporary local economic impacts of development in Fannin County

Description	Impact	
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

Sources: North Texas Municipal Water District; Clower, 2012.
[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.

It is difficult to estimate what portion of labor, materials, and equipment that could 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 Section 3.12, the 2010 Civilian Labor Force in Fannin County consists of approximately 14,005 people, of which 12,698 were employed. It would seem unlikely that Fannin County could supply the 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 significant 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.

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.

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)].

Based on the IMPLAN study, the proposed action 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 6,000 direct, indirect, and induced jobs created by the project would last only for the duration of the five-year construction phase.

A comparison of figures in Table 4-28 below to the Table 4-27 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 4-5 year development 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 reservoir development phase when compared to Fannin County. Gross area product would also increase by more than $150 million during the same five-year phase. Total labor income paid

Table 4-28. Temporary economic impacts of development in Fannin, Collin, Delta, Lamar, Grayson and Hunt counties

Description	Impact	
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

Sources: North Texas Municipal Water District; Clower, 2012.
* 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.

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, 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.

Construction costs would potentially create impacts of major magnitude due to the creation of jobs, property income, and indirect business taxes. The extent of impacts would be medium (localized) to large, since not all of the jobs would be filled by area residents, so a portion would travel from outside of the economic region. The likelihood of impacts would be probable, since the relationship between an infusion of capital and direct, indirect, and induced impacts is well-established. The precedence and uniqueness of the impact would be moderate since such a large, concentrated, infusion of capital would be rare and unprecedented in Fannin County. The setting is unique but not unpredictable given its proximity to the Dallas Fort-Worth Metroplex, the largest metropolitan area in the South. Other areas may have experienced similar impacts from dam construction, but even still there is moderate confidence in the accuracy of the predictions as to types, extent, and likelihood of impacts based on the experience of others that have constructed dams in the recent past. Impacts would be short-term and last not much longer than the 3-5 year construction phase.

4.14.2.4 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, 2010; NTXe-News, 2009). The Proposed Action 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 (NTXe-news, 2009). However, the fact that the NTMWD has already acquired 82 percent of the property within the reservoir footprint from landowners suggests that sellers have been willing and have received fair compensation.

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 (not all) were paid up to $15,000 for relocation costs as part of the purchase negotiations (McCarthy, 2011). 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 (Anonymous, 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, 2010). However, these voiced concerns do not necessarily reflect the majority opinion. The NTMWD has already acquired more than 82 percent of the land within the reservoir site and mitigation property from willing sellers. This figure would indicate not all landowners resent relocating and further; that compensation thus far has proved fair.

Indicators of community cohesion might "measure" or qualify Fannin County as a place where a high percentage of people feel they belong to their community and have meaningful interactions with those in their community.

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, since it is within reasonable reach of big-city amenities, yet removed from most urban disamenities (Clower, 2012). According to the 2008-2010 American Community Survey, 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.

Impacts to the local homes and the social landscape would create adverse impacts of minor to moderate magnitude due to the community cohesion associated with this part of rural Texas. Spillover from the Dallas Fort-Worth metropolitan area has already infused a new class of workers into Fannin County. Drought has further exasperated already failing farms. The extent of impacts would be medium (localized) by definition, since the homes impounded are currently located on the proposed project site. The likelihood of adverse impacts would be probable in light of media and public scoping comments. The precedence and uniqueness of the impact would be moderate, since historical homes built before the1940s and their families have likely not experienced similar displacement. The setting is unique but not unpredictable given its proximity to the Dallas Fort-Worth Metroplex, indicating relatively certain potential impacts. The Proposed Action is controversial, since it is difficult to value the intangible histories of families and homes, unlike economic activity. Impacts would be felt in both the short-term and long-term since they would be permanent and irreversible.

4.14.2.5 Maintenance and Operation

As displayed above in Table 4-23, Project Cost Estimates, the annual operating maintenance cost is an estimated $3,670,814 (Freese & Nichols, 2012). 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 (Table 4-29).

Table 4-29. Recurring annual economic impacts of maintenance & operation in Fannin Co.

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
Indirect Business Taxes**	$91,000

Sources: North Texas Municipal Water District; Clower, 2012
* 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.

Maintenance costs would potentially create beneficial impacts of minor magnitude due to the creation of jobs and recurring expenditures. The extent of impacts would be medium (localized), since long-term jobs and economic benefits would be felt most by the NTMWD service area. The likelihood of impacts would be probable as the required maintenance and operation of a dam and reservoir is established in order for it to serve its main purpose. The precedence and uniqueness of the impact would be slight, since annual O&M costs represent an infusion of capital that is rare but not unprecedented. Impacts would be long-term and last as long as the dam's lifetime (50-100 years).

The recurring impacts in Table 4-29 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.

4.14.2.6 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 fully developed. However, a mid-1990s survey by Texas A&M, Texas Parks and Wildlife Department, 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 (Table 4-30). 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 4-30. 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

Recreation and business development would potentially create beneficial impacts of major magnitude due to spending from recreational visitors. The extent of impacts would be large since the reservoir might attract recreationists from outside the immediate region. The likelihood of impacts would be probable, since the relationship between reservoirs and recreation is well-established. The precedence and uniqueness of the impact would be moderate, since the proposed Lower Bois d'Arc Creek Reservoir is the first in Fannin County but not the first in the region or in Texas. The setting is unique but recreational spending would not be unpredictable given the experience of other reservoirs like Lake Fork, and therefore the potential impacts would be relatively certain. The proposed action as a recreational reservoir is not controversial as the economic benefits would appear to be welcome. Impacts would be long-term and last as long as the reservoir's lifetime (50-100 years).

4.14.2.7 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, 2005), 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 (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, which would be on the north side of the reservoir, would be only 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 4-30).

Businesses located in Fannin, Hunt, Lamar, Grayson, and Delta 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 (Table 4-31), boost local income by $22 to $24 million, and support between 857 to 947 permanent jobs (Clower, 2012).

Table 4-31. 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

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).

New permanent and weekend residents would potentially create beneficial impacts of moderate magnitude due to increased spending on homes and goods and services. The extent of impacts would be medium (localized) since the homes and goods and services would be offered in the immediate area. The likelihood of impacts would be probable, since the relationship between reservoirs and recreational real-estate development in Texas is well-established. The precedence and uniqueness of the impact would be moderate, because the significant increase in residents would permanently and drastically alter the social and economic genotype of Fannin County. The setting is unique but not entirely unpredictable given its proximity to the Dallas Fort-Worth Metroplex, making the potential impacts relatively uncertain. New permanent and weekend residents are expected to be controversial, following the controversial dam and real-estate construction as discussed above under *Impacts to Homes and Social Landscape.* Impacts would be both short- and long-term.

4.14.2.8 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 4-32. 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 4-32. 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

Source: Clower, 2012
[1]30-year development

New housing construction would potentially create impacts of moderate magnitude due to the creation of jobs. The extent of impacts would be medium (localized) to large, 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 probable, since the relationship between an infusion of capital and direct, indirect, and induced impacts is well-established. The precedence, uniqueness, setting, and controversiality of the impact would be slight following reservoir construction. Impacts would be medium (intermittent) to long-term and last approximately 30 years.

4.14.2.9 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 magnitude 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 acre-feet per year between 2020 and 2030. Water used for steam electricity generation is expected to increase by 436 acre feet per year. 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 acre feet per year, 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. Firstly, 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. Secondly, 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. 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 (Table 4-33) (Clower, 2012).

Table 4-33. 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

Source: Clower, 2012
[1]10-year increase after reservoir development

Business development and recruitment would potentially create beneficial impacts of major magnitude due to infusion(s) of capital and their ripple effects. The extent of impacts would be large, since the reservoir might attract investors from outside the previously defined region. The likelihood of impacts would be probable, since the relationship between water supply and development is well-established. The precedence and uniqueness would be slight, even expected. Impacts would be long-term and last at least as long as the reservoir's lifetime (50-100 years).

4.14.2.10 Local Fiscal Impacts

New construction would increase economic activity in the area by creating jobs for construction and maintenance and operation 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 maintenance of the dam and reservoir, the tax base would also expand. Although tax revenues would initially decrease due to taxable land that would be impounded or allocated for mitigation, 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, 2012).

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. 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 has offset lost tax revenue due to inundation, mitigation lands, and redrawn flood plains that have occurred as NTMWD has acquires 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, at or below 545 feet above mean sea level. The affected land parcels were identified using GIS data and software that was provided by the consulting engineers on the Lower Bois d'Arc Creek Reservoir project. Data were obtained from the Fannin County Appraisal District 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 at or below the 545-foot elevation level. Of these, data for 502 parcels are available on the Fannin County Appraisal District 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 reservoir 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 4-34 (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 (NTXe-News, 2009).

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, were treated differently. Table 4-34 includes the estimated taxable value of the country club for Fannin County, the City of Bonham, and the Bonham Independent School District that include an estimated taxable value of the country club. However, it is possible that the country club 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 country club is removed from the tax rolls (Clower, 2012).

As property values begin to rise based on new development near the new 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 4-34. In addition to the inundation area, the Riverby Ranch has been acquired by NTMWD that would serve as environmental mitigation for the reservoir. Prior to acquisition, this property had an appraised value of slightly more than $4 million included improvements and generated just under $78,000 per year in total property taxes, about $52,000 of which goes to the Sam Rayburn Independent School District (ISD).

Table 4-34. 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**

Sources: Fannin County Appraisal District, 2010; North Texas Municipal Water District; Clower, 2012
[1]2011 valuation estimates including mitigation area

At full development, the taxable value of permanent and weekend residences is approximately $326.2 million[1], 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

[1] The average value of homestead, senior citizen, disabled, veteran and other exemptions is estimated at 15 percent of total valuation.

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 reservoir (See Table 4-35).

Taxable retail sales in Fannin County would increase with new residents and visitors. Local sales tax revenues could potentially increase by upwards of $203,000 per year. Hotels could expect revenues of at least $3.7 million per annum 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).

Table 4-35. 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

Source: Clower, 2012
* Includes golf course.
** Value will be impacted by land annexation and business location decisions.

Fiscal impacts would likely be negligible in magnitude due to the extraction of property taxation in the short-term, since the affected landowners would be compensated at fair market value and 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 extent of impacts would be medium (localized) since town and county fiscal operations would be most affected. The likelihood of impacts would be probable, since the relationship between local taxes and fiscal health is well-established. The precedence and uniqueness of the impact would be slight since the extraction of taxable land is rare but not unprecedented, making the potential impacts relatively certain. The dam and reservoir is controversial due to the perceived loss of tax revenue and land acquisitions. Long-term impacts would be beneficial pending development, new permanent and weekend residents, and business investments.

4.14.2.11 Riverby Ranch Mitigation Site

The Riverby Ranch in Fannin County has been purchased by the NTMWD as the designated environmental mitigation site. The following summarizes the potential impacts to economic activity in Fannin County found in Dr. Clower's *The Economic Impacts of Riverby Ranch Operations* (Appendix G). Estimates of the economic and fiscal impacts of closing operations at Riverby Ranch are based on data provided by Riverby executives and analyzed using the IMPLAN economic input-output model. The fiscal impacts reported here are based on indirect spending activities and do not include the loss of taxable property value when the North Texas Municipal Water District purchased the ranch, which is addressed by payments in lieu of taxes by the water district. All results are reported in 2011 dollars.

Based on current operations – which would likely continue unless the proposed reservoir is impounded – Riverby Ranch creates $13.5 million in economic activity in Fannin County. The supported 264 jobs pay about $962,000 in salaries, wages, and benefits. However, most of these jobs are part-time positions employed during key ranching operations. Riverby boosts gross county product by less than $3 million a year, suggesting that its removal would have a modest impact on the local economy. If ranch operations ceased, property income would decrease by $1.6 million, and local tax jurisdictions would fall about $100,000. Additionally, state tax revenues would decline by about $244,000 per year. Table 4-36 below displays the results to Fannin County.

Table 4-36. Economic and fiscal losses from ceasing operations at Riverby Ranch

Description	Impact
Economic Impact	$13,524,000
Gross County Product (value added)	$2,935,000
Jobs (full- and part-time)	264
Labor Income	$962,000
Property Income*	$1,596,000
Indirect Business Taxes**	$98,000

Sources: Riverby Ranch; Clower, 2012.
* 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.

Mitigation impacts would potentially be minor and adverse in magnitude due to the elimination of economic activity, jobs, and wages (but not taxable property) from the Fannin County economy. The extent of impacts would be medium (localized) since Fannin County's fiscal operations would be most affected; state revenue would decline slightly. The likelihood of impacts would be probable, since the relationship between businesses and fiscal health is well-established. The precedence and uniqueness of the impact would be negligible since closure of a ranch is neither rare nor unprecedented, especially in the last decade. As such, the potential impacts would be almost certain. Long-term impacts would be adverse and minor since the designated mitigation area would be developed as wetlands and other wildlife habitats and would not include the possibility for future development or investment.

4.14.2.12 Conclusion

Overall socioeconomic impacts of the Proposed Action on Fannin County and the ROI 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 significant. 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 reservoir and related facilities. Over time, socioeconomic impacts associated with the Proposed Action 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 citizens of Fannin County would welcome the short-term 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. On balance, whether or not one sees this tradeoff as good or bad is a question of one's personal values and interests.

4.15 ENVIRONMENTAL JUSTICE AND PROTECTION OF CHILDREN

Consideration of the potential consequences of the Proposed Action for environmental justice requires three main components:

1. A demographic assessment of the affected community to identify the presence of minority or low-income populations that may be potentially affected;

2. An assessment of all potential impacts identified to determine if any result in significant adverse impact to the affected environment; and

3. An integrated assessment to determine whether any disproportionately high and adverse impacts exist for minority and low-income groups present in the study area.

Where minority, low-income, and/or youth populations are found to represent a high percentage of the total affected population, 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 assessed for posing an environmental justice concern. The ROI for this analysis is the same five-county region as for the socioeconomic analysis in Section 4.14 (Fannin, Collin, Lamar, Hunt, and Delta counties).

4.15.1 No Action Alternative

Assuming that the proposed project is not implemented, no change would occur to the existing counties. Since ongoing activities would be substantially the same as those already occurring, no significant 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 Proposed Action

As discussed in Section 3.13, Fannin County represents the primary focus and Region of Influence (ROI) for any direct and indirect impacts that may be associated with the implementation of the proposed action. For purposes of comparison, the five surrounding counties – Collin, Hunt, Lamar, Delta, and Grayson – and the state of Texas were defined as the geographic units of analyses and the "general" population.

4.15.2.1 Minority Populations

Fannin County does not constitute an environmental justice population since the percentage of minority population neither exceeds 50 percent nor is substantially higher than the percentage of minorities in the five surrounding counties. The discussion of potential impacts to minority populations in Fannin County overall are therefore negligible and not discussed further.

However, a closer look at the distribution of minority populations within Fannin County using Block Group data reveals that Honey Grove, Ladonia, and Bonham consist of environmental justice populations, as established in Section 3.13.1.1 and shown in Figure 3-47 (Distribution of minority populations within Fannin County).

Construction Phase
The construction of the proposed project could possibly have disproportionate, negligible to minor, indirect impacts on minority populations in Ladonia, Honey Grove and/or Bonham. Beneficial impacts could include the availability of short-term construction jobs.

The types of impacts on minority populations in Honey Grove and/or Bonham from the construction equipment, vehicles, and activities could include:

1) Noise Disturbances: Disturbances could occur from increased level of noise created by construction equipment and vehicles.

2) Congestion: Congestion would increase in the immediate area due to additional vehicles and traffic delays near the site.

3) Community Cohesion: An increase in travel time or miles traveled could affect (reduce) access to community centers, neighborhood parks, and recreation areas.

4) Human Health and Safety: Construction workers are inherently exposed to safety risks by operating heavy machinery and working on-site, like injury by unguarded machinery and dust inhalation.

5) Job opportunities: Beneficial impacts could include the availability of short-term construction jobs.

During at least a portion of the construction phase, the Proposed Action could result in disproportionate impacts on Honey Grove, Ladonia, and/or Bonham residents. As discussed in 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 minimum 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 pipeline would not be fixed in one location but would progress along the pipeline as construction progressed; and the pipeline would not traverse any of the environmental justice communities. Some nearby residents may experience annoying levels of 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 residential and recreation areas; and construction equipment mufflers would be properly maintained and in good working order.

As discussed in Section 4.12 on Transportation, congestion would increase in the immediate area due to additional vehicles and traffic delays near the site. 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. 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 north would be affected by increased traffic and time delays. Community cohesion could be affected since 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 within Fannin County. In other words, the potential benefit of job opportunities would not be a function of location, just as it would not be a function of race, or income. Impacts would be felt most by those who might be in search of a short-term job, but as discussed in Section 4.14 (Socioeconomics), construction of the dam would also create a number of indirect or induced jobs from project-related spending and the spending decisions of workers.

Operations
Over the long term, operation of the LBCR would not disproportionately impact minority populations adversely. The proximity of Honey Grove, Ladonia, and/or Bonham to the reservoir might be advantageous for local recreationists and job-seekers. The replacement for FM 1396 could benefit Fannin County residents, as it would be built to higher speed standards, and would be centrally located across the reservoir site. For roadways being replaced or repaired, the effects would be beneficial when compared to existing conditions, that is, the No Action Alternative. The proposed dam would introduce a recreational area to the county, and represent a beneficial impact for its residents.

Conclusion
Environmental justice impacts to minority populations in Ladonia, Honey Grove, and Bonham would be negligible. Given the distance of minority populations in Ladonia, Honey Grove, and Bonham and the temporary nature of the proposed construction activities, all adverse impacts would be indirect. The extent of impacts would be small (localized) as the above discussion of impacts applies only to the Census Block Groups in Honey Grove, Ladonia, and Bonham. The likelihood of the impacts would be improbable as the impacts as discussed above would not necessarily be felt by all minority populations in said Block Groups.

4.15.2.2 Low-Income Populations

Since the representation of socioeconomically disadvantaged individuals in Fannin County is not greater than those of Collin, Delta, Hunt, Lamar, and Grayson counties' populations in a meaningful way, Fannin County does not qualify as an environmental justice population on this basis. However, as established in Chapter 3, low-income populations represent between 21 and 25 percent of the populations in Bonham. (See Figure 3-48: Distribution of low-income populations in Fannin County).

4.15.2.3 Protection of Children

In compliance with EO 13045, *Protection of Children From Environmental Health Risks and Safety Risks*, this analysis examines demographic data on the local, regional, and national populations; and, in particular on children, to evaluate the number and distribution of children in the area and whether these children are exposed to environmental health and safety risks from the Proposed Action. 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, low-income, and indigenous 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 a significant environmental health and safety risks if they were to generate disproportionately high environmental effects on populations of children within the ROI. Potential effects include health and safety concerns such as hearing loss, non-auditory health effects, and interruption of communication or attention in nearby residences and schools with children present.

As discussed in *Section 3.13.2, Protection of Children,* children under the age of 19 represent a smaller portion of the Fannin County population than do children in surrounding counties. Since the safety risks are higher in the vicinity of the dam and pipeline, census tracts were examined to identify the minority and age distribution in Fannin County. As discussed above in 14.15.2.1 Minority Populations, Bonham and Honey Grove constitute environmental justice populations. As displayed in Figure 3-55: Age distribution in Fannin County, Honey Grove has a higher percentage of children under the age of five. As such, places where children "learn, live, and play" in Honey Grove are the focus of this analysis.

Construction

The construction of the proposed project and connected actions could have disproportionate impacts on children in the vicinities of Bonham and Honey Grove. The types of adverse impacts on children from the construction equipment, vehicles, and activities could conceivably include:

1) Noise: Increased level of noise created by construction equipment and vehicles could affect children's learning, especially near homes and recreational areas.

2) Mobile Source Air Pollutant Emissions (including traffic): Children residing along the eastern perimeter of the impoundment area and northern portion of the pipeline in close proximity to the project construction site would 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.

3) 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.

4) Safety: Children residing in close proximity to the dam and pipeline construction sites are inherently at a higher risk of accident or incident that could result in bodily harm.

Possible impacts 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 the Proposed Action as posing a concern to the protection of children. The types of potential impacts will be used to qualify the potential level of impacts.

The Head Start Program at Bailey Inglish 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 Bailey Inglish 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 Bailey Inglish, or 48 three-year olds and 91 four-year olds (Hunt, 2012). Since 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 would adversely impact those children of low-income families commuting from the east and northeast.

As discussed in Section 4.14.2.10 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 (PILT) until re-growth in the tax base compensates for initial lost tax revenues. As such, potential impacts from lost tax revenues to the Bonham ISD should be negligible.

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-around (TPWD, 2012). Due to the distance from the active construction zone (more than 10 miles) for the LBCR, children recreating in Bonham State Park would probably not be at an increased risk of dust inhalation.

The Red River Regional Hospital is a Joint Commission accredited Critical Access facility 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. While children would be admitted to the Emergency Room, no pediatricians are on staff and the hospital does not treat children on a regular basis (RRRH, no date). In the case of an accident, time delays due to traffic or congestion from the proposed project could hypothetically have serious consequences, although this is very unlikely.

The construction phase of the proposed action would potentially create impacts of negligible to minor magnitude due to disturbances and the increased risk of dust inhalation and accidental injury of children residing in Honey Grove. The extent of impacts would be small, limited to Honey Grove, where a slightly higher percentage of youths younger than five are concentrated. The likelihood, or probability, that the impacts would occur is possible. The probability or likelihood would increase or decrease depending on the actual timing of construction as many of the potential impacts could be avoided if completed during summer months. The precedence and uniqueness of the impact would be moderate since such a construction project of this size would be rare and unprecedented in Fannin County. The dam and reservoir is not controversial since none of the structures that would be removed for the impoundment are defined as youth facilities, and the adverse impacts would occur almost entirely during the construction phase. Impacts would be short-term and last for parts of the 3-5 year construction phase with relation to specific stages of construction. Impacts from ancillary development (real estate and businesses) discussed in Section 4.14 could extend the duration of construction impacts since their presence would depend on the completion of the dam and pipeline.

Operations

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 were applied for the purpose of maintenance around the periphery of the reservoir and/or pipeline right-of-way, this could result in adverse health impacts to children, although this is considered improbable and would likely be uncommon and of negligible to minor impact. As the population grows with economic development during the maintenance phase of the dam, 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 4.14.2.10 on 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 since 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 beneficial impacts of minor to moderate magnitude due to the increased tax revenue without (necessarily) an increase in youth populations, since children of weekend residents are not expected to necessarily enroll in the Bonham, Trenton, or Leonard

Independent School Districts. The extent of impacts would be medium (localized), since long-term teaching jobs, materials, and facilities would be felt most by children attending schools in Fannin County. The likelihood of impacts would be probable, 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 precedence and uniqueness of the impact would be slight, since the regular increase in capital – a benefit to the community - would not be controversial. Impacts would be long-term and last as long as the dam's lifetime (50-100 years).

Existence of a major new recreational facility close to Bonham and Honey Grove offering boating, fishing, swimming, and other outdoor activities would represent a benefit for area youth. The visual and aesthetic value of the reservoir and the green space around it would also be considered by many to be beneficial in the long-term.

4.15.2.4 Conclusion

The Proposed Action does not entail environmental justice impacts in the overall ROI. Populations within the ROI as a whole are not disproportionately low-income. Census Block Group data revealed Honey Grove, Ladonia, and Bonham have a higher percentage of minorities than Fannin County as a whole, and the Proposed Action could create indirect, adverse impacts of negligible to minor magnitude on minority residents for at least a portion of the construction phase, though not during the operational phase. Beneficial impacts in the form of jobs would not impact minorities disproportionately in the short or long term. Census Tract data also revealed that Honey Grove consists of a slightly higher percentage of children under the age of five. Children residing in especially Honey Grove could experience adverse, short-term impacts of negligible to minor magnitude during the construction phase of the Proposed Action. Long-term impacts of the Proposed Action on children would be primarily beneficial.

4.16 CULTURAL RESOURCES

The ROI for the cultural resources analysis is the same as the Area of Potential Effects (APE), which is defined in the PA as the reservoir footprint itself including the dam and all associated construction and staging areas, planned new water treatment facility, raw water pipeline, and Riverby Ranch mitigation site.

4.16.1 No Action Alternative

Because the reservoir, pipeline, water treatment plant and terminal storage reservoir would not be built under this alternative, there would be no impacts to cultural resources from the proposed action. However, over the long term, any cultural resources within the reservoir footprint and mitigation sites would be largely unprotected by federal law, since they are on private properties. Thus, cumulatively and over the long term, impacts to cultural resources from the No Action alternative are unknown.

4.16.2 Proposed Action

Impacts of the Proposed Action are discussed here according to the category of cultural resource that may or may not be affected by the undertaking.

4.16.2.1 National Register Properties

The Proposed Action would have no effect on properties currently listed on the National Register of Historic Places.

4.16.2.2 Historical Markers

The Proposed Action would have no effect on State of Texas historical markers.

4.16.2.3 Historic Cemeteries

Within the Reservoir
One cemetery is located within the proposed reservoir. The Wilks Cemetery (41FN96) is a small historic family cemetery with graves dating from 1852 to 1927. The cemetery contains 21 known graves within its immediate limits although an additional two graves are located a short distance to the west. The Wilks Cemetery has been recommended as eligible for the NRHP and this recommendation is being reviewed by the THC. The Proposed Action would adversely affect it. Regardless of its NRHP status, measures to mitigate this adverse effect in accordance with the Texas Health and Safety Code 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, and White Family, are located within the flowage easement to be acquired by NTMWD between the 541' contour and the 545' contour. The Stancel Cemetery contains at least four known graves dating from the 1870s. The White Family Cemetery contains 14 markers ranging from 1849 to 1926. The Proposed Action could result in temporary inundation and erosion of these cemeteries. Measures to mitigate this adverse effect 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 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.

4.16.2.4 Historic Buildings and Structures

Within the Reservoir APE
Thirty-four structures and/or building are within the APE, none of which are eligible for the NRHP. Thus, the Proposed Action would have no effect on significant historic buildings or structures.

Outside of the APE
The Proposed Action would have no effect on buildings or structures outside the APE and above the 541 foot MSL elevation.

4.16.2.5 Archeological Sites

Currently Known Sites Within and Close to the Reservoir APE
Within the proposed Lower Bois d'Arc Creek Reservoir, 44 sites were recorded as a result of ARC's 2011 archeological survey. In addition, four sites were recorded outside the APE for a total of 48 sites. Of these 48 sites, 20 are historic-era sites, 26 are prehistoric sites, and two are multiple component sites. Two sites (41FN96, 41FN120) have been determined to be eligible as a National Register property and nine other sites (including seven prehistoric and two historic-era) were assessed of undetermined significance and were recommended for further investigation. The remaining 37 sites were evaluated as

not significant and were recommended as not eligible for listing on the NRHP. The Proposed Action would have a direct adverse effect on these sites. Impacts 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.

Site 41FN96 is the Wilks Cemetery and would require mitigation of adverse effect, as described above.

Site 41FN120 has been determined by the USACE to be eligible for the NRHP. Measures to mitigate the adverse effect to this site should be developed in a Memorandum of Understanding between the project proponent (NTMWD), the USACE, and the Texas Historical Commission. Mitigation measures could include archeological data recovery.

4.16.2.6 Raw Water Pipeline Route and Associated Facilities

Overall, seven historic archaeological sites within the APE were documented during a 2013 survey along the raw water pipeline route and associated facilities (TSR, WTP, etc.). Each of these sites represents the remnants of either late 19th or 20th century farmsteads or homesteads found on upland divides. 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 is eligible for the NRHP. Thus, impacts on cultural resources from these connected actions are expected to be non-existent to negligible.

4.16.2.7 Riverby Ranch Mitigation Site

As noted in Chapter 3, archeological investigations are ongoing at the Riverby Ranch mitigation site according to procedures outlined in the PA. Investigations there will be completed in accordance with Section 106 and the PA and particular findings will determine specific management actions at the site to protect any significant resources.

4.16.2.8 Conclusion

Because of the potential for "disturbance of a site listed on or eligible for listing on the National Register of Historic Places," the impacts from Proposed Action would be of major magnitude. Two sites have been identified but additional sites may be identified, including many more in unsurveyed areas. Duration would be long-term, because "cultural resources are non-renewable; any adverse effect is permanent/long-term." The extent would be rated as large, because "most of the historic or archaeological site or district [is] affected" (more than 50%). The likelihood is probable. Given all of these ratings, the Proposed Action's impacts on cultural resources, primarily archeological sites, would be considered significant under NEPA.

As discussed above, these potential impacts can be mitigated, including archeological data recovery, exhumation of burials including possible repatriation 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 in general to below the threshold 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 4-37 lists, by resource topic, unavoidable adverse impacts that would result from the Proposed Action, i.e. construction of the Lower Bois d'Arc Reservoir and related facilities. As noted throughout this chapter, some of these adverse effects can be mitigated to some extent, often to below the threshold of significance, and many of these adverse effects are not considered significant adverse effects even without mitigation.

Table 4-37. Unavoidable adverse impacts associated with LBCR

Resource topic	Unavoidable adverse effects
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 slurry trench and placement of 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, water treatment facility, and terminal storage reservoir. • Overall unavoidable adverse effects on topography, geology, and soils of constructing the LBCR would be less than significant.
Water Resources	• Proposed Action would permanently impact up to 5,876.76 acres of wetlands, 225 acres of streams, and 113 acres of open waters. • Lake Bonham Dam would be adversely affected by the LBCR, but these impacts can be mitigated to an acceptable level. • Temporarily adverse but no permanent impacts to waters and wetlands from constructing a 35-mile raw water transmission line from LBCR to the proposed North WTP near Leonard, TX, as well as the WTP, a TSR, FM 1396 relocation, bridge construction, and related activities and appurtenant facilities. • Would reduce cumulative downstream flows in Bois d'Arc Creek. • Would result in minor reductions of flows and water supply in the Red River downstream of the Bois d'Arc Creek confluence
Air Quality and Climate	• Short-term 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 small carbon footprint, and would have an incremental, but overall negligible, contribution to global warming.
Acoustic Environment (Noise)	• Would have short-term minor adverse effects on the noise environment. • Short-term minor increases in noise would result from the temporary 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.

Resource topic	Unavoidable adverse effects
Biological Resources	• Approximately 6,330 acres of bottomland vegetation and wildlife habitat would be permanently eliminated within the reservoir footprint. • Adverse impacts of Proposed Action on some existing aquatic biota in Bois d'Arc Creek and tributaries within the reservoir footprint.
Recreation	• Reservoir construction of the reservoir would have minor to moderate, short-term 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 to severe storm events.
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.
Land Use	• Long-term changes in land use toward higher-density development in the project vicinity induced by the Proposed Action itself and in Fannin County generally both from LBCR and growth of the DFW Metroplex may be regarded by some existing and future residents 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.
Transportation	• Short-term adverse effects on transportation and traffic, would be of major magnitude, due to the number and length of roads requiring temporary or permanent closure and relocation.
Socioeconomics	• Would entail both short-term and long-term 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	• Adverse, short-term, negligible to minor magnitude impacts could occur during the construction phase. These impacts would not be significant.
Cultural Resources	• Would adversely affect the Wilks Cemetery within the reservoir footprint.

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 the Proposed Action – 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 discussed in

Chapter 4 (Section 4.4.2.2), after a century of operation, the proposed reservoir would have lost approximately 7.5% of its capacity. Thus, hypothetically, the LBCR project could help meet water needs for North Texas municipalities for a period of time measuring in the centuries, which would qualify as long-term. Therefore, with regard to water, the Proposed Action would not 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 – in additional to Prime Farmland Soils in certain upland areas, some of which are currently used as agricultural land (cropland and pasture) and all of which could potentially be used as such. Effects on wetlands, in any case, as mandated by Section 404 of the Clean Water Act, would require 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 the extinction of a species, removal of mined ore or pumped oil and gas, permanent conversion of wetlands, 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 minerals 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 the Proposed Action – construction and operation of the LBCR and construction and operation of related facilities and connected actions, the following would constitute essentially irreversible commitments of resources:

- 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 all the grading required at the Riverby Ranch mitigation site.

- Materials used to construct the dam and all other facilities, including cement/concrete, soil cement, slurry material, clay, sand, gravel, steel, iron, and other metallic alloys, copper wiring, PVC piping, 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 to the north water treatment plant 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 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 more, likely removing 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 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 analysis. 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 (Caddo National Grasslands), 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.

5.2 PAST ACTIONS

The main (but not exclusive) geographic ROI of the cumulative effects analysis is Fannin County, where both the proposed LBCR and the proposed Lake Ralph Hall are located, as well as the Riverby Ranch, the proposed main mitigation site for the LBCR. 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 bottomed out 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 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).

For the purposes of this EIS, past actions are defined as those large, relevant projects that have occurred in Fannin County within approximately the past 40-50 years. "Relevant" projects are those which, due to their size, proximity, and influence on water resources, are most likely to interact or combine with the current proposed action (LBCR) and result in cumulative impacts. As noted at top, cumulative impacts are those which result from the incremental impact of the proposed action when added to impacts from other actions, including past ones.

5.2.1 Channelization of Bois d'Arc Creek

As described in some detail in Chapter 3 (Section 3.2.1.2) 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 within much of the reservoir footprint itself. These actions continued as recently as the 1970's. As documented in the 2010 Instream Flow Study (Freese and Nichols, 2010a) and elsewhere, channelization and straightening have thoroughly modified the original hydrologic regime and geomorphology of Bois d'Arc Creek, resulting in channel downcutting and increased 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. Its 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.

The impacts of Bois d'Arc Creek channelization that contribute to cumulative impacts are shown in Table 5-2.

5.2.2 Lake Bonham

Lake Bonham (Figure 5-1) 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 5-1. View of Lake Bonham in Fannin County

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 are about 2,350 AFY in 2010. The reliable supply for NTMWD from Lake Bonham is about 5,340 AFY.

Construction and operation of Lake Bonham likely entailed many of the same direct and indirect, short-term and long-term impacts that construction of LBCR would, although on a much smaller scale, since its surface area is about 1/17th and reliable supply about 1/24th that of LBCR.

The impacts of Lake Bonham construction and operation that likely contribute to cumulative impacts are shown in Table 5-2.

5.2.3 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 project 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 was begun in April 1960 and finished in September 1961. Impoundment of water started in December 1960. The reservoir has a storage capacity of 16,400 AF, encompassing a surface area of 1,080 acres, at the normal pool elevation of 611 feet MSL (TWDB, no date-c). 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).

Valley Lake likely entailed many of the same direct and indirect, short-term and long-term impacts that construction of LBCR would, although, as with Lake Bonham, on a much smaller scale, since its surface area and storage capacity are much smaller than LBCR's.

The impacts of Valley Lake construction and operation that likely contribute to cumulative impacts are shown in Table 5-2. In contrast to Lake Bonham, Valley Lake would not contribute cumulatively to hydrological impacts on Bois d'Arc Creek, since it is not located in the Bois d'Arc Creek watershed.

5.2.4 Coffee Mill Lake (Caddo National Grasslands)

Coffee Mill Lake is located in 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 above the dam of 39 square miles (TWDB, no date-d). It has a surface area of 650 acres and a maximum depth of 30 feet. Its normal pool elevation sits at 496 feet msl. It is a popular, stocked fishing lake; largemouth bass, channel catfish, and crappie are the predominant species (TPWD, 2010e).

Construction and operation of Coffee Mill Lake likely involved many of the same direct and indirect, short-term and long-term impacts that construction of LBCR would, although on a qualitatively and quantitatively much smaller scale, since its surface area and volume are much smaller than LBCR's.

The impacts of Valley Lake construction and operation that likely contribute to cumulative impacts are shown in Table 5-2. Like Lake Bonham, Coffee Mill Lake would contribute cumulatively to hydrological impacts on the lower reaches of Bois d'Arc Creek, since it is located in the Bois d'Arc Creek watershed.

5.2.5 Davy Crockett Lake (Caddo National Grasslands)

Davy Crockett Lake 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 rests at 487 feet msl. Like Coffee Mill Lake, Crockett Lake is a popular, stocked fishing lake; largemouth bass, channel catfish, bluegill, and crappie are the predominant species (TPWD, 2007d).

Construction and operation of Davy Crockett Lake likely involved many of the same direct and indirect, short-term and long-term impacts that construction of LBCR would, although on a qualitatively and quantitatively much smaller scale, since its surface area and volume are much smaller than LBCR's.

The impacts of Valley Lake construction and operation that likely contribute to cumulative impacts are shown in Table 5-2. Like Lake Bonham and Coffee Mill Lake, Davy Crockeet Lake would contribute cumulatively to hydrological impacts on the lower reaches of Bois d'Arc Creek, since it is located in the Bois d'Arc Creek watershed.

5.3 RECENT AND REASONABLY FORESEEABLE ACTIONS

The following projects were identified as having potential cumulative effects when considered in conjunction with the proposed Lower Bois d'Arc Creek Reservoir.

5.3.1 Lake Ralph Hall

The Upper Trinity Regional Water District's (UTRWD) proposed Lake Ralph Hall (LRH) was initially identified as the main project considered in the assessment of cumulative impacts. 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 north of the City of Ladonia in Fannin County. Construction of the proposed 11,200 -acre water supply reservoir would likely not take place during the same time-frame as the LBCR, but some years later. Figure 5-2 is a map displaying the two proposed reservoirs in relation to one another. This figure also depicts the location of the Riverby Ranch, proposed mitigation site for the Lower Bois d'Arc Creek Reservoir (the proposed action in this EIS). Figure 5-3 depicts a reach on the North Sulphur River in the vicinity of the proposed dam site.

The purpose of the proposed project (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 serve than it would be for NTMWD to extend lines to serve those areas, but generally services from NTMWD and UTRWD would not overlap.

In March 2012 a meeting was held to consider possible cumulative interactions between the two projects. 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 (Table 5-1) 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, ranching ensued.

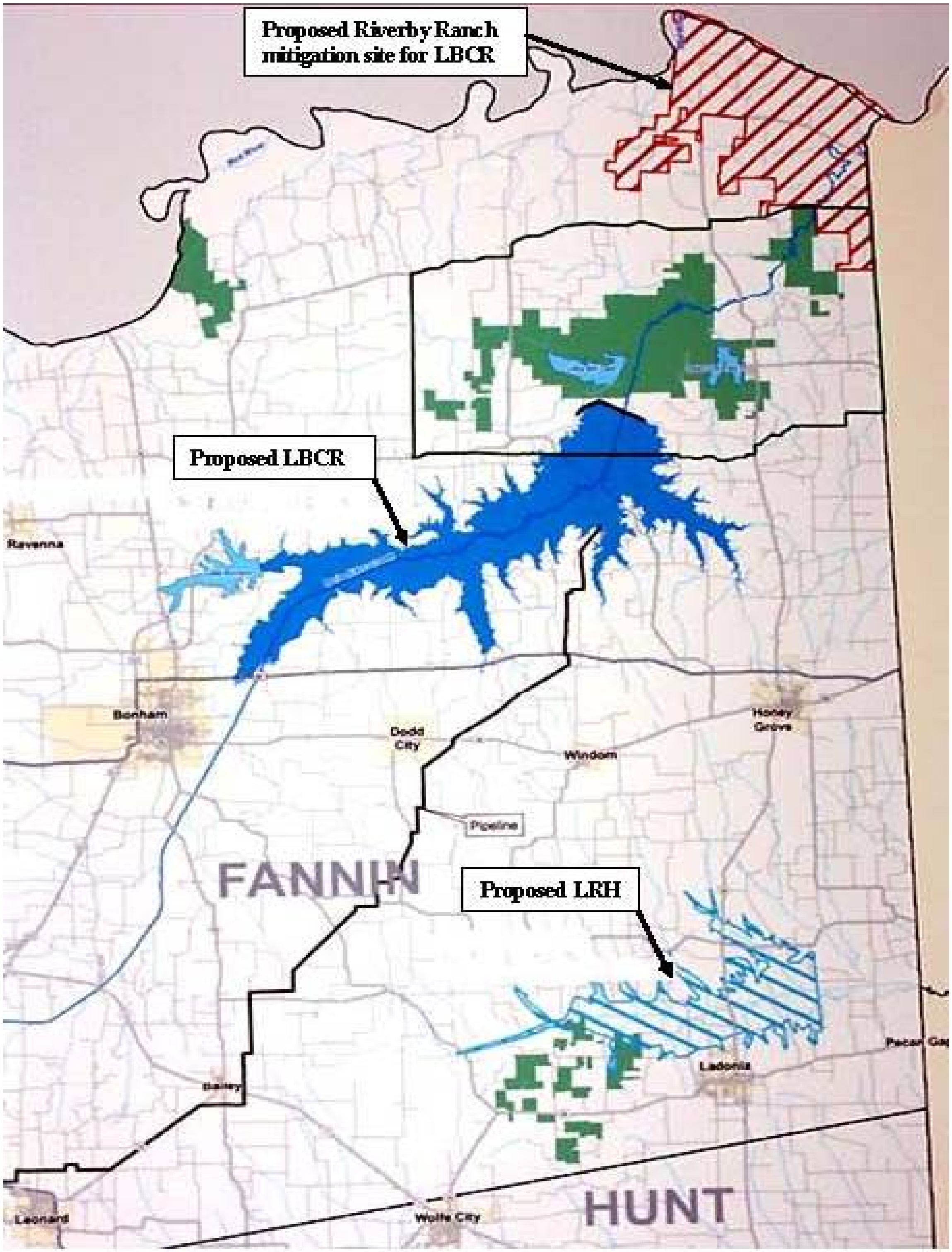


Figure 5-2. Relative locations of LBCR, LRH and Riverby Ranch mitigation site in Fannin County

Figure 5-3. North Sulphur River channel in the vicinity of the proposed Lake Ralph Hall

Table 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
Project Site 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

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 might overlap, which would cause short-term cumulative impacts. However, this situation has changed. The current construction timeframe for LRH now shows construction between 2025 and 2030. This would be subsequent to the proposed construction of LBCR. It is thus likely that both projects will not be built concurrently.

Construction of a large reservoir like LRH would likely cause many of the same environmental impacts as LBCR. The impacts of LRH that likely contribute to cumulative impacts are shown in Table 5-2. In contrast to several of the existing reservoirs cited above, LRH would not contribute cumulatively to hydrological impacts on Bois d'Arc Creek, because it is not in this watershed, but rather in the N. Sulphur River watershed, which discharges into the Red River downstream of the Bois d'Arc Creek confluence.

5.3.2 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 ($1,000,000 EDA investment and $700,000 applicant 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 boosted demographic growth, which 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 5-2.

5.3.3 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 water drainage system was updated to correct the undersized water drainage and a $4.0 million taxiway rehabilitation project is still underway. This action is related to regional transportation and general economic activity within the ROI.

The impacts of North Texas Regional Airport construction and operation that likely contribute to cumulative impacts in the region are shown in Table 5-2.

5.3.4 TransCanada Gulf Coast Pipeline Project

The Keystone Pipeline is 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 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 (Rich, 2011).

The 1,700 new miles of pipeline that constitutes the Keystone XL has two sections. First, a southern leg connects Cushing, OK, where there is a current bottleneck of oil, with the Gulf Coast of Texas, with its numerous oil refineries. That leg – 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 new leg of the pipeline, the one currently awaiting approval of a Presidential Permit from the U.S. State Department, 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.

The southern leg of the pipeline – the TransCanada Gulf Coast Pipeline Project – cuts through 16 counties in North and East Texas – including Fannin, Lamar, and Delta – 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 (shape) 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 produce temporary construction-related jobs. Figure 5-4 shows the typical pipeline construction sequence.

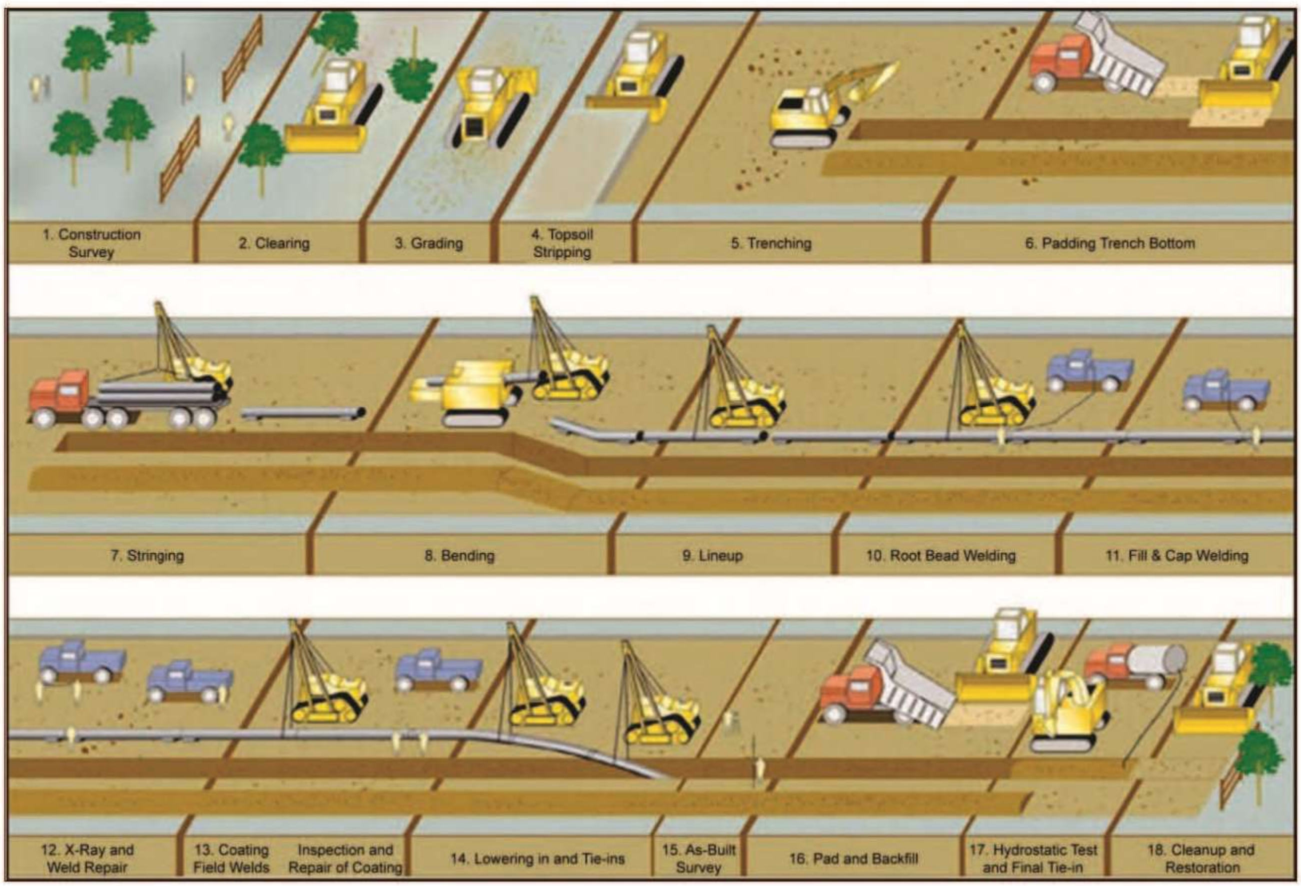


Figure 5-4. TransCanada Gulf Coast Project typical pipeline construction sequence
Source: U.S. Department of State, 2014

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 Gulf Coast Pipeline construction and operation that potentially contribute to cumulative impacts in the region are shown in Table 5-2.

5.3.5 Gulf Crossing Project - Boardwalk Pipeline Partners, LP

In 2009, Boardwalk Pipeline Partners, LP – through its subsidiaries Gulf Crossing Pipeline Company LLC and Gulf South Pipeline, LP – completed construction of the interstate natural gas pipeline and associated ancillary and aboveground facilities, collectively known as the Gulf Crossing Project. The newly-constructed interstate natural gas pipeline begins near Sherman, Texas (in Grayson County), and proceeds to the Perryville Louisiana, area (Figure 5-5). It consists of approximately 357 miles of 42-inch pipeline that can carry approximately 1.7 billion cubic feet of natural gas each day.

Within the socioeconomic ROI, the pipeline crosses Grayson, Fannin and Lamar counties. It crosses 7.5 miles of the extreme northeast corner of Fannin County. The taxable value of the Boardwalk pipeline in 2010 was $6,467,190 (FirstSouthwest, 2010). The Boardwalk Pipeline Partners, LP pay approximately $250,000 to Fannin County government per year during the operational phase of this pipeline (FERC, 2008). This is a long-term, beneficial cumulative fiscal and socioeconomic impact for the county. The EIS for this project concluded that its construction and operation would result in impacts on soils, groundwater, surface water, wetlands, vegetation, wildlife, fisheries, threatened and endangered species, cultural resources, air quality, noise, and land use (FERC, 2008).

The potential impacts of Gulf Crossing Project construction and operation that would likely contribute to cumulative impacts in the region are shown in Table 5-2.

5.3.6 Panda Power Lateral Project – Gulf Crossing Pipeline Company LLC

On March 11, 2013 the Federal Energy Regulatory Commission (FERC) published a Notice of Intent (NOI) to prepare an environmental assessment (EA) that will discuss the environmental impacts of the Panda Power Lateral Project involving construction and operation of facilities by Gulf Crossing Pipeline Company LLC in Grayson County, Texas. The Panda Power Lateral would provide 125,000 dekatherms per day of deliverable natural gas capacity from its takeoff at the Sherman Compressor Station located 10 miles northeast of Sherman, Texas, to Panda Sherman Power, LLC's Panda Sherman Power Plant I electric generation power plant, currently under construction on the south side of Sherman, Texas.

The Panda Power Lateral Project would consist of 16.5-mile-long 16-inch-diameter pipeline lateral; a pig launcher barrel and system tie-in facilities at Milepost (MP) 0.0 consisting of a 16-inch launcher barrel and associated piping and valves; two mainline valves and appurtenant facilities at MPs 8.74 and 14.76; a pig receiver barrel and meter station consisting of a 16-inch receiver barrel and associated piping and valves at MP 16.52; and an Enterprise Texas Pipeline (ETP) interconnect at MP 14.75 consisting of a meter and flow control station to be built, owned, and operated by ETP (78 FR 15364).

The potential impacts of Panda Power Lateral Project construction and operation (mostly socioeconomic) that would likely contribute to cumulative impacts in the ROI are shown in Table 5-2.

5.3.7 Growth of the Dallas – Fort Worth Metroplex

"Growth of the Metroplex" refers not 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 Metroplex is more a trend than an action, but a trend with real physical implications for the landscape and the affected environment.

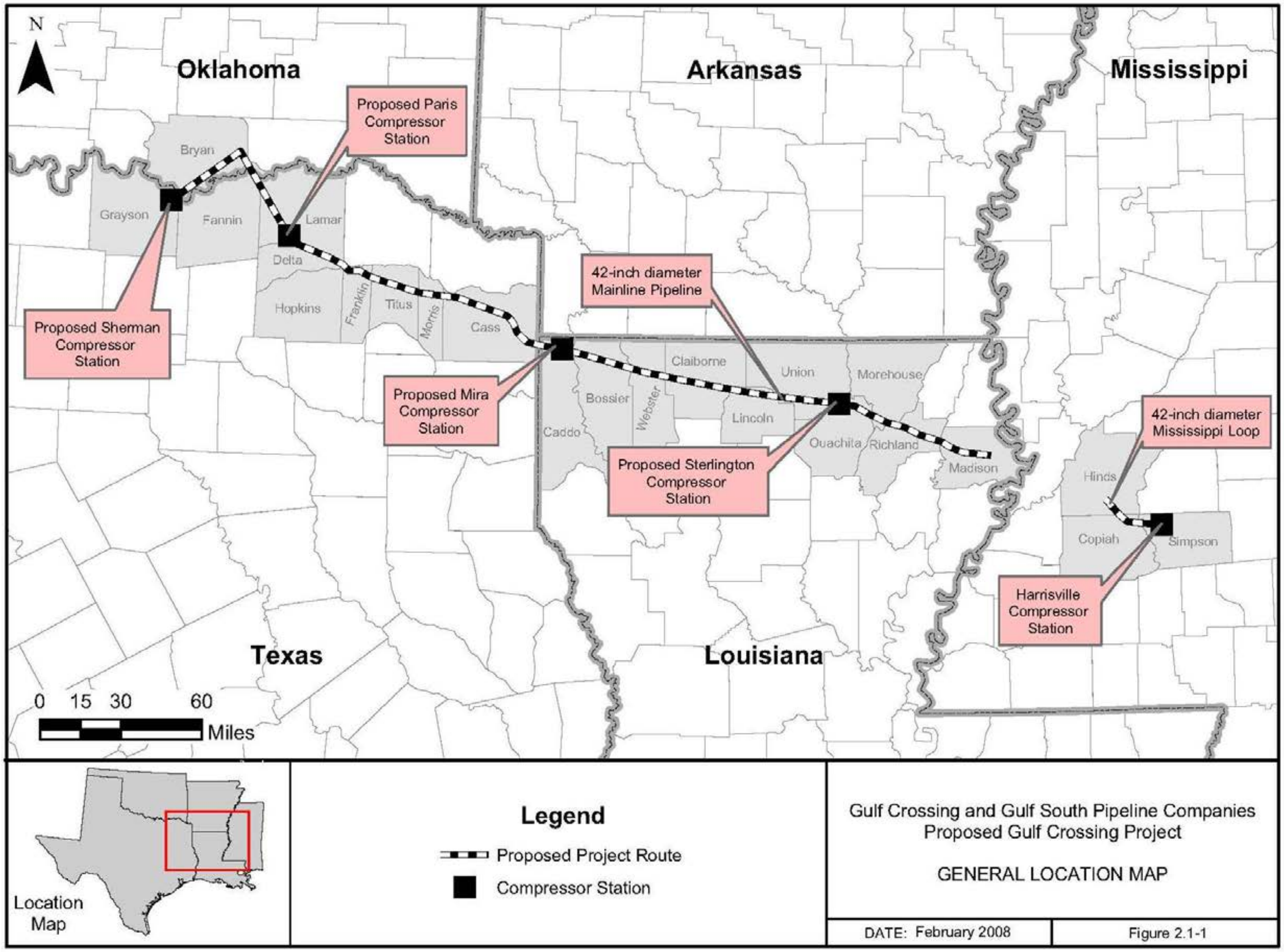


Figure 5-5. Gulf Crossing Project location map

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 converted into (i.e., built up or developed as) 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). (This is obtained by dividing the area of non-federal developed land in the state by the total number of residents.) Using these estimates and averages, on the order of 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), larger than the surface area of the LBCR, would be developed to accommodate almost 50,000 new residents. However, 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/square mile (Demographia, 2000), or 0.64 acre per resident, this would represent approximately 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 31-48 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 have changed.

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, 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, visual resources, socioeconomics, and cultural resources.

Potential cumulative impacts associated with growth of the DFW Metroplex are listed in Table 5-2.

5.4 CUMULATIVE EFFECTS OF PROPOSED ACTION, NO ACTION, AND OTHER ACTIONS

5.4.1 Soils

For analysis of cumulative impacts on soils, the ROI is Fannin 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. Indeed, 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).

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact Fannin County's soils include Bois d'Arc Creek channelization, all of the reservoir and pipeline projects, and the growth of Fannin County and the Dallas - Fort Worth 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.
1
Two large new reservoirs in Fannin County plus their mitigation site(s) would permanently inundate or change the vegetative cover on several thousand of acres of prime farmland soils in the county. Looking ahead to the year 2060, however, another cause of conversion (loss) of prime farmland soils in the county, from agriculture or potential use for agriculture to being covered with impervious surfaces, is likely to be population growth and associated land development. Census Bureau and Office of the State Demographic projections indicate that Fannin County's population is likely to be more than 100% higher by 2060 – roughly 50,000 new residents over the coming five decades. 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 Dallas-Fort Worth Metroplex expands northward. However, the Proposed Action would certainly contribute directly and indirectly to this adverse cumulative effect by stimulating additional real estate development.

5.4.1.1 Conclusion

Chapter 4 concluded that the effects on soils, including Prime Farmland soils, of constructing and operating the LBCR in and of itself would be adverse but less than significant. However, TWDB's adopted county population projections show Fannin County growing from 38,129 in 2010 to nearly 87,000 by 2060, an increase of more than 48,000. Assuming a small town urban/suburban population density of 1,000/square mile (Demographia, 2000), this would represent approximately 48 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, under the **Proposed Action**, the sum total of all other development in Fannin County by 2060 would use an additional 109 percent more land than the proposed reservoirs themselves, and given current land use in the county, much of it would likely be farmland, including Prime Farmland soils. This would constitute an adverse, long-term (permanent), moderate to major impact covering a large area. It may well be considered significant. The Proposed Action itself would contribute incrementally towards, and perhaps be partially responsible for some of this adverse cumulative effect (in the sense that without municipal water being made available, 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) 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 due to the conversion of rural land soils to urbanized or developed lands. Impacts would thus be adverse, long-term, and moderate to major.

5.4.2 Water Resources

Climate change is predicted to result in drier, hotter conditions in the region. 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 discharges. In this context, expanding water storage capacity represents an important strategy for dealing with the likelihood of increasing water scarcity.

While Fannin County is the primary ROI for this cumulative effects analysis, the primary ROI for water resources in the affected environment and environmental consequences chapters is the Bois d'Arc Creek watershed (which would exclude Lake Ralph Hall). However, to obtain a broader perspective, it is also worth, at least in passing, viewing these projects in the wider context of the State of Texas as a whole.

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 acre-feet 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 USA (TSHA, no date-b).

In addition to the 187 existing major reservoirs, the 2012 State Water Plan recommends 26 new major reservoirs to meet water needs in several regions (Figure 5-6), the majority located east of Interstate 35where rainfall and runoff are more abundant. These new reservoirs would produce 1.5 million AFY of water in 2060 if all are built (TWDB, 2012).

Overall, the construction of all of these reservoirs have had marked and significant cumulative effects – both beneficial and adverse – on the surface water hydrology of Texas. The LBCR would represent an incremental contribution to these already accumulated and reasonably foreseeable impacts.

5.4.2.1 Streams

For analysis of cumulative impacts on streams, the ROI is Fannin County, with a particular focus on the Bois d'Arc Creek watershed. 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 southeast 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 the Red's confluence with Bois d'Arc Creek.

The streams in Fannin County are impounded by four existing reservoirs: Lake Bonham, Lake 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 in chapters 3 and 4 and Section 5.2.1, much of Bois d'Arc Creek itself has been channelized, which has affected the hydrology and geomorphology of this principal stream.

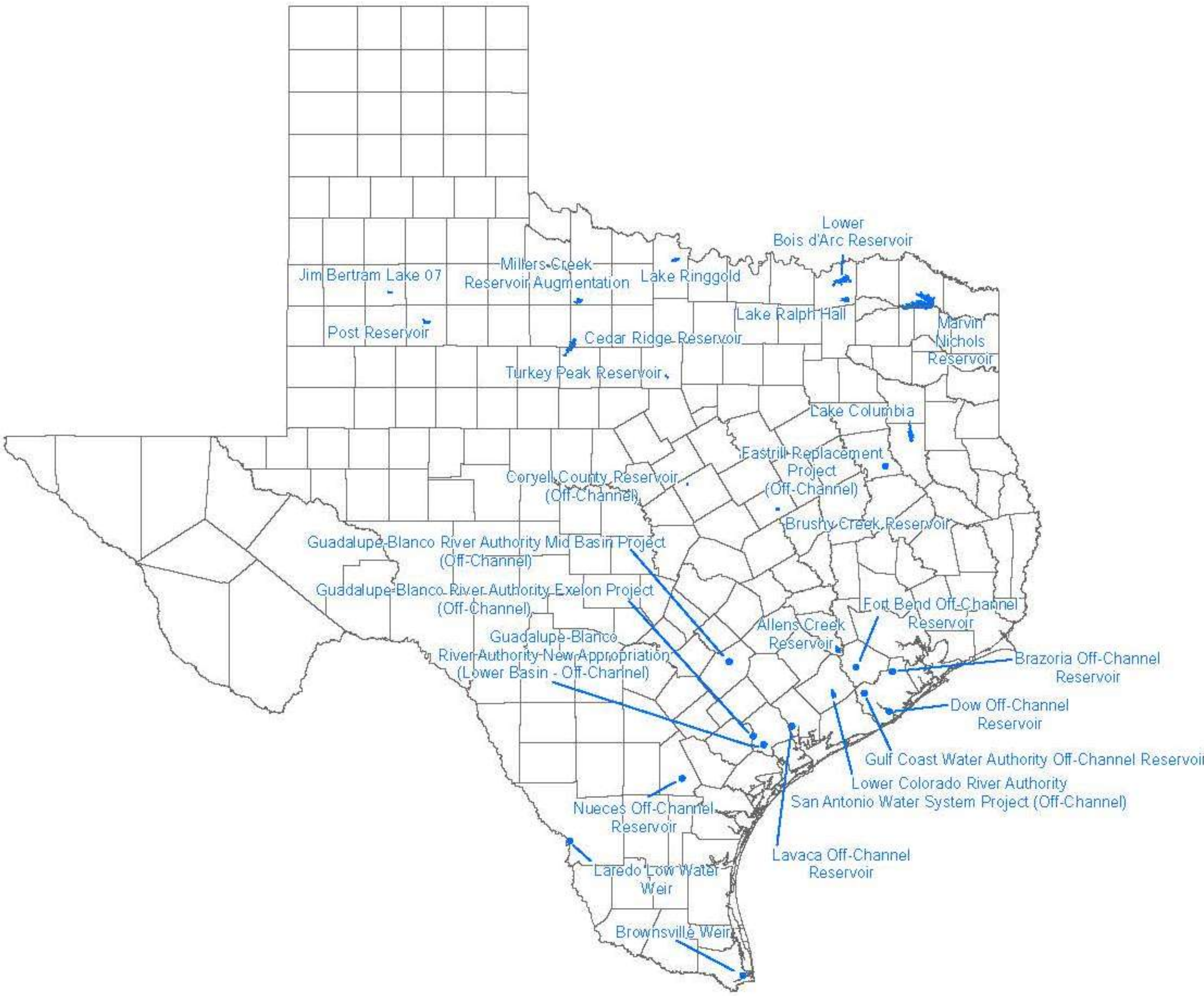


Figure 5-6. Recommended new major reservoirs in the 2012 Texas Water Plan

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact Fannin County's streams include Bois d'Arc Creek channelization, all of the reservoir and pipeline projects, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

Conclusion

The LBCR proposed action would directly impact 651,024 linear feet of stream on Bois d'Arc Creek itself and its tributaries. This represents 229,054 linear feet of Stream Quality Units (SQUs). At Riverby Ranch, 404,979 linear feet of streams are proposed for mitigation, representing 193,334 SQUs. Thus, there would be a net loss of 246,045 linear feet (46.6 miles) or 35,720 SQU's. While net losses of stream length have not been quantified and evaluated for LRH, that project and reservoir are smaller, and 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 (e.g., pavement, rooftops) – unless mitigated – associated with projected development and urbanization (estimated at roughly 48 square miles) that would occur in Fannin County to accommodate a projected 48,000 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 faced with 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, the net effect of which is to reduce storm runoff and peak flows.

In sum, under the **Proposed Action**, by 2060 the cumulative effect of all reasonably foreseeable changes on streams in Fannin County would be adverse, moderate, long-term, of large extent, probable likelihood, and slight precedence.

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 adverse, moderate, long-term, of large extent, probable likelihood, and slight precedence.

5.4.2.2 <u>Bottomland Hardwoods/Wetlands</u>

For analysis of cumulative impacts on streams, the ROI is the state of Texas. In good part this is 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 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).

Concerning bottomland hardwood forests in particular, statewide, as a result of dams/reservoirs and all other causes (clearing for agricultural purposes, channelization, urbanization, etc.) the area of forested river and creek floodplain vegetation (i.e., bottomland hardwood forests 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).

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact Fannin County's bottomland hardwoods and wetlands include Bois d'Arc Creek channelization, all of the reservoir and pipeline projects, and the growth of Fannin County and the Dallas - Fort Worth Metroplex. Specific projects and actions in the entire state of Texas would be far too many to enumerate, but the rapid population growth the state has experienced in recent decades and is projected to undergo through the year 2060 and beyond is correlated with a high degree of new development, some of which could potentially affect wetlands generally and bottomland hardwoods in particular.

Conclusion
Total direct impacts to wetlands and waters of the U.S. from the dam and reservoir would be 6,180 acres. However, once all forms of proposed mitigation are taken into account, the Proposed Action would not lead to any long-term net loss of waters and wetlands values and functions. According to Table 4-10 in this EIS, while there would be a net loss of 650 acres of forested wetlands due to the project, there would be a net gain of 1,115.6 Habitat Units (HU's). As a result of wetland restoration and enhancement there

would be net gains of both acreage and HU's for emergent and shrub wetlands. Impacts associated with LRH are unknown.

Other reasonably foreseeable action within Fannin County would likely impact wetlands only indirectly or on a small scale, in part because of the state and nation's regulatory apparatus (such as the USACE's Section 404 regulatory program) to protect wetlands and pursuit of the no-net-loss goal. On the statewide and national levels, wetland losses continue, albeit at a reduced rate from that which prevailed during the 20th century prior to the advent of wetlands conservation efforts from the 1970s and 1980s onwards. The U.S. Fish and Wildlife Service estimates that between 2004 and 2009, the acreage of wetlands in the nation as a whole declined by 62,300 acres, or 0.06 percent of the 110.1 million acres of wetlands in the conterminous United States in 2009 (Dahl, 2011).

Under both the **Proposed Action** – with mitigation – and **No Action Alternatives**, little or no contribution to cumulative adverse impacts on waters and wetlands in Fannin County or Texas as a whole is anticipated.

5.4.2.3 Groundwater

For analysis of cumulative impacts on groundwater, the ROI is Fannin County. As described in Section 3.2.2, 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 produced from locally 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.

In the entirety of Region C, an estimated 146,152 AFY of groundwater is hypothetically available in perpetuity, which is more than the estimated firm yield of 126,200 AFY for the LBCR. However, many providers and users compete for this water already, and little additional water supply is actually available from Region C aquifers. Indeed, TCEQ has designated a ten-county area within Region C as a priority groundwater management area (PGMA) due to pronounced declines in groundwater in the region.

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact Fannin County's aquifers and groundwater resources include Bois d'Arc Creek channelization, all of the reservoir and pipeline projects, and the growth of Fannin County and the Dallas - Fort Worth 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 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 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.

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 5-2 would have at most localized effects on groundwater.

Therefore, the **Proposed Action** is not expected to exacerbate 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 and pressure on already stressed groundwater resources within the county and wider region.

5.4.2.4 Water Supply Availability Downstream

For analysis of cumulative impacts on downstream water supplies, the ROI is Bois d'Arc Creek and the Red River downstream of its confluence with Bois d'Arc Creek. As described in Section 4.4.2.3, 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 3-4 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.

The Texas 2011 Region C water plan reports that Fannin County has run-of-the-river (diversion) rights to 72 AFY for mining. The only other county in the region that is listed as having a run-of-the-river right is Wise County (205 AFY), located to the west-southwest (Wise County does not border the Red River). The 2011 Region C water plan lists ten other counties (of 16 in the region) as having other local supply for mining, totaling 3,031 AFY. The 2006 Region C water plan indicates that total water use for mining in the region was 10,367 AFY in 2006, or less than 1% of total water use. Total water use for mining in the Northeast Texas Planning Region (Region D) totaled 11,448 AFY in 2004, or approximately 3% of total water use for the region in that year. The regional mining water supply is cited as 26 AFY for the portion of the Red River Basin that lies within Region D (the bulk of the mining water use within this planning region occurs in the Cypress, Sabine, and Sulphur River Basins). The mining sector does not account for significant water demands in either of Texas Water Planning Regions C or D.

The Railroad Commission of Texas (RRC) has jurisdiction over the exploration, development, and production of oil and gas and geothermal resources in Texas, in addition to surface mining for coal, uranium, and iron ore gravel (RRC, 2012). The RRC reports four core counties (Harrison, Panola, Shelby, and San Augustine) and six non-core counties (Angelina, Gregg, Marion, Nacogdoches, Rusk, and Sabine) for the Haynesville/Bossier Shale development. These counties are located in the southern portion of Texas Water Planning Regions D and I, in northeast and eastern Texas, south of the Red River and south-southeast of Fannin County. The Barnett Shale development is centered in southeast Wise County, and extends into 16 north Texas Counties (RRC, 2012), west-southwest of Fannin County (R.W. Harden & Associates, 2007). Hydraulic fracturing (aka 'hydrofracking' or 'fracking') is used to extract natural gas from the Barnett Shale (RRC, 2012).

Hydrofracking involves pumping large volumes of fresh water into the gas-bearing shale formation. Water volumes injected during hydraulic fracturing treatment can range from 70,000 barrels (2.9 million gallons) in a vertical well to over 90,000 barrels (3.8 million gallons) in a horizontal well (RRC, 2012).

Water use for fracking in the Barnett Shale is estimated at 1.2 to 3.5 million gallons or 4 to 11 acre-feet for each well, with the water use spanning over a period of approximately 1 month per well (R. W. Harden & Associates, 2007). Fracking generally takes place immediately after drilling a new well and can occur again periodically during the life of the well (RRC, 2012).

The TWDB published a study in 2007 analyzing groundwater availability in a 19-county area of North Texas, and the report discusses water use for Barnett Shale development (R.W. Harden & Associates, 2007). The 19-county study area does not include Fannin County, and Montague County is the only county included in the planning area that borders the Red River. Eighty-nine percent of the total water supply in the 19-county study area comes from surface water, with the amount of water used for Barnett Shale development accounting for less than 1% of total water use (RRC, 2012). The report estimates that a total of 7,200 acre-feet of water was used for Barnett Shale development in 2005, with 60 percent of this use being supplied by groundwater from the Trinity and Woodbine aquifers (R.W. Harden & Associates, 2007). Future demand for Barnett Shale development was also projected as a part of this study, yielding a projected use of between 5,200 to 25,000 acre-feet of water for hydrofracking of the Barnett Shale in 2025 (RRC, 2007).

Hydrofracking is not occurring in Fannin County or in the surrounding counties, although it is occurring in other areas of Texas with large proportions of groundwater are being used for this purpose (R.W. Harden & Associates, 2007). Due to the lack of any hydrofracking in Fannin County, or in the surrounding counties, no cumulative impacts on the flow of the Red River are expected to result from the combined withdrawals of 126,200 acre-feet at the Lower Bois d'Arc Creek Reservoir and the water used for hydrofracking.

Regarding any hydrofracking return flows, several companies have submitted applications to the RRC for recycling projects that would reduce the amount of fresh water used in gas development, and some of the applications have been approved, resulting in pilot studies and a handful of recycling project authorizations (RRC, 2012). Water injected to fracture formations is unusable when it returns to the ground surface due to high salt content, and one proposed recycling process involves distilling the water so that it can be reused for hydrofracking additional wells instead of disposing the returned fluids in disposal wells (RRC, 2012). Other recycling programs are awaiting authorizations that will allow them to dispose of produced water and drilling fluids into City wastewater systems for treatment and reuse (e.g., the City of Fort Worth system) (RRC, 2012).

Natural gas production in the Haynesville Shale Play had been increasing rapidly in recent years (Kaiser and Yu, 2011) and water use has increased commensurately and quickly (Nicot and Scanlon, 2012). The Haynesville Play straddles the Texas-Louisiana border (Figure 5-7) and the Red River traverses this region.

As of 2011, water use for hydrofracking shale gas in Texas amounted to less than one percent of total statewide water withdrawals; however, local impacts can vary with water availability and competing demands. A total of 55,000 AF had been used in the Texas portion of the Haynesville Play Area as of 2011, of which an estimated 62 percent came from surface water withdrawals and 38 percent came from groundwater. Projections of cumulative net water use over the coming 50 years in all statewide shale plays total 3.5 million AF, peaking at 118,000 AFY in the mid-2020s, and declining to 19,000 AFY by 2060 (Figure 5-8). The Texas portion of the Haynesville play is projected to peak at 15,000 AF in 2022.

In contrast to municipal water use, which increases as population grows, shale-gas water use represents a transitory demand over a 30-40 year period (Nicot and Scanlon, 2012). As demand continues to grow, it is possible to employ conservation and recycling measures as well as shift to brackish water in hydrofracking/shale-gas production to avoid competition with other water users.

Figure 5-7. Haynesville Shale Play of Louisiana and Texas
Source: http://www.gohaynesvilleshale.com/shale-plays

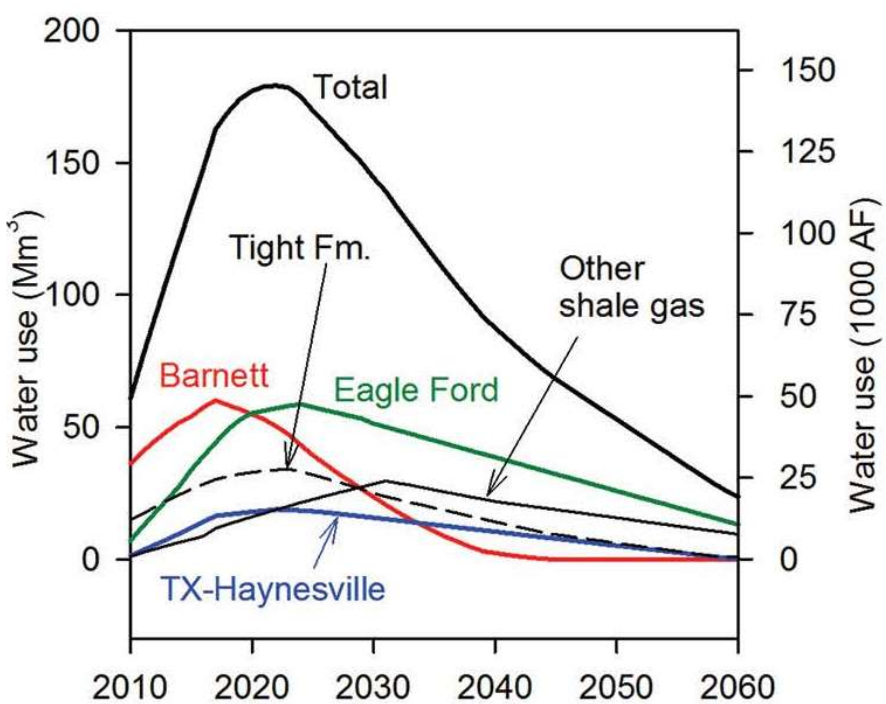


Figure 5-8. Time evolution of net water use in shale-gas production in Texas
Source: Nicot and Scanlon, 2012

Groundwater is generally available in each of the shale-gas plays, and in contrast to surface water, it is widespread, accessible, and generally available close to natural gas production wells (Nicot and Scanlon, 2012. This is especially true in East Texas and Louisiana, where the Haynesville Play is located.

From Table 5-2, the past, present and reasonably foreseeable actions in Fannin County anticipated to cumulatively affect water supplies downstream in Bois d'Arc Creek and the Red River include, all of the reservoir and pipeline projects (except LRH, which is not in the Red River Basin), the Center for Workplace Learning, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

Conclusion
By impounding and diverting water from the LBCR, the **Proposed Action** 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 significant adverse impact. Cumulative impacts from all actions, including hydraulic fracturing for shale-gas production, are not likely to cause water supply shortages. The **No Action Alternative** would not contribute to cumulative downstream water supply impacts.

5.4.2.5 Water Quality

For analysis of cumulative impacts on water quality, the ROI is Bois d'Arc Creek and the Red River downstream of its confluence with Bois d'Arc Creek. 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 one proceeds 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).

From Table 5-2, 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 all of the reservoir and pipeline projects, the Center for Workplace Learning, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

Conclusion
Bois d'Arc Creek is one of the Red River tributaries whose flows dilute the salinity of the Red River; thus by eliminating much of these inflows from impounding and diverting most of Bois d'Arc Creek flows at 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 mentioned in Chapter 4, analysis of specific conductance data shows that with the reservoir present, TDS concentrations in the Red River downstream of the Bois d'Arc Creek confluence would have likely increase by less than 2 percent. This is a minor cumulative, long-term impact.

General growth and development in Fannin County would increase stress on general water quality from non-point sources (erosion, nutrients from fertilizer use, runoff carrying contaminants from impervious surfaces, etc.), though this is not expected to present serious problems for water quality in either the LBCR or LRH reservoirs. Natural gas development (hydrofracking for shale gas) in the Red River Basin is on the increase in the Haynesville Play, and this can also impact surface and groundwater water quality from soil erosion, turbidity, and sedimentation, as well as improper disposal of produced water and methane contamination (McBroom et al., 2012; Nicot and Scanlong, 2012).

The **Proposed Action** 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.

5.4.3 Air Quality

The ROI for the analysis of cumulative impacts on air quality in this EIS is the 19-county Air Quality Control Region (AQCR) 215. As stated in Chapter 3 of this EIS (Section 3.3.1), 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).

From Table 5-2, the past, present and reasonably foreseeable actions in Fannin County anticipated to cumulatively affect air quality within the ROI include all of the reservoir and pipeline projects, the Center for Workplace Learning, North Texas Regional Airport, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

Both dam/reservoir projects and the pipeline construction projects 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. The 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 reservoir projects 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 Dallas-Fort Worth 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 and other emissions sources, such as fossil fuel fired power plants, industrial and manufacturing facilities. There would 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 will probably offset or even slightly reverse this trend, in spite of the increase number of pollutant sources.

5.4.3.1 <u>Conclusion</u>

Chapter 4 concluded that, overall, the Proposed Action's impacts on air quality would be adverse, and generally of negligible to minor magnitude, both short-term (construction) and long term (operation) duration, small or limited extent, probable likelihood, and slight precedence.

As the DFW Metroplex expands into Fannin County over the coming 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, especially ozone, within the county. However, as just noted, continuing improvements in fuel efficiency (CAFÉ) standards and ever more stringent tailpipe emissions requirements would likely substantially offset or even slightly reverse this trend. In sum, while there would likely be adverse effects on air quality, that is, lower average air quality in the future, they would probably not be significant, and the area is likely to stay in attainment for all criteria air pollutants.

LBCR, the **Proposed Action**, would contribute directly to these cumulative impacts only to a negligible to minor degree. To the extent that the probable recreational features of the reservoir as well as the water supply it represents occasion some (impossible to quantify) portion of the population growth and development that end up occurring in Fannin County – with concomitant air emissions – LBCR may 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.

5.4.4 Acoustic Environment (Noise)

The ROI for the analysis of cumulative impacts on the acoustic environment in this EIS is Fannin County. Neither Fannin County nor the State of Texas have noise ordinances. Bonham has a nuisance noise ordinance that addresses common noises such as car radios, but not construction noise. According to Section 3.4.3, 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.

From Table 5-2, the past, present and reasonably foreseeable actions in Fannin County anticipated to cumulatively affect noise levels within Fannin County include the reservoir and pipeline projects, North Texas Regional Airport, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

Both dam/reservoir projects and all other projects would generate noise during construction, degrading the acoustical environment, but only to a localized extent. Fannin County will become a noisier place in the future primarily as a result of projected growth and development – such as that represented by the other projects mentioned above – and the increasing number and use of noise-generating machinery, from autos and light trucks to air conditioners, lawn mowers, and generators associated with this.

5.4.4.1 <u>Conclusion</u>

Chapter 4 (Section 4.6) concluded that the Proposed Action would have short-term minor adverse and long-term minor beneficial effects on the noise 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. The **Proposed Action** (LBCR) would contribute both directly and indirectly to this cumulative increase in noise levels, however as just noted, these impacts and noise levels would not be significantly adverse.

The **No Action Alternative** would not contribute at all to the expected cumulative increase in future ambient noise levels in Fannin County as it becomes more populous and developed.

5.4.5 Biological Resources

5.4.5.1 Overview of Cumulative Effects

The ROI for cumulative analysis of biological resources overall is Fannin County.

In several decades, after mitigation, no net long-term, adverse cumulative impacts on biological resources are anticipated for either LBCR or Lake Ralph Hall. 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.

If both dam/reservoir projects are constructed simultaneously (which appears increasingly unlikely), there would be a short-term net loss in species abundance and biodiversity within Fannin County as a result of conversion of bottomland hardwood forest, streams, and riparian habitats and wildlife dependent on these habitats.

Statewide, as a result of dams/reservoirs and all other causes (clearing for agricultural purposes, channelization, urbanization, etc.) 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 six million acres at present (Texas Water Matters, 2012). However, following the successful implementation of mitigation at the Riverby Ranch, the LBCR would not contribute to further net loss.

Impacts of the Proposed Action on aquatic wildlife within the reservoir footprint would be both adverse and beneficial, short-term and long-term, of medium extent, probable likelihood, and moderate precedence. Within Bois d'Arc Creek downstream of the reservoir, likely long-term effects of the Proposed Action on aquatic wildlife would be largely beneficial, due to the ability of water managers to control flows throughout the year.

Conclusion
Chapter 4 concluded that, on net, the impacts of the Proposed Action on upland or terrestrial vegetation would be minor adverse over the long term. With mitigation measures implemented, these impacts would be less than significant. Once the reservoir habitats are established and stabilized, and once Riverby Ranch mitigation site habitats have been fully developed, benefits for wildlife overall would likely have developed sufficiently as to offset and perhaps surpass the initial adverse effects, provided that mitigation goals and objectives are achieved. Once proposed mitigation is taken into account, overall impacts to wildlife from the Proposed Action would be both adverse and beneficial, and less than significant. No adverse effects to federally listed species are anticipated.

The cumulative impacts of all other reasonably foreseeable actions, including expected growth and development 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 built-up 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 their numbers 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, and the challenges and costs they impose, is expected.

Overall cumulative effects on biological resources from all reasonably foreseeable actions, including the Proposed Action, are expected to be adverse but not significant.

5.4.5.2 Vegetation

The ROI for the analysis of cumulative impacts on vegetation in this EIS is Fannin County. As described in Chapter 3 (Section 3.5.1.1), 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 found 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 3.5.1.1, depicted graphically in Figure 3-21, and listed in Table 3-15. The two most abundant vegetation communities occurring on the project site are bottomland hardwoods/forested wetlands and grasslands/old fields. In the Proposed Action 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 Chapter 4 (Section 4.7.1.1). Additional minor effects on vegetation would be associated with connected actions. Unavoidable impacts to both bottomlands/wetland and upland vegetation from the Proposed Action 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 Tables 4-10 and 4-17. 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, but 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 HU's).

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact Fannin County vegetation include Bois d'Arc Creek channelization, all of the reservoir and pipeline projects, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

Conclusion

The **Proposed Action** 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 more than an expected doubling of its population by the year 2060, all vegetation communities, particularly upland sites more amenable to building and not protected by the regulatory apparatus in place to conserve wetlands, are likely to decline. The proposed LBCR would not contribute to the growing cumulative pressure on wetlands-associated vegetation, but 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, but under this scenario, there would still be a net decrease in natural vegetation in Fannin County, especially upland vegetation, associated with anticipated population growth and development.

5.4.5.3 Terrestrial Wildlife

The ROI for the analysis of cumulative impacts on terrestrial wildlife in this EIS is Fannin County. According to Section 3.5.2.1, the Proposed Action, connected actions and Fannin County are all 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 and Fannin County in particular 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.

As described in Chapter 4 (Section 4.7.2.2), adverse effects from the proposed LBCR dam and reservoir construction on wildlife would be expected to be moderate in magnitude, short-term and long-term in duration, medium in extent, probable, and moderate in precedence and uniqueness. 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 both 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.

From Table 5-2, 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, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

Conclusion
The **Proposed Action** would have medium-term adverse effect on existing wildlife and wildlife habitat by converting those existing habitats, which support wildlife populations, into another habitat type altogether (mostly open water). However, over the long term, the immediate adverse effects of the Proposed Action on wildlife in Fannin County would be offset by wildlife habitat restoration and improvement at the Riverby Ranch mitigation site. Thus, the long-term net cumulative effect of the Proposed Action 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 diversity) in Fannin County than at present due to the need to develop existing wildlife-supporting habitats to support another 48,000 human residents within the county. The **No Action Alternative** would not contribute to adverse cumulative impacts on wildlife associated with growth and development, but nor would it prevent this growth and development from occurring.

5.4.5.4 Aquatic Life

The ROI for the analysis of cumulative impacts on aquatic life in this EIS is Bois d'Arc Creek itself, 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. As recounted in Chapter 3 (Section 3.5.4.1), the Instream Flow Study, IBI scores for fish community structure were Intermediate to High, with scores that increased longitudinally within the mainstem of Bois d'Arc Creek 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.

As recounted in Chapter 4 (Section 4.7.2.3) the effects of dam and reservoir construction to 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 atop what is now an intermittent stream, and 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 undergoing impoundment. 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, since 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 community 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, barring unforeseen actions by others. The macroinvertebrate communities downstream of the impoundment should not change greatly, as long as adequate flows are maintained.

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact aquatic life in Bois d'Arc Creek include channelization, the reservoir and pipeline projects except for LRH (which is not in the same watershed), and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

Conclusion

The **Proposed Action** 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 the segment that would be downstream of the proposed dam; on balance, 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 of the draft water right permit. 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 48,000 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.

5.4.5.5 Threatened and Endangered Species

The ROI for the analysis of cumulative impacts on threatened and endangered species in this EIS is Fannin County. According to Section 3.5.5.1 in Chapter 3 of this EIS, three federally-listed species have been documented in the county – the bald eagle (in recovery), interior least tern (endangered), and black bear (only because of its similarity of appearance to the Louisiana black bear (a sub-species of black bear). However, the project site contains no nesting and limited foraging habitat for interior least terns and bald eagles (now de-listed by USFWS but still protected under the Bald and Golden Eagle Protection Act). While potential habitat for black bears does occur within the reservoir footprint, none have ever been documented on site. Thus, it is unlikely that any federally listed species would be adversely affected by the Proposed Action.

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. Adverse impacts are possible to the Texas state threatened blackside darter, blue sucker, creek chubsucker, and timber/canebrake rattlesnake due to the construction and inundation of the proposed dam and reservoir. Potential adverse effects to all these species would be moderate in magnitude, medium in extent, long-term in duration, and unlikely.

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact threatened and endangered species within the ROI include Bois d'Arc Creek channelization, the reservoir and pipeline projects except for LRH (which is not in the same watershed), and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

Conclusion
The **Proposed Action** 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 potentially be present in the project vicinity. Other projects and general development expected within the county to accommodate the needs of 48,000 projected new residents by 2060 might 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 either federal or state threatened and endangered species in Fannin County. However, cumulative adverse impacts might still occur on these species due to expected growth and development.

5.4.6 Recreation

The ROI for the analysis of cumulative impacts on recreation in this EIS is Fannin and surrounding counties (Collin, Hunt, Lamar, Grayson, Delta). As related in Chapter 3 of this EIS (Section 3.6.1), recreation land within the reservoir footprint site and pipeline route 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 occasional 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-country ROI contains a number of lakes and parks that provide outdoor recreation experiences, in addition to the Caddo National Grasslands, managed by the U.S. Forest Service.

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact recreation within the ROI include Bois d'Arc Creek channelization, the two reservoir projects, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

Long-term cumulative impacts of both the LBCR and LRH reservoirs in relatively close proximity operating and providing recreational opportunities such as fishing and boating in the future would likely occur, although at this juncture it is impossible to predict whether they are likely to compete with or complement one another. In general, if population continues to grow in the region over time, even if the two lakes compete with each other at first, cutting into each others' commercial prospects and performance, subsequent increases in demand for lake-based outdoor recreation could eventually reduce or eliminate any antagonistic interaction (competition). At some point, the very proximity of the two facilities could actually become advantageous as a draw to visitors.

5.4.6.1 Conclusion

Chapter 4 concluded that recreational opportunities at the **Proposed Action** (LBCR) are likely to be moderately beneficial, long term and medium in extent. As the population and level of development in Fannin County increase, recreational opportunities overall would be expected to increase in tandem. 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 will decrease, because in general, hunting is not compatible with higher human population densities due to safety concerns. Overall cumulative effects related to recreation are generally beneficial, and the LBCR would contribute to these. A potential downside is that with 48,000 projected additional residents in Fannin County, and similar demographic trends in some of the other surrounding counties within the ROI (from 791,000 to 1,938,000 in Collin County; from 126,000 to 254,000 in Grayson County, etc.), some outdoor recreation sites and facilities could face overcrowding, which would diminish the visitor experience. The **No Action Alternative** would experience neither the adverse nor the beneficial, long-term and cumulative effects of the Proposed Action.

5.4.7 Visual Resources

The ROI for the analysis of cumulative impacts on visual resources in this EIS is Fannin County.
As described in Chapter 3 of this EIS (Section 3.7.2), overall, 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.

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact recreation within the ROI include Bois d'Arc Creek channelization, the two reservoir projects, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

Both reservoir projects (LBCR and LRH) in particular would represent significant changes to the existing visual appearance of Fannin County, which is 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.

5.4.7.1 Conclusion

Chapter 4 (Section 4.9.2) concluded that, due to its size and salience, the **Proposed Action** (in particular, dam and reservoir construction and operation) would have a major, long-term impact on visual resources, but 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 in question. Some individuals would regard the permanent elimination of gently rolling pastoral scenery along Lower 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 on the landscape as an aesthetic asset to the community. Many members of the public would 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 50 years hence, 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 and environs, for better or worse. Cumulatively, over the long run, by not developing a lake with a protected green perimeter, this alternative would deny future residents a positive visual element in a county that would be both more populous and more developed.

5.4.8 Land Use

The ROI for the analysis of cumulative impacts on land use in this EIS is Fannin County. The county is relatively sparsely populated, 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, which is made up of 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 itself would cover 17,068 acres of bottomland and adjacent upland habitat along Bois d'Arc Creek in Fannin County, Texas. This land is predominantly undeveloped with scattered rural residences. The sites to be developed for the WTP, TSR, and related facilities near Leonard is also rural agricultural land.

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact land use within the ROI include Bois d'Arc Creek channelization, the two reservoir projects (LBCR and LRH), and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

In combination, the two reservoirs and their mitigation area(s) represent a significant 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 built-up and the area of lands in residential, commercial, and institutional uses 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.

5.4.8.1 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 in farmland and a growing percentage in developed land of one type or another. In this context, the fixed or permanent nature of the **Proposed Action**, LBCR, and its surrounding open space would represent a positive element. The **No Action Alternative** would not contribute to any cumulative changes in land use over the long term.

5.4.9 Utilities

The ROI for the analysis of cumulative impacts on utilities in this EIS is Fannin County. As detailed in Chapter 3 (Section 3.9), 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.

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact utilities within the ROI include the two reservoir projects (LBCR and LRH), the Center for Workplace Learning, the three pipeline projects, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

5.4.9.1 Conclusion

No cumulative impacts are expected from either the **Proposed Action** or **No Action Alternative**. As the county and ROI populations grow, there will be more utilities and utility corridors of all types.

5.4.10 Transportation

The ROI for the analysis of cumulative impacts on transportation in this EIS is Fannin County. As detailed in Chapter 3 (Section 3.10.1), the proposed reservoir footprint is traversed by a number of roads and bridges. Many of these would be impacted by the Proposed Action, especially FM 1396, for which is proposed a major relocation and new bridge construction over the proposed reservoir.

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact utilities within the ROI include Bois d'Arc Creek channelization, the two reservoir projects (LBCR and LRH), the Center for Workplace Learning, the North Texas Regional Airport, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

If the two 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 increased vehicles miles traveled in the future, Fannin County will have to add capacity to its ground transportation network as do all areas in the process of growth and development.

5.4.10.1 Conclusion

Chapter 4 concluded that the **Proposed Action** would have short-term adverse effects on transportation and traffic, of major magnitude, due to the number and length of roads requiring temporary or permanent closure and relocation. These short-term effects would be significant. Short-term and long-term effects to Fannin County's road network would be mixed. After completing the proposed dam, the reservoir would effectively close the 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 Proposed Action. Effects would be of minor magnitude, medium to large extent, probable likelihood, and slight precedence. Given the mitigation measures proposed to ameliorate these impacts, the long-term effects of the Proposed Action on transportation would be less than significant.

Anticipated growth and development in Fannin County would bring about significant cumulative effects in the county's road transportation network and traffic situation. Whether traffic congestion will be a significant problem 50 years from now is impossible to predict due to the number of variables. What is certain is that there will be more traffic than at present. The reservoirs' contribution to these cumulative effects related to transportation would be minimal.

5.4.11 Socioeconomics

The ROI for the analysis of cumulative socioeconomic effects is the six-county region described in Chapter 3, including Fannin, Collin, Hunt, Lamar, Grayson, Delta counties.

5.4.11.1 Short-Term Effects

Financing Costs
No tax revenues would be used to construct either the LBDC or Lake Ralph Hall reservoirs. UTRWD is a non-profit, government utility and therefore has no taxing powers. It is limited to revenues from service requested and authorized by member cities and entities who execute service contracts with Upper Trinity. After the cost of pumping, conveying, treating, storing and delivery is included, the cost of water to a wholesale customer is expected to be in a range of $2.25 to $2.50 per thousand gallons (UTRWD, 2005a). Debt financing for LRH includes a 40-year term.

Before amortization for LBCR, the cost of water would be $1.07 per thousand gallons. After amortization, water would drop to $0.21 per thousand gallons. 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 6 percent higher than existing rates (NTMWD, 2007a).

In 2008 the UTRWD received a $10.4 million loan from the Texas Water Development Board to support ongoing planning and permitting. The NTMWD 2010-2011 Comprehensive Financial Report indicates that the NTMWD May 2011 Water Rate Projections included funding for a $350 million bond issue in 2014 and a $450 million bond issue in 2019 for construction of the reservoir. Since the bonds are planned to be issued pursuant to two separate bond resolutions, the balance, term, and interest rates can be expected to differ and therefore so can the annual debt payments.

The UTRWD is rated "A3" by Moody's Investors Service, Inc. and "A-" by Standard & Poor's Ratings Services, a Standard & Poor's Financial Services LLC business, reflecting an above-average creditworthiness relative to other U.S. municipal or tax-exempt issuers or issues (FirstSouthwest, 2012).

In 2009 Standard & Poor's (S&P) Ratings Services assigned NTMWD an 'AAA' long-term credit rating based on its financial strength, or ability to pay a bond's principal and interest in a timely fashion. S&P's rating indicates that the district's members have strong credit quality. The contracts between the district and its member cities remain in-force unconditionally throughout the final maturity of all parity debt, or debt securities that have an equal and ratable claim on the same underlying asset as collateral. These contracts also essentially create an unlimited step-up provision, so the value of an asset that has appreciated over time can be readjusted for tax purposes upon inheritance. Additionally, the District's strong management at the authority level (as demonstrated by the degree of long-range planning and conservative fiscal policies) was another factor in the evaluation of NTMWD's credit rating.

See Section 4.14.2.2 for the detailed discussion of LBCR financing costs.

Construction
Assuming both reservoirs are permitted, the construction timeframe of both reservoirs would possibly overlap, although this appears less and less likely. In the worst case scenario of simultaneous construction, this might cause the cost of materials – especially fuel and cement - to 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. (Moreover, 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 LBDC 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 its pre-project(s) level. A large amount of land would be acquired for the two impoundment areas, which would otherwise create a significant loss in property tax revenue. With payments extending beyond both construction periods, no such losses would occur (McCarthy, 2012).

5.4.11.2 Long-Term Effects

Recreational Users and Revenue
Both proposed reservoirs plan to provide recreational opportunities like boating and fishing.

The Texoma Council of Government (TCOG) 2012 *Texoma Comprehensive Economic Development Strategy* 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 Army Corps of Engineers, nearby Lake Texoma attracts more than six million visitors a 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 this goal, it can be assumed that both lakes 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).

Since LRH is roughly 30 miles closer to Dallas, spillover from the DFW-Metroplex might arrive first. 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; indeed, Lake Ralph Hall would inundate approximately 250 acres within the 2,780-acre Ladonia Unit. The majority of this nearly 18,000-acre recreational area occurs within the Bois d'Arc Unit which is adjacent to – but would not overlap with – the proposed LBCR. One designated camp exists in the Ladonia Unit, compared to several in the Bois d'Arc Unit as well as campgrounds, multi-purpose trails, and boating on Coffee Mill Lake and Lake Crockett (See Figure 5-9, Caddo National Grasslands – Ladonia and Bois d'Arc Units). The area in and around the Lower Bois d'Arc Creek Reservoir, then, would offer more activities and thus might be more appealing to prospective anglers and boaters.

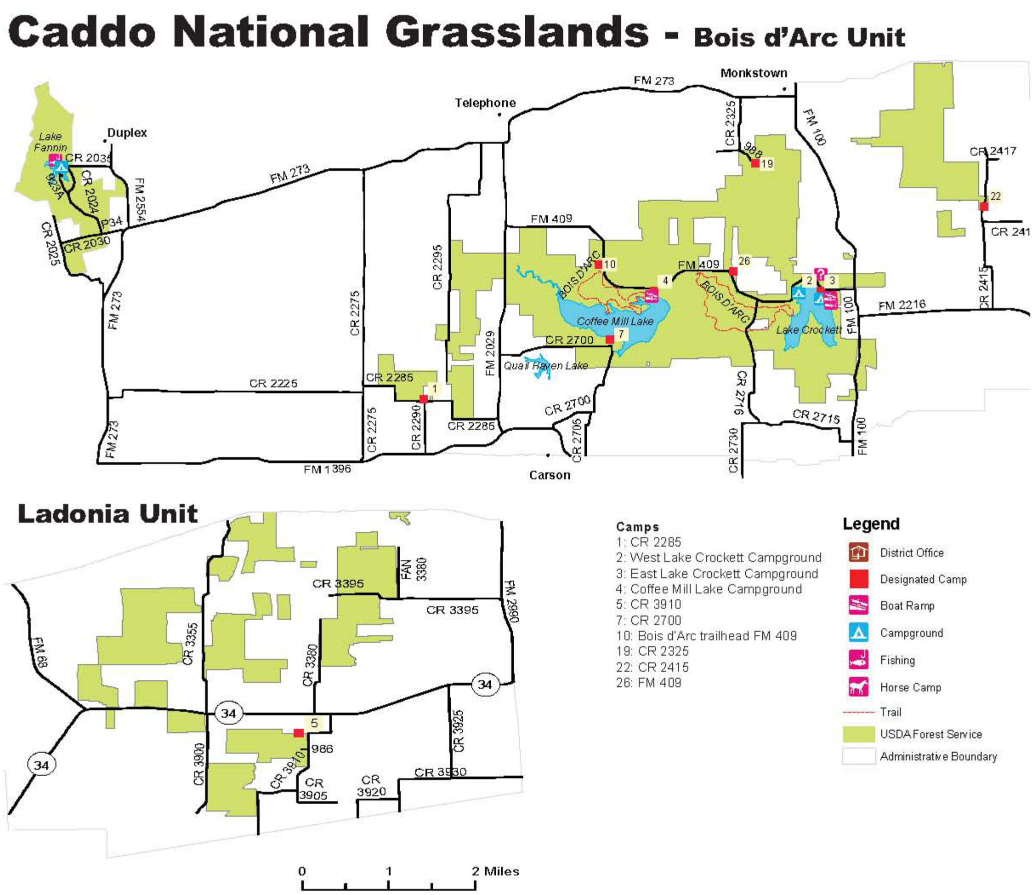


Figure 5-9. Caddo National Grasslands – Ladonia and Bois d'Arc Units
Source: USFS, no date

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, but 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 the Gulf Crossing Project, TransCanada Gulf Coast Pipeline Project, and eventually Panda Power Lateral Project would also contribute to the increased tax revenues in Fannin, Lamar, and Grayson counties.

Social Impacts
As established in Section 4.14.2, 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 assertion 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.

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, but the town kept fighting the project. It claims that the UTRWD has overbuilt infrastructure based on inflated population estimates. It has also raised questions about the district's financial condition (Hundley, 2012).

5.4.11.3 Conclusion

If the two 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 (influx of outside workers with possible attendant problems). 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 project costs for both 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 probable that the two reservoir projects would occur sequentially rather than simultaneously, which would dampen and draw out socioeconomic effects, both beneficial and adverse ones.

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(s) level; in the long-term both reservoirs would create additive, cumulative impacts. Additionally, tax receipts from both the Gulf Crossing Project, TransCanada Gulf Coast pipeline, and eventually the Panda Project would create thousands annually in additional revenue to Fannin, Lamar, and Grayson counties.

In the long-term, beneficial impacts from recreational revenue, commercial and real estate development (property tax revenue) of 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 greater in the presence of the two projects than in their absence.

5.4.12 Environmental Justice

The ROI for the analysis of cumulative effects related to environmental justice is the same six-county region as for socioeconomic effects, including Fannin, Collin, Hunt, Lamar, Grayson, Delta counties. Chapter 3 (Section 3.13.1.1) stated that 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.

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact environmental justice within the ROI include the two reservoir projects, the Center for Workplace Learning, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

5.4.12.1 Conclusion

Any long-term cumulative effects from the **Proposed Action** (LBCR) 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.

5.4.13 Cultural Resources

The ROI for the analysis of cumulative effects related to cultural resources is Fannin County. Chapter 3 details cultural resources present within the proposed reservoir's footprint and the overall APE. Thirty-four structures and/or buildings are within the APE, none of which are eligible for the NRHP. The Proposed Action would also affect the Wilks Cemetery within the reservoir footprint. 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 might 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 at least five and as many as 24 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, the Proposed Action's impacts on cultural resources, primarily archeological sites, would be considered significant under NEPA. Impacts can 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.

From Table 5-2, the past, present and reasonably foreseeable actions anticipated to cumulatively impact cultural resources within the ROI include Bois d'Arc Creek channelization, existing reservoirs, the two new reservoir projects, the pipeline projects, and the growth of Fannin County and the Dallas - Fort Worth Metroplex.

Both reservoir projects and other construction projects would impact cultural resources, although both will have to reduce those impacts to below the threshold of significance in order to comply with federal and state law. 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, the Proposed Action has had also beneficial effects related to cultural resources. It 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 Proposed Action and its analysis.

5.4.13.1 Conclusion

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, since they are on private properties. Thus, cumulatively and over the long term, impacts to cultural resources from the No Action Alternative are unknown.

Chapter 4 concluded that the impact from the **Proposed Action** on cultural resources would be of major magnitude. Its overall impact on cultural resources, primarily archeological sites, would be considered significant, although mitigation would reduce impacts to below the threshold of significance.

As just noted, 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 significant, and the proposed LBCR would contribute to these significant adverse impacts. However, the LBCR has already, and will continue to, trigger the generation of a large amount of information and knowledge about Fannin County's cultural resource legacy. Cumulatively, in forthcoming 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 5-2. Cumulative Impacts associated with Lower Bois d'Arc Creek Reservoir

		Past Actions					Recent and Reasonably Foreseeable Future Actions							
Resource	**ROI**	**Bois d'Arc Creek Channelization**	**Lake Bonham**	**Valley Lake**	**Coffee Mill Lake**	**Davy Crockett Lake**	**Lake Ralph Hall**	**Center for Workplace Learning**	**North Texas Regional Airport**	**TransCanada Gulf Coast Pipeline Project**	**Gulf Crossing Project**	**Panda Power Lateral Project**	**Growth of Fannin County**	**Growth of DFW Metroplex**
Soils	Fannin County	X	X	X	X	X	X			X	X		X	X
WATER RESOURCES														
Streams	Fannin County	X	X	X	X	X	X			X	X		X	X
Bottomland Hardwoods / Wetlands	Texas	X	X	X	X	X	X			X	X		X	X
Groundwater	Fannin County	X	X	X	X	X	X			X	X		X	X
Water Supplies	BDC & Red River[1]		X	X	X	X		X					X	X
Water Quality	BDC & Red River[1]	X	X	X	X	X	X			X	X		X	X
Air Quality	AQCR 215[2]		X	X	X	X	X		X	X	X	X	X	X
Acoustic Environment (Noise)	Fannin County		X	X	X	X	X		X	X	X		X	X
BIOLOGICAL RESOURCES	Fannin County	X	X	X	X	X	X			X	X	X	X	X
Vegetation	Fannin County	X	X	X	X	X	X			X	X		X	X
Terrestrial Wildlife	Fannin County	X	X	X	X	X	X			X	X		X	X
Aquatic Life	Bois d'Arc Creek	X	X	X	X	X	X			X	X		X	X
T & E Species	Fannin County	X	X	X	X	X	X			X	X		X	X
Recreation	6-county ROI[3]	X	X	X	X	X	X						X	X
Visual Resources	Fannin County	X	X	X	X	X	X						X	X
Land Use	Fannin County	X	X	X	X	X	X	X		X	X		X	X
Utilities	Fannin County						X	X		X	X	X	X	X
Transportation	Fannin County		X	X	X	X	X	X	X				X	X
Socioeconomic Impacts	6-county ROI[3]		X	X	X	X	X	X	X	X	X	X	X	X
Environmental Justice	6-county ROI[3]						X	X					X	X
Cultural Resources	Fannin County	X	X	X	X	X	X			X	X	X	X	X

[1]Bois d'Arc Creek and portion of Red River downstream of confluence; [2]19-countyAir Quality Control Region
[3]Fannin, Collin, Hunt, Lamar, Grayson, Delta counties

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