Bois d'Arc Lake WPP Chapter 3: Watershed Characterization

Texas Water Resources Institute
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Texas A&M AgriLife

North Texas Municipal Water District

Chapter 3: Watershed Characterization

Introduction

This chapter provides geographic, demographic and water quality overviews of the Bois d'Arc Lake watershed. Development of the information within this chapter relied heavily on state and federal data resources as well as local stakeholder knowledge. The collection of this information is critical for the reliable assessment of potential sources of water quality impairment and the recommendation of beneficial management measures.

Watershed Description

The Bois d'Arc Lake watershed lies within the larger Red River Basin, which begins in the panhandle and runs east along the Texas-Oklahoma border for approximately 400 miles. The watershed captures runoff from 326 square miles (208,454 acres) of mostly grasslands and is located in portions of Fannin and Grayson counties (Figure 1). There are seven incorporated towns and cities (Table 1) in the watershed with the City of Bonham being the largest urban area. There are also seven unincorporated towns in the watershed including: Allen's Town, Carson, Cotton Center, Ely, Lamasco, Lannius, and Randolph. The four main waterbodies within the watershed are Bois d'Arc Creek, Honey Grove Creek, Lake Bonham, and Bois d'Arc Lake.

Bois d'Arc Lake is located immediately below the Bois d'Arc Lake Dam and stretches throughout the northern area of the watershed adjacent to Lake Bonham. One of the lake's tributaries, Bois d'Arc Creek, begins from the southwestern arm of the lake and flows approximately 30 miles to the headwater northwest of Whitewright. The Bois d'Arc Creek subwatershed drains approximately 96,525 acres into the lake (Table 2). In the 1940's, much of Bois d'Arc Creek was channelized to mitigate flooding. The lake's other major tributary, Honey Grove Creek, begins from the most eastern arm of the lake upstream approximately five miles to the headwater west of the city of Honey Grove.

Table 1. Incorporated towns and cities in the Bois d'Arc Lake watershed (USCB, 2019)

Name	USCB Population Estimate	County
Bonham	10,386	Fannin
Boyd	1,518	Fannin
Dodd City	389	Fannin
Honey Grove	1,737	Fannin
Midway	236	Fannin
Whitewright	1,721	Grayson
Windom	205	Fannin

Table 2. Bois d'Arc Lake subwatershed drainage areas

Subwatershed	Percentage of Total	Acres	Sq. Miles
Bois d'Arc Creek	46.2%	96,252	151
Honey Grove Creek	2.22%	4,645	7
Bois d'Arc Lake[1]	43.26%	90,203	141
Lake Bonham[2]	8.32%	17,354	27
Total	100.0%	208,454	326

[1]Surface area of Bois d'Arc Lake at conservation pool elevation and subwatershed drainage area
[2]Surface area of Lake Bonham at conservation pool elevation and subwatershed drainage area

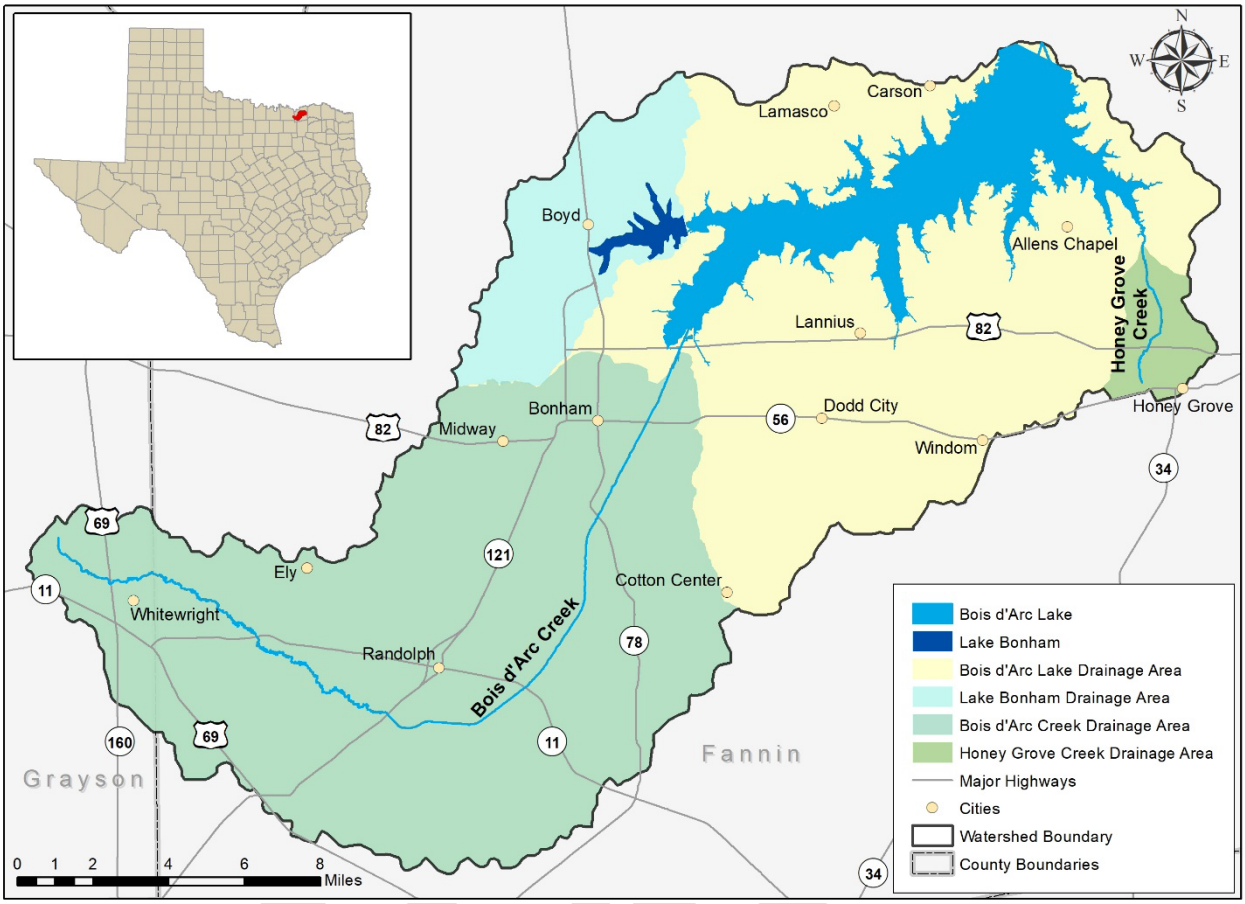

Figure 1. Bois d'Arc Lake watershed

Physical Characteristics

Soils and Topography

The soils and topography of a watershed are important components of watershed hydrology. Slope and elevation define where water will flow, while elevation and soil properties influence how much and how fast water will infiltrate into, flow over, or move through the soil into a water body. Soil properties may also affect the types of development and activities that should occur in certain areas.

The watershed is predominantly flat and has moderate drainage. The Bois d'Arc Lake watershed has a peak elevation of 830 feet with the lowest elevation point being 465.9 feet (USGS, 2013) (Figure 2). There is an average of a 3% slope gradient across the watershed, with more intense slopes restricted to areas such as cut banks near the creek systems.

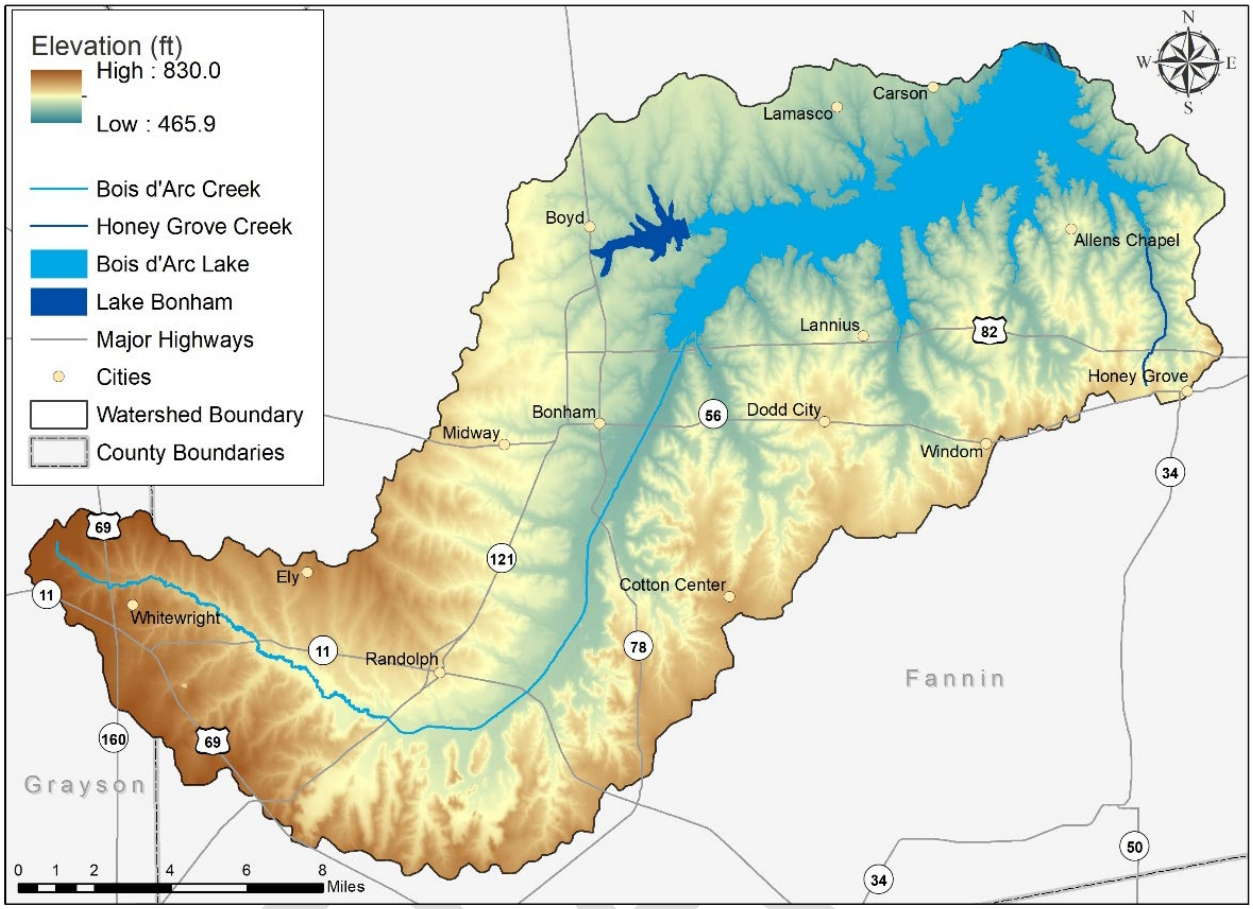

Figure 2. Elevation of the Bois d'Arc Lake watershed

The soils in the Bois d'Arc Lake watershed are mostly Inceptisols (34.3%, 71,499.7 acres (ac)), and Mollisols (31.2%, 65,037.6 ac) (Figure 3). Inceptisols are young soils that have a wide range of characteristics depending on the environment they form in. They do not have any of the unique properties of Mollisols, which are characterized by a dark surface layer indicative of high amounts of organic material and are very fertile and productive for agricultural uses. Mollisols are abundant throughout the watershed while the Inceptisols are mainly distributed around the streams. There are also other soil types, like Alfisols (11.5%), Aridisols (2.8%), Entisols (6.3%), Vertisols (4.9%) and other unclassified order (9%).

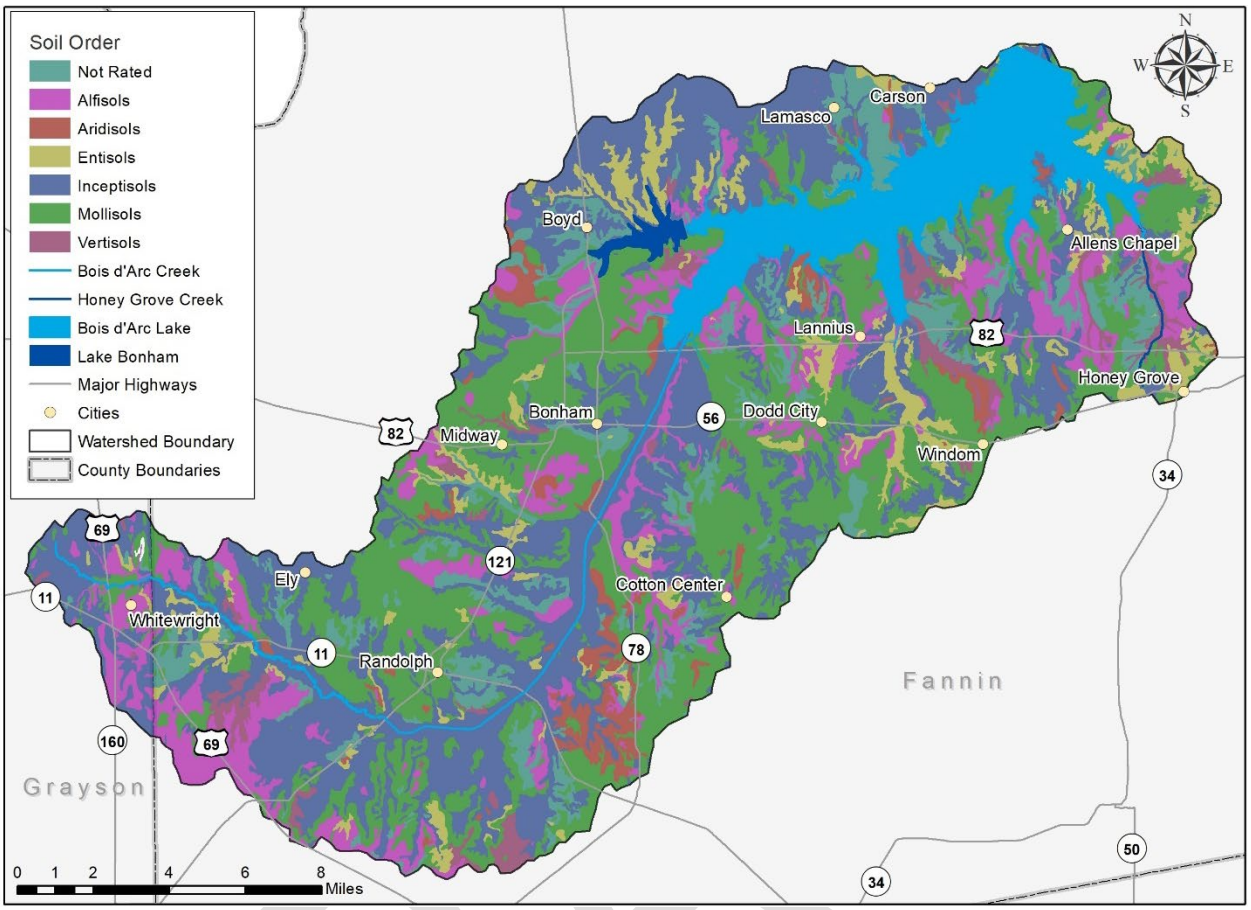

Figure 3. Bois d'Arc Lake watershed soil orders

Hydrologic Soil Groups (HSG) are groups of soil with similar runoff potential properties. HSGs are useful to consider the potential for runoff from sites under similar storm and cover conditions. Group A soils have high infiltration rate when wet (therefore low runoff potential). Group A soils are deep and well-drained (typical of well-drained sands or gravelly sands). Conversely, Group D soils have very slow infiltration rates with high runoff potential when wet. Group D soils are typically soils with high clay content, soils with high water tables or shallow soils on top of clay or impervious material. Group B and C soils are defined as having moderate and slow infiltration rates, respectively. The majority of soils in the Bois d'Arc Lake watershed have an HSG of B (42.7% of the watershed) or D (23.4%) (Figure 4). The remaining four groups are the least dominant HSGs in the watershed (Table 2) (NRCS, 2020).

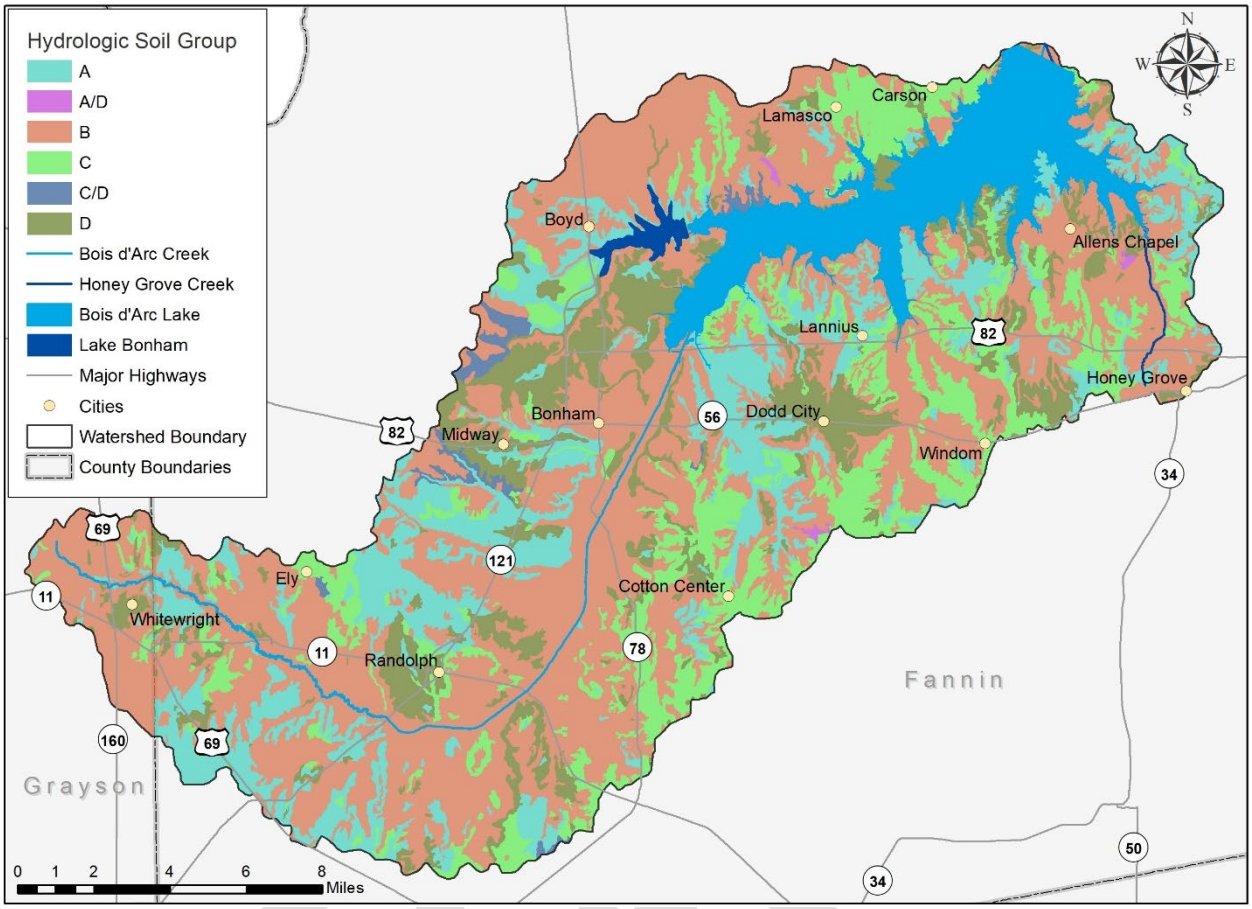

Figure 4. Bois d'Arc Lake watershed Hydrologic Soil Groups

Table 3. Descriptions of the Hydrologic Soil Groups in the Bois d'Arc Lake watershed

Hydrologic Soil Group	Acres	Percent of Total
A	36,383	17.5%
A/D	249	0.1%
B	111,102	42.7%
C	33,546	17.0%
C/D	1,874	0.5%
D	25,301	23.4%
Total	208,454	100%

Land Use and Land Cover

The land use/land cover (LULC) data for the Bois d'Arc Lake watershed were obtained from the U.S. Geological Survey (USGS) 2016 National Land Cover Database (NLCD) and are displayed in Figure 5. For descriptive purposes, similar land uses were aggregated where appropriate. For example, the developed land use category includes

four subcategory land uses: open, low, medium, and high intensity urban development and the rangeland category includes grasslands and shrub/scrub. The NLCD shows that Rangeland (40.5%) is the predominant land use in the watershed. The watershed is mostly rural in land use; around 6% of the area is classified as Developed. Table 3 illustrates the type of land uses within the watershed, as well as their corresponding percentage of land that each land use covers.

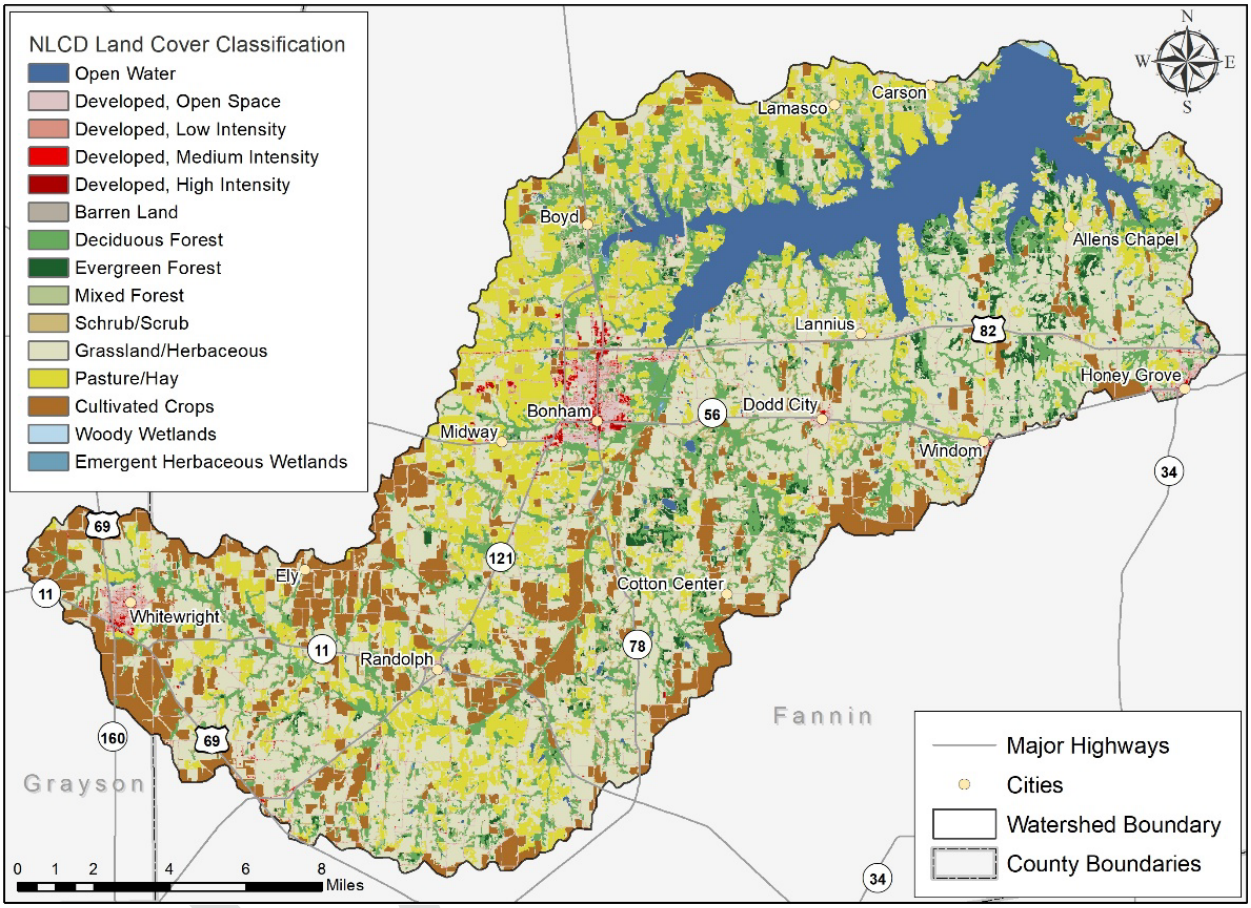

Figure 5. Land use and land cover classifications in the Bois d'Arc Lake watershed (NLCD, 2016)

Table 4. LULC classifications for Bois d'Arc Lake watershed (NLCD, 2016)

NLCD Classification	Acres	Percent of Total
Rangeland	84,375	40.5%
Forest	35,417	17.0%
Pasture	32,386	15.5%
Cultivated Crops	25,219	12.1%
Open Water	18,449	8.9%
Developed	12,608	6.0%
Total	208,454 acres	100%

Ecoregions

Ecoregions are land areas that contain similar quality and quantity of natural resources (Griffith, 2007). The watershed flows through two major ecoregions including the Blackland Prairies ecoregion, which encompasses most of the watershed, and the Post Oak Savannah ecoregion in the northeastern portion of the watershed (Figure 6). The Blackland Prairies ecoregion is dominated by tall grasses and deep, fertile black soils characterize the area. Cattle ranching and crop production are the primary agricultural industries in the ecoregion. The Post Oak Savannah ecoregion can be described as oak savannah with areas of oak woodland interspersed with grasslands. Cattle ranching is the primary agricultural industry. Animals native to these areas include white-tailed deer, beaver, nutria, bobcat, coyote, fox, skunk, raccoon, rabbit, gopher, squirrel, and a diverse array of other small mammals and birds. In addition, feral hog (non-native, invasive species) populations are known to be significant.

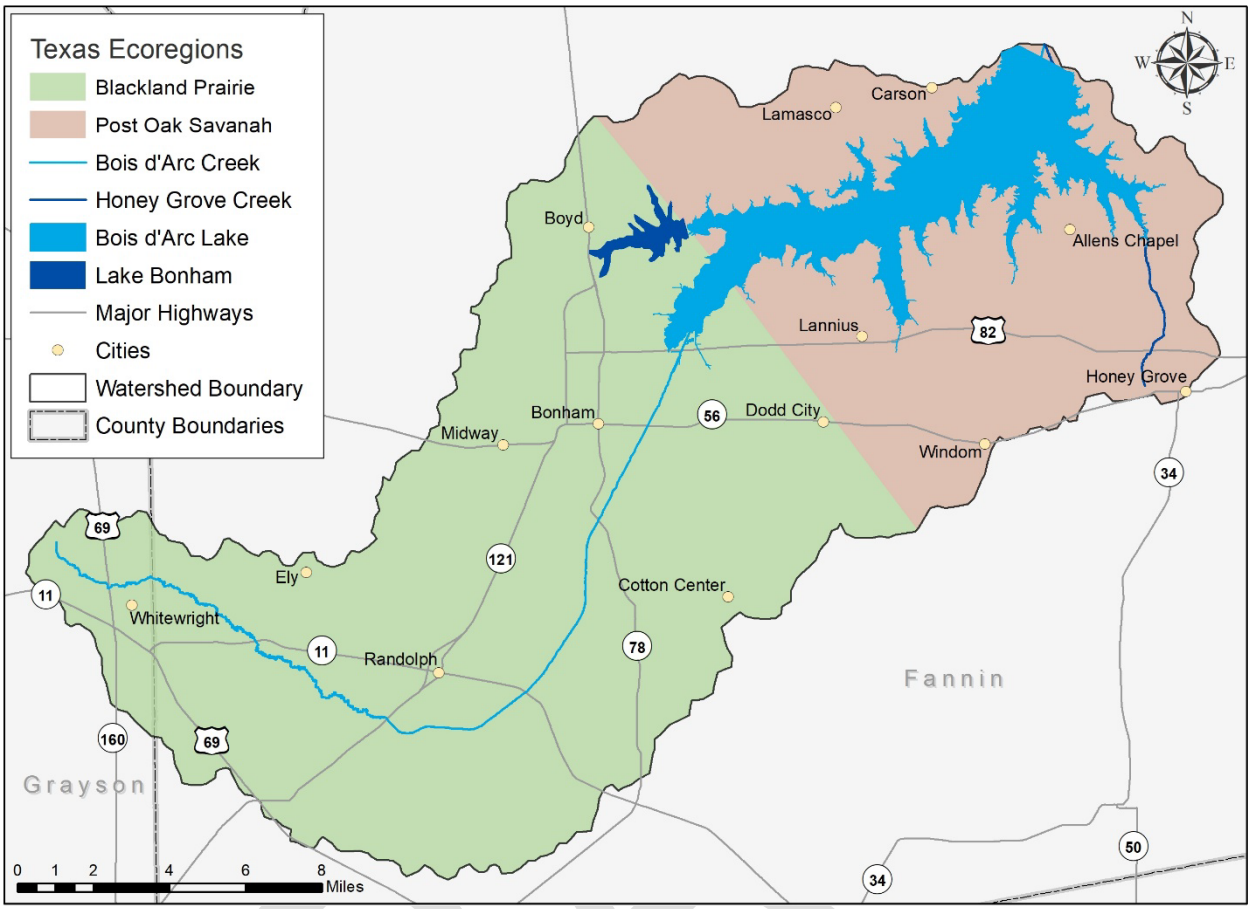

Figure 6. Bois d'Arc Lake watershed ecoregions

Water Resources

The Bois d'Arc Lake watershed is unique in that Bois d'Arc Lake is the first major reservoir constructed in Texas in nearly 30 years. It was developed by the North Texas Municipal Water District (NTMWD) to provide treated water for up to 80 communities in 10 North Texas counties, including Fannin County.

Planning for the 16,641 acre reservoir began in earnest after a series of meetings between Fannin County and NTMWD in 2004. In 2005, the Fannin County Commissioners Court passed a resolution supporting the lake and encouraging the formation of the Fannin County Water Supply Agency (FCWSA) to represent the County, cities and local water providers. Since then, NTMWD, has collaborated with Fannin County to develop Bois d'Arc Lake as a regional water supply and a destination for outdoor recreation. The work put forth by these entities is expected to enhance economic opportunities to Fannin County for years to come.

After more than a decade of planning and permitting, construction of Bois d'Arc Lake, the dam, and the Leonard Water Treatment Plant began in Fannin County in 2018. The

lake was impounded and began filling in 2021. NTMWD expects the reservoir to be filled enough to begin providing treated water to its customers and member cities in 2022. As a critical part of the state water plan, Bois d'Arc Lake will help meet projected North Texas water supply needs through 2040 with a firm yield of 120,000 acre-feet per year.

The lake is able to store up to 367,609 acre-feet of water and has a maximum depth of 70 feet. The elevation of the lake at conservation pool is 534 feet above mean sea level (msl) and it covers 16,641 acres of surface area. When the Bois d'Arc Lake project is fully completed it will help supply water to almost 2 million people in North Texas and provide recreation to the region.

To effectively balance and maintain a high-quality drinking water supply while also supporting recreation activities on and around Bois d'Arc Lake, the NTMWD developed the Bois d'Arc Lake Shoreline Management Plan (SMP). The SMP details strategies for maintaining drinking water quality such as establishing erosion control requirements and implementing best management practices for vegetation removal and chemical hazardous material use. It also includes guidelines for the protection and use of the lake's shoreline on NTMWD-owned land up to 541 feet above msl at about the 100-year floodplain (Figure 7). Flowage and flood easements also offer certain water quality protections up to 545 feet above msl which is approximately the 500-year floodplain (Figure 8). Additionally, Fannin County has the authority to apply land use zoning to the area within 5,000 feet of the lake's normal conservation pool. Collectively these measures will help reduce erosion and protect water quality in the reservoir. Upstream flood mitigation areas were selected in an area prone to localized flooding. Mitigation measures carried out by the NTMWD aim to restore and enhance forested wetlands (USACE, 2017).

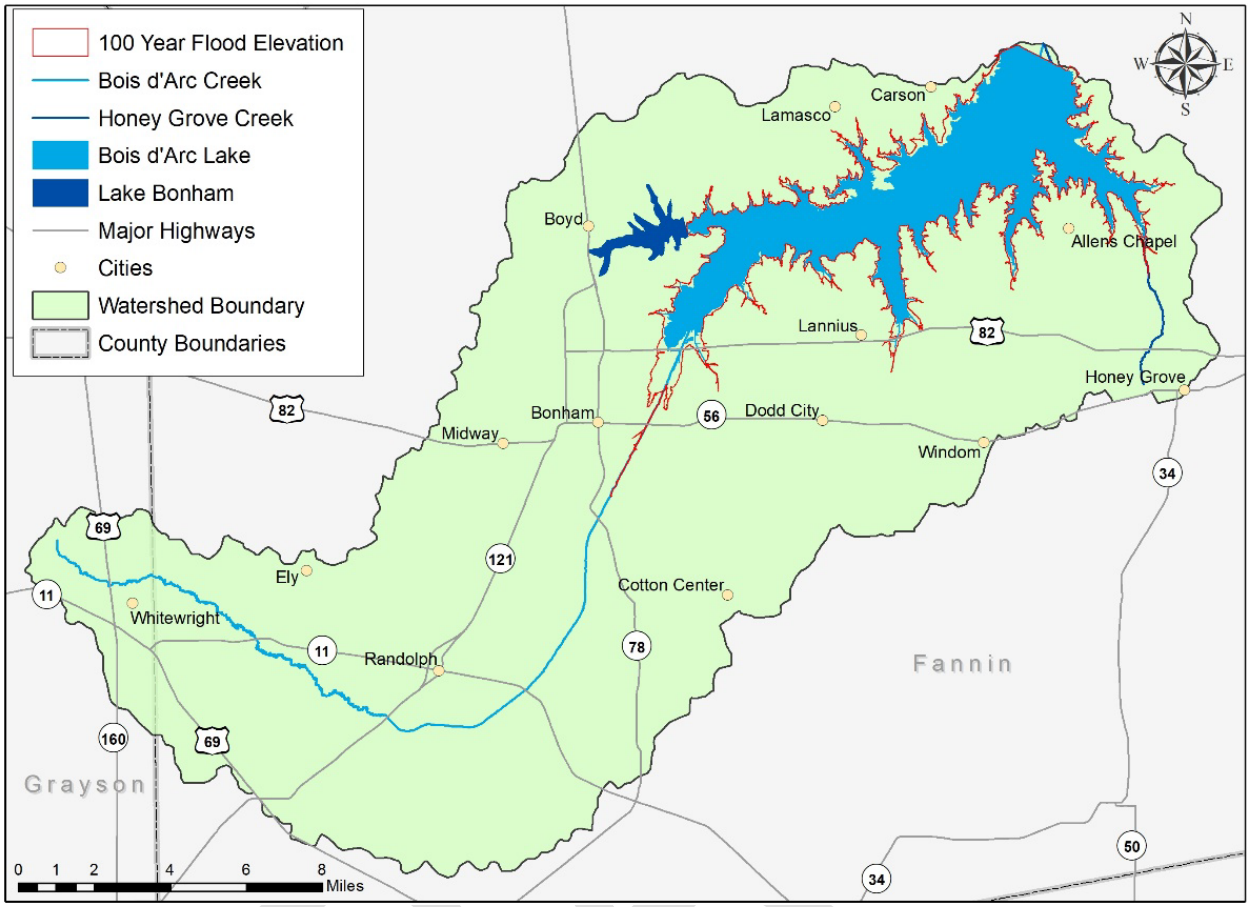

Figure 7. 100-year flood elevation for Bois d'Arc Lake

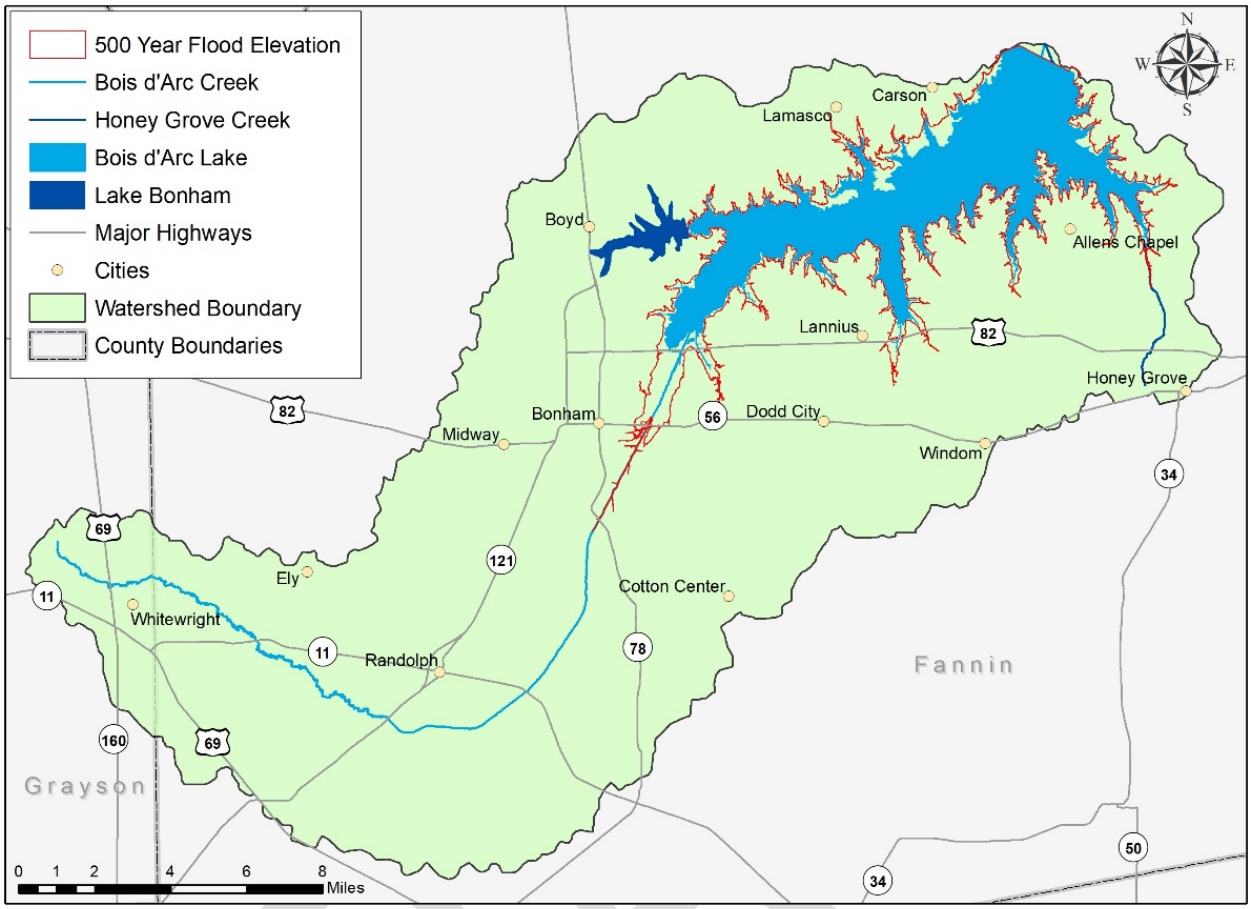

Figure 8. 500-year flood elevation for Bois d'Arc Lake

The other surface water resource in the watershed, Lake Bonham, was developed in 1969 and is the primary drinking water supply for the City of Bonham. The City of Bonham holds water rights to divert and use up to 5,340 acre-feet of water per year from the lake. Lake Bonham has a maximum depth of approximately 29.9 feet and a storage capacity of 11,038 acre-feet of water. The surface area of the lake encompasses 1,012 acres and has a lake elevation of 565 feet above msl.

The principle water bearing strata under the watershed are the Trinity and Woodbine aquifers. The watershed lies wholly within both. The Trinity Aquifer is a major aquifer that spans across central and northeast Texas and consists of limestones, sands, clays, gravels, and conglomerates. Water quality is generally good in much of the Trinity Aquifer but levels of total dissolved solids (TDS) can range from 1,000-5,000 mg/L, or slightly to moderately saline, in deeper parts of the aquifer. The average saturated thickness of the Trinity Aquifer in North Texas is approximately 600 feet. However, heavy usage has caused drastic declines in the Trinity Aquifer throughout many parts of the state (TWDB, 2020a). The Woodbine Aquifer is classified as a minor aquifer by TWDB and consists of sandstone interbedded with shale and clay that form three water-bearing zones. Water quality and yield vary with the depth of the Woodbine aquifer. For

example, water extracted from above 1,500 feet generally contains less than 1,000 mg/L of total dissolved solids, while lower water-bearing zones generally produce water that is slightly to moderately saline (1,000-5,000 mg/L) (TWDB, 2020b).

This watershed is also located in a Priority Groundwater Management Area (PGMA) designated by the Texas Commission on Environmental Quality (TCEQ). PGMAs are areas that are experiencing or are expected to experience critical groundwater issues within 50 years. These issues include shortages of surface and groundwater, contamination of groundwater resources, and land subsidence from groundwater withdrawals. The primary reason for TCEQ designating the area within and surrounding the Bois d'Arc Lake watershed a PGMA is to prevent a shortage of groundwater in the aquifers as the population is projected to grow rapidly over the next few decades.

To help manage and protect groundwater in Fannin and Grayson counties, the Red River Groundwater Conservation District (RRGCD) was created in 2009. Their primary goals include the promotion of conservation, protecting groundwater quality, protecting existing wells, and ensuring that local residents maintain control over their groundwater. The RRGCD is also in charge of registering and permitting all non-exempt wells in the counties and tracking monthly well usage from well owner reported meter readings.

Fish and Benthic Macroinvertebrate Communities

To help characterize stream conditions in Bois d'Arc Creek prior to the construction of the reservoir and dam, the NTMWD and other partners conducted the *Instream Flow Study for Proposed Lower Bois d'Arc Creek Reservoir* (FNI, 2010) in 2010. One component of this study examined the aquatic biology in the creek, which was evaluated in the context of the current and future stream system. The primary purpose of this examination was to inform sound management of aquatic ecosystems downstream of the dam post completion of the lake.

From March to July 2009, 3,138 fish species were collected in Bois d'Arc and Honey Grove creeks. The results of the collection concluded that the dominant fish type in the creeks was generalist species with a tolerance for varying environmental conditions. Concurrently to the fish collection for the 2010 Instream Flow Study, a total of 2,621 aquatic and terrestrial insects were collected.

To help promote recreation on the lake, The NTMWD partnered with the Texas Parks and Wildlife Department (TPWD) on constructing fish habitats and seeding stock ponds with selected fish species. In 2019, TPWD stocked ponds in the lake area with 2,000 bass bred to have the greatest potential to reach trophy size.

Climate

The Bois d'Arc Lake watershed lies within the subtropical humid sub-climate zone. Measurements taken at the Bonham, TX weather station note that the average daily temperature in the watershed is approximately 62.3°F (NOAA, 2016) (Figure 9). Average daily lows reach the lowest temperatures in January at 30.9°F. Meanwhile, average peak daily highs of 93.3°F occur in August. Monthly normal precipitation indicates that the area had a mean annual rainfall from 1981-2010 of 46.1 inches (NOAA, 2016). Rainfall normally peaks in May (5.57 inches) with the lowest totals occurring in August (2.17 inches) (NOAA, 2016). Average annual precipitation values across the watershed from the PRISM Climate Group at Oregon State (2012) indicate average annual rainfall ranges from 42 to 45 inches per year, with a clear East to West decreasing gradient (Figure 10).

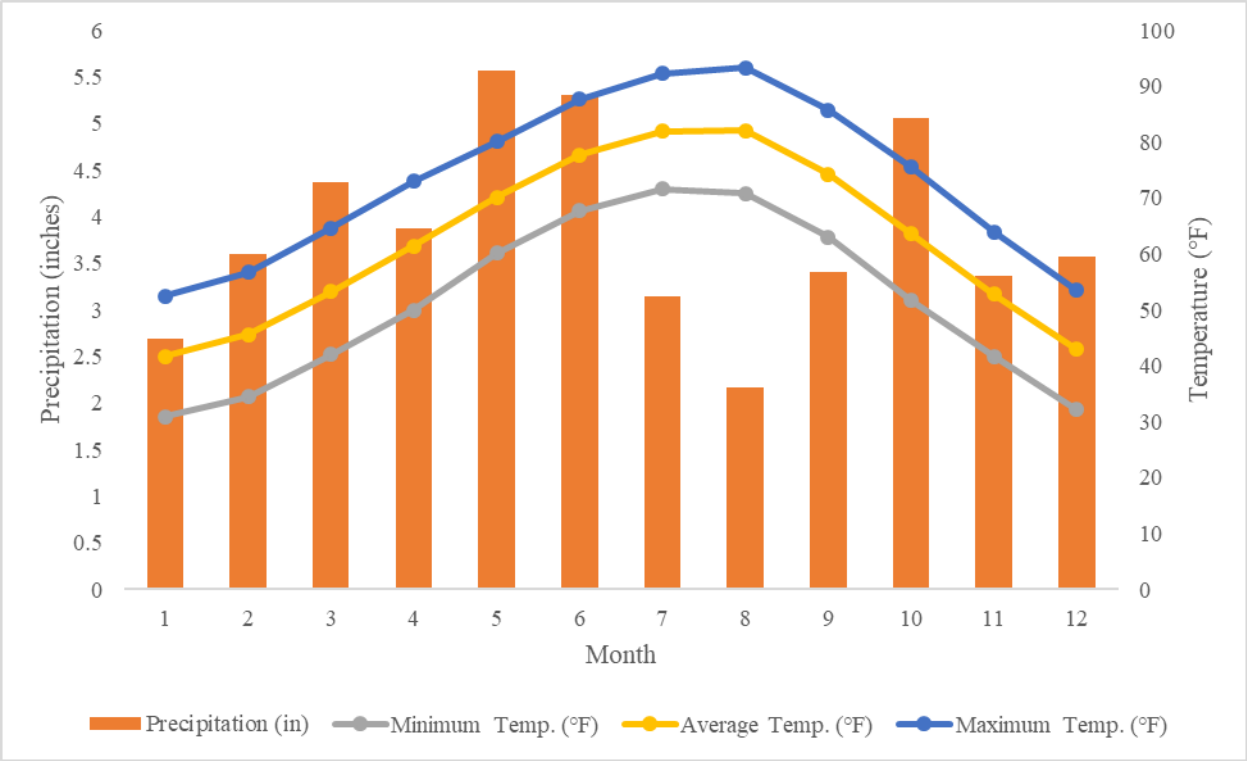

Figure 9. Monthly climate data, including precipitation, normal average, maximum and minimum air temperature, for Bonham, Texas from 1981-2010

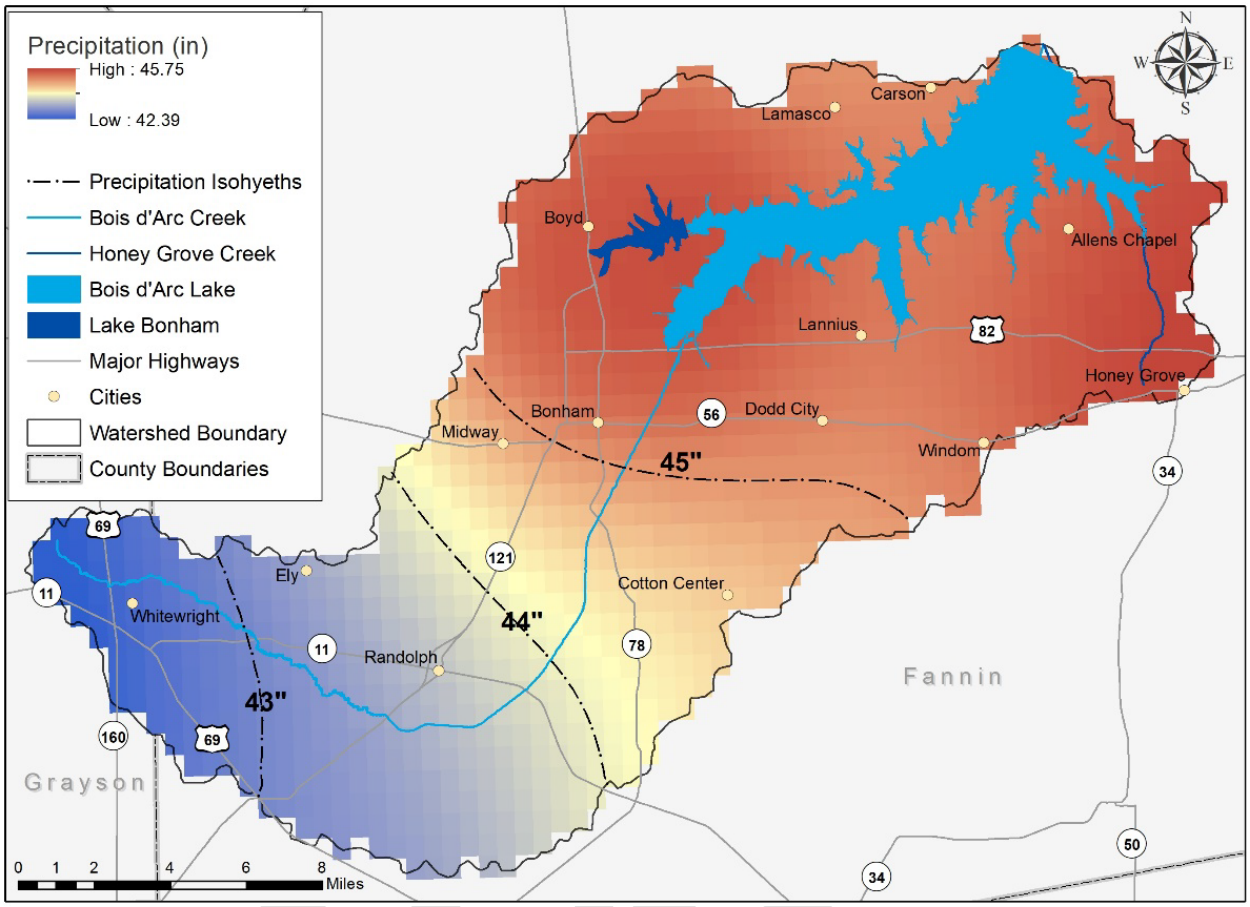

Figure 10. 30-year average precipitation in the Bois d'Arc Lake watershed

Population Projections

According to the 2010 Census (USCB, 2010), the total population of the Bois d'Arc Lake watershed was approximately 20,991 with a population density of 10 people/acre. Population is the densest within and near the cities of Bonham, Honey Grove, and Whitewright (Figure 11). Population projections by the Texas Water Development Board (TWDB, 2016) for the portions of both Fannin and Grayson counties in the watershed are provided in Table 5. From 2010-2070 the population of both counties are expected to increase drastically with an estimated overall population increase for the watershed of almost 300%.

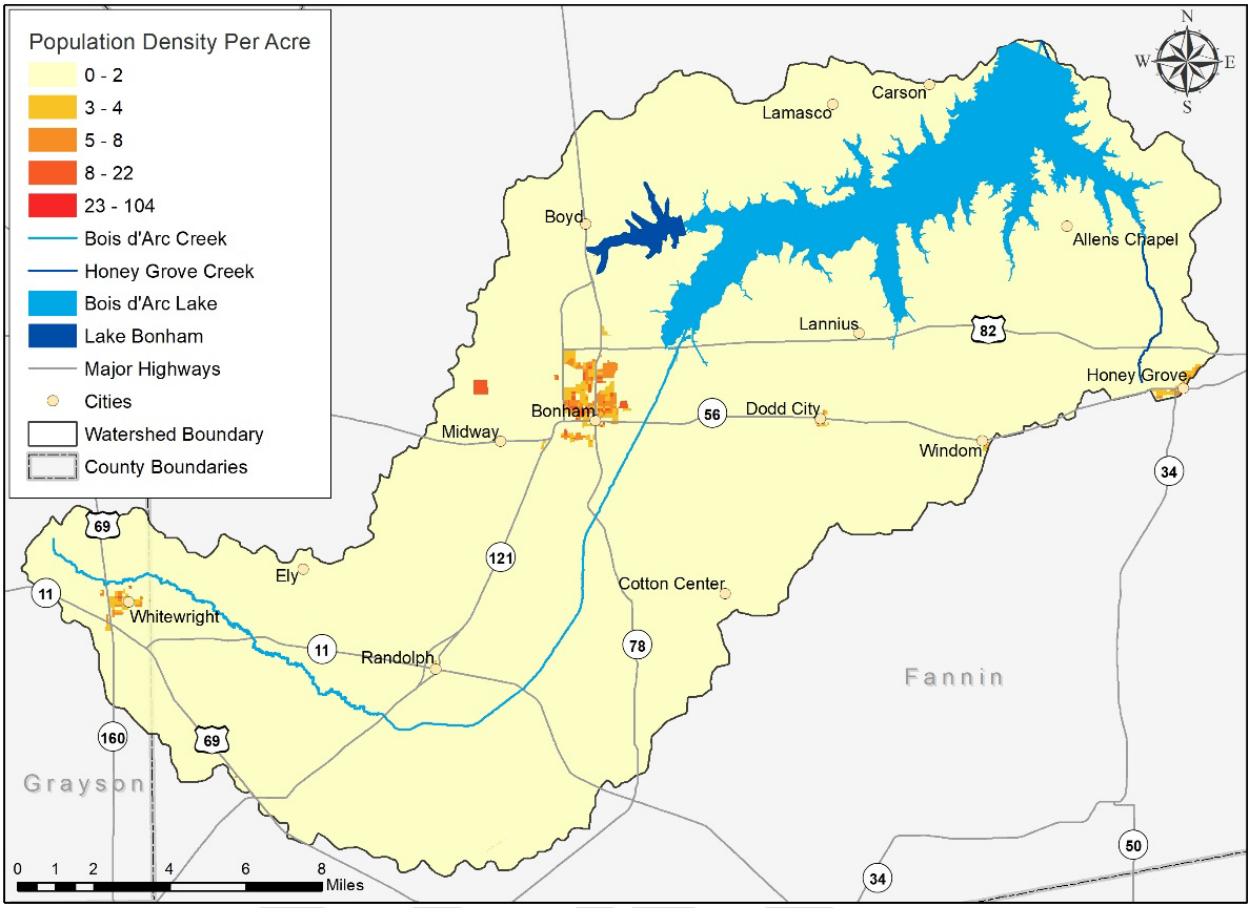

Figure 11. Bois d'Arc Lake watershed 2010 population by census block

Table 5. Population projections by county for the Bois d'Arc Lake watershed

County	2010 U.S Census	Projected Population in the Watershed by Year						Percent Increase (2010-2070)
		2020	2030	2040	2050	2060	2070	
Fannin	19,145	21,637	24,321	29,857	39,136	57,413	77,750	306.1
Grayson	1,846	2,066	2,283	2,437	2,732	3,709	5,148	178.9
Total	20,991	23,704	26,604	32,294	41,868	61,122	82,898	294.9

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