# Middle Brazos Systems Assessment, Phase II: Aquilla Water Supply Reallocation Report and Environmental Assessment (Draft)

Aquilla Lake, Hill County, Texas

US Army Corps of Engineers®
Fort Worth District

Brazos River Authority

U.S. Army Corps of Engineers
Southwest Division
Fort Worth District
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# EXECUTIVE SUMMARY

## STUDY DESCRIPTION AND PURPOSE

The Phase II Aquilla Lake Water Supply Reallocation study investigates reallocation of storage capacity within Aquilla Lake. The findings of the study are presented in this integrated reallocation report and environmental assessment (EA). Aquilla Lake is a U.S. Army Corps of Engineers (USACE) reservoir located in rural Central Texas just southwest of the City of Hillsboro in Hill County. The lake was formed at river mile 23.3, along Aquilla Creek by Aquilla Dam. The primary streams flowing into the lake are Aquilla Creek and Hackberry Creek, with discharges from the lake flowing into Aquilla Creek below the dam. The Aquilla reservoir covers a surface area of approximately 7,000 acres at the top of the flood pool elevation of 556 feet above mean sea level (ft-msl), and 3,060 acres at the top of conservation pool elevation of 537.5 ft-msl. The non-federal sponsor for the study is the Brazos River Authority (BRA).

## PLANNING PROBLEMS/OPPORTUNITIES/OBJECTIVES

Water users currently receiving water from Aquilla Lake will not be able to completely satisfy their projected future water requirements. As a result, the BRA requested the USACE to conduct this reallocation study to evaluate reallocation of storage from the flood pool to the conservation pool, which would result in an increased firm yield available for municipal and industrial (M&I) water supply. According to the Water Supply Agreement (WSA) between the U.S. Government and BRA, dated April 5, 1976, BRA has the right to the total useable storage below elevation 537.5 ft-msl (estimated in 1976 to contain 33,600 acre-feet (AF) after adjusting for expected future sedimentation) in Aquilla Lake for M&I water supply. BRA currently contracts with the Aquilla Water Supply District, the City of Cleburne, and Hilco United for maximum total withdrawals of 11,403 AF of water annually. Aquilla Lake has sufficient supply to meet these existing water supply contracts. However, increased demand due to population growth, which is driving the need for additional water, is projected to result in water supply shortages beginning as early as 2020 (2,800 to 3,700 AF per year), with the shortage in 2070 forecasted to be approximately 7,500 to 30,000 AF per year.

The water supply alternatives evaluated in the reallocation study offer opportunities to reduce water shortages faced by the BRA in a way that complements other water supply activities while maintaining the authorized project purposes for Aquilla Lake. There is also an opportunity at the local level to educate the public on water conservation activities currently practiced, and recommend additional conservation activities that might be undertaken.

The objective of the study is to provide a means to meet, to the extent practicable, the forecasted water demand placed on Aquilla Lake by the BRA water supply customers currently withdrawing from the lake.

## RECOMMENDED PLAN

The recommended plan would reallocate approximately 15,073 AF of storage from the flood pool to the conservation pool. Currently, the conservation pool has a storage capacity of approximately

44,577 AF, with the top of the conservation pool being elevation 537.5 ft-msl. The designated top of the flood pool is elevation 556 ft-msl, with a spillway crest of 564.5 ft-msl.

The recommended plan is to increase the top of conservation pool by 4.5 feet. Based on the USACE critical period yield simulations, the estimated increase in yield with this reallocation is 2,463 AF per year. Three scales of reallocation were evaluated, none of which provide sufficient supply to fully meet the projected need as a standalone project. Based on an incremental cost analysis, the 4.5-foot pool raise was determined to maximize the yield at the lowest marginal cost.

The proposed reallocation would require placement of a 2-foot thick layer of rock riprap sufficiently high to protect the embankment up to the new conservation pool level, but no other changes in the dam or spillway height would be necessary. Two steel lattice towers that provide power would require replacement within the existing lake. The raw water intake tower deck for Aquilla Water Supply District would require modification to maintain the minimum freeboard for operation. Some recreation features, including restrooms, boat ramps, picnic tables, and park roads will need to be relocated. The estimated first cost of construction is estimated at $10.5 million, while the cost of storage is estimated at $14.2 million.

**ENVIRONMENTAL COMPLIANCE**

The reallocation report contains an integrated EA which demonstrates compliance with the National Environmental Policy Act, Endangered Species Act, and other pertinent environmental laws and executive orders. It has been determined through the findings of the EA that some mitigation is anticipated for riparian woodland habitat impacted and/or permanently lost as a result of the pool raise. A draft mitigated Finding of No Significant Impact (FONSI) has been prepared.

**NON-FEDERAL SPONSOR SUPPORT**

In April 2008, the BRA Board of Directors authorized this study by passing a resolution supporting the Brazos Systems Assessment – Interim Feasibility Study, Phase II - Aquilla Lake Storage Reallocation Project. Reallocating flood storage to water supply storage at Aquilla Lake appears to produce additional water supply that could address needs of current users of Aquilla Lake water, which would be beneficial. Supporting the development of water resources through the assessment of reallocation at Aquilla Lake is one of the BRA's primary goals and objectives within its strategic plan.

**AREA OF CONTROVERSY AND UNRESOLVED ISSUES**

Aquilla Lake Dam was screened by a national risk cadre as part of the Fiscal Year 2005 Screening Portfolio Risk Assessment (SPRA) and categorized as a Dam Safety Action Classification (DSAC) 3 (Moderate Urgency). Corps criteria does not allow for the reallocation of flood storage on projects with a DSAC of 3 or less, without exception from the Dam Safety Officer (DSO) for the Corps. The Fort Worth District implemented Interim Risk Reduction Measures (IRRMs) to improve project conditions and further evaluate the known Dam Safety concerns. In September 2012, a re-evaluation was completed which recommended that DSAC be changed from 3 to 4 based on IRRM implementation.

In November 2014, the Fort Worth District conducted a Potential Failure Mode Analysis (PFMA) of the existing conditions for the Aquilla Lake Dam to better define the risks associated with operation of the Federal Project. This is a crucial step to confirming that the 4.5-ft change to the conservation pool would not substantially increase the risks for the project. Preliminary PFMA results confirmed the need to further evaluate site conditions and downstream consequences with a Semi-Quantitative Risk Assessment (SQRA) to confirm the DSAC and allow for safe pool reallocation. This was conducted in June 2016 with the first Periodic Assessment of the project, in conjunction with Periodic Inspection #11. The Periodic Assessment, approved in May 2017, confirmed the DSAC 4 for Aquilla Lake Dam. The incremental risks associated with Aquilla Dam are low.

**MAJOR FINDINGS AND CONCLUSIONS**

If a proposed reallocation will not have a severe impact on authorized project purposes and/or will not require any major structural or operational change to a facility, the USACE has the authority to reallocate at its own discretion. As a general rule, up to 50,000 AF or 15 percent of the total authorized storage, whichever is less, is not considered to have a severe impact. Congressional approval is required when authorized project purposes are severely impacted. Raising the conservation pool 4.5 feet will reallocate 15,073 AF, which equates to 11 percent of the total storage. The recommended plan would not change the elevation of the top of the flood pool so the storage allocated to flood risk management is reduced by the same amount. Findings, however, indicate that it would not significantly impact its authorized flood-risk management project purpose. Risk assessments performed to date have been reviewed, consistent with USACE regulations to ensure there are no adverse impacts to the authorized flood risk management mission. Detailed analysis shows that the peak discharge only increases versus the existing condition for discharges with a frequency less than 1/300. The 1/500 discharge would go from 2,950 cubic feet per second (cfs) (discharged completely through the existing outlet works) to 8,550cfs (discharged from the uncontrolled spillway). The stream reach affected by this increase is only about 3 miles in length, due to another uncontrolled drainage area, Cobb Creek, combining with Aquilla Creek at this location. The discharges from Cobb Creek exceed this discharge but recede prior to any discharge from the uncontrolled spillway. The estimated cost of the features identified to ensure the integrity of the dam embankment make up less than five percent of the estimated updated facility costs. The recommended plan to increase the conservation pool elevation by 4.5 feet is environmentally compliant with some anticipated mitigation associated with riparian woodland habitat impacts. Previous dam safety issues have been resolved based on IRRM implementation and evaluation from the Periodic Assessment. Additionally, extensive data has been collected over the past 2 years of flood operations further verifying operation of the project at or above elevation 542 ft-msl. Finally, the recommended plan met the National Economic Development (NED) objective for providing the most cost-effective water supply to meet the region's future M&I requirements when considering economic, social, and environmental impacts of the potential reallocation.

# TABLE OF CONTENTS

* Indicates this section satisfies one or more of the requirements of the National Environmental Policy Act

# LIST OF APPENDICES



# LIST OF FIGURES



# LIST OF TABLES

# CHAPTER 1: INTRODUCTION

Reservoirs owned by the USACE typically serve multiple functions, including flood control, water supply, and recreation. Most USACE reservoirs contain a significant amount of storage dedicated to flood control. This flood control storage is used to temporarily hold flood waters in the top portion of the reservoir to reduce flooding downstream. It is possible to increase the available water supply from these reservoirs by changing a portion of the flood control storage to the reservoir storage dedicated to water supply, or conservation storage. This process is called reallocation. In the case of the Aquilla project, the proposed reallocation is from its present use (Flood-Risk Reduction) to M&I water supply. A reallocation of this type generally occurs under the authority of the Water Supply Act of 1958, if authorized project purposes are not severely impacted. In these cases, the Commander USACE has discretionary authority to reallocate up to 50,000 AF or 15 percent of the total storage capacity of a project, whichever is less. In addition, reallocations that exceed the Commander USACE's authority may be approved at the discretion of the Secretary of the Army if such reallocations do not require Congressional approval. If the determination is made that project purposes are severely impacted, Congressional approval is required regardless of the size of the proposed reallocation.

Aquilla Lake was developed as a component in a system of projects to reduce flood risk along the mainstem of the Brazos River to the Gulf of Mexico. From the time of its impoundment in 1983 through 2015, Aquilla Lake has prevented an estimated $55,772,800 (September 2015 prices) in flood damages. In 2008, the USACE in conjunction with the BRA prepared a feasibility study (Brazos River Basin Systems Assessment, Interim Feasibility Study – Phase I, July 2008) for reallocating flood control storage to water supply storage for nine lakes in the Brazos River Basin, one of those lakes being Aquilla. The results suggested that Aquilla Lake should be assessed in an independent study to determine if reallocation is appropriate for addressing both immediate and future water needs. This report documents the independent study referred to as the Brazos Systems Assessment – Interim Feasibility Study, Phase II Aquilla Lake Storage Reallocation Project.

## NON FEDERAL SPONSOR

In April 2008, the BRA Board of Directors authorized participation in this study by passing a resolution supporting the Brazos Systems Assessment – Interim Feasibility Study, Phase II – Aquilla Lake Storage Reallocation Project. Reallocating flood storage to water supply storage at Aquilla Lake could produce additional water supply that could address the needs of customers served by Aquilla Lake. Furthermore, supporting the development of water resources through the assessment of reallocation at Aquilla Lake is one of the BRA's primary goals and objectives within the region's strategic plan.

## STUDY PURPOSE AND NEED*

The purpose of this Phase II reallocation study is to determine whether reallocation at Aquilla Lake is the most efficient and effective solution for addressing water supply needs in the area currently served by Aquilla Lake.

## PROBLEMS AND OPPORTUNITIES

The current water supply yield provided by Aquilla Lake is not sufficient to completely meet both immediate and future water needs of the population it currently supplies. Aquilla has sufficient supply to meet existing water supply contracts. Increased demand due to projected population growth, which is driving the need for additional water, is expected to result in water supply shortages beginning as early 2020 (2,800 to 3,700 AF per year), with the shortage in 2070 forecasted to be approximately 7,500 to 30,000 AF per year.

The alternatives evaluated in this reallocation study offer opportunities to reduce the water shortage faced by the BRA in a way that complements other water supply activities while maintaining the authorized project purposes for Aquilla Lake. There is also an opportunity at the local level to educate the public on water conservation activities currently practiced, and recommend additional conservation activities that might be undertaken.

## STUDY OBJECTIVE

The objective of the study is to provide a means to provide a means to reduce to the extent practicable, the municipal and industrial water supply shortage forecasted for Brazos River Authority's existing Aquilla Lake customers in the immediate future.

## SCOPE*

The scope of this study is to evaluate reallocation at Aquilla Lake to determine if it is a viable option for meeting both immediate and future water needs. This report identifies the estimated cost for reallocated storage and compares that estimated cost to that of other available alternatives. An EA has been integrated within this reallocation report. The EA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, and also serves as compliance for other pertinent laws related to this study, such as the Fish & Wildlife Conservation Act, Endangered Species Act, etc. The EA evaluates the environmental effects associated with project alternatives, including the No Action alternative.

## STUDY AUTHORITY

This study is authorized by the 1958 River and Harbor Act (PL 85-500), Section 301, as amended in 43 U.S.C. 390b. The law commonly known as the "Water Supply Act of 1958" as amended by Section 10, PL 87-88 and Section 932, PL 99-662 states:

> *"(a) It is hereby declared to be the policy… that the Federal Government should participate and cooperate with States and local interests in developing such water supplies…*
>
> *(b) In carrying out the policy set forth in the section, it is hereby provided that storage may be included in any reservoir project… planned, surveyed and/or constructed by the Corps of Engineers… to impound water for present or anticipated future demand or need for municipal or industrial water…*

*(d) Modifications of a reservoir project heretofore authorized, surveyed, planned or constructed to include storage as provided in subsection (b), which would seriously affect the purposes for which the project was authorized, surveyed, planned, or constructed, or which would involve major structural or operational changes, shall be made only upon the approval of Congress as now provided by law."*

## STUDY LOCATION

Aquilla Lake is located in rural Central Texas, approximately seven miles southwest of the city of Hillsboro in Hill County, Texas. The reservoir covers a surface area of approximately 7,000 acres at the top of flood pool elevation of 556 ft-msl, and 3,060 acres (based on the pertinent data listed in Table 2) at the top of conservation pool elevation of 537.5 ft-msl. It is bordered to the north by State Highway 22 and to the south by Farm-to-Market Road 310 (Figure 1). The predominant adjacent land use is agriculture. The lake was formed by the impoundment of Aquilla Creek just downstream of its confluence with Hackberry Creek. Little Aquilla Creek, Rocky Branch, Jacks Branch, and various other unnamed tributaries empty into the reservoir as well. Aquilla Creek resumes flow below the spillway and ultimately empties into the Brazos River approximately 24 miles downstream.

## STUDY AREA

The Aquilla Lake study area, approximately 11,430 acres in size, encompasses the lake and adjacent USACE-owned property. In addition, a 150-foot wide corridor between Aquilla and an existing pipeline between Pat Cleburne and Aquilla Lakes is considered to be the study area, as shown in Figure 2. Whitney Lake is also given consideration for a number of resources in the next chapter, due to its proximity to Aquilla, and for its potential to supplement water supply for the area.

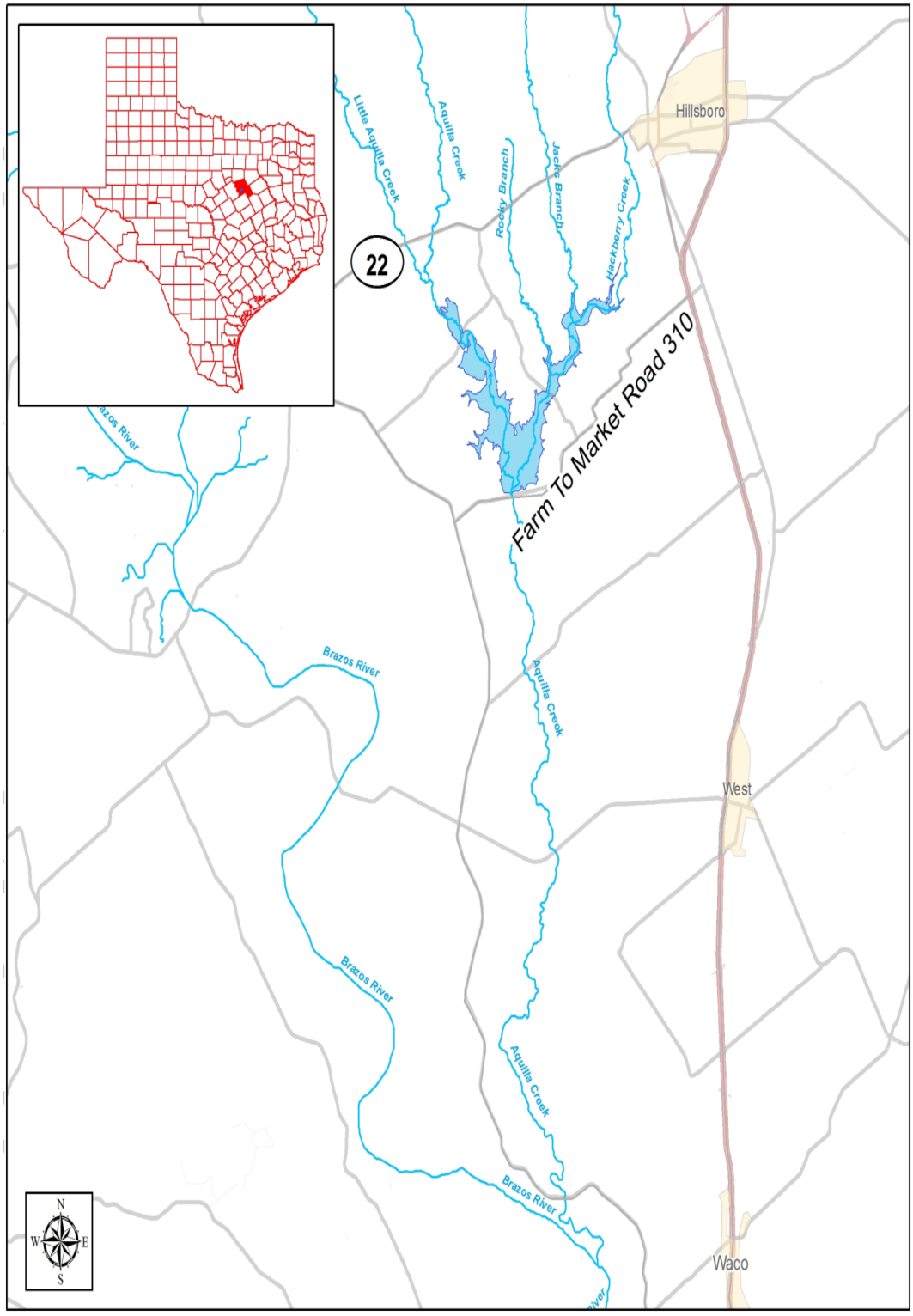



**Figure 1. Aquilla Lake Study Location**

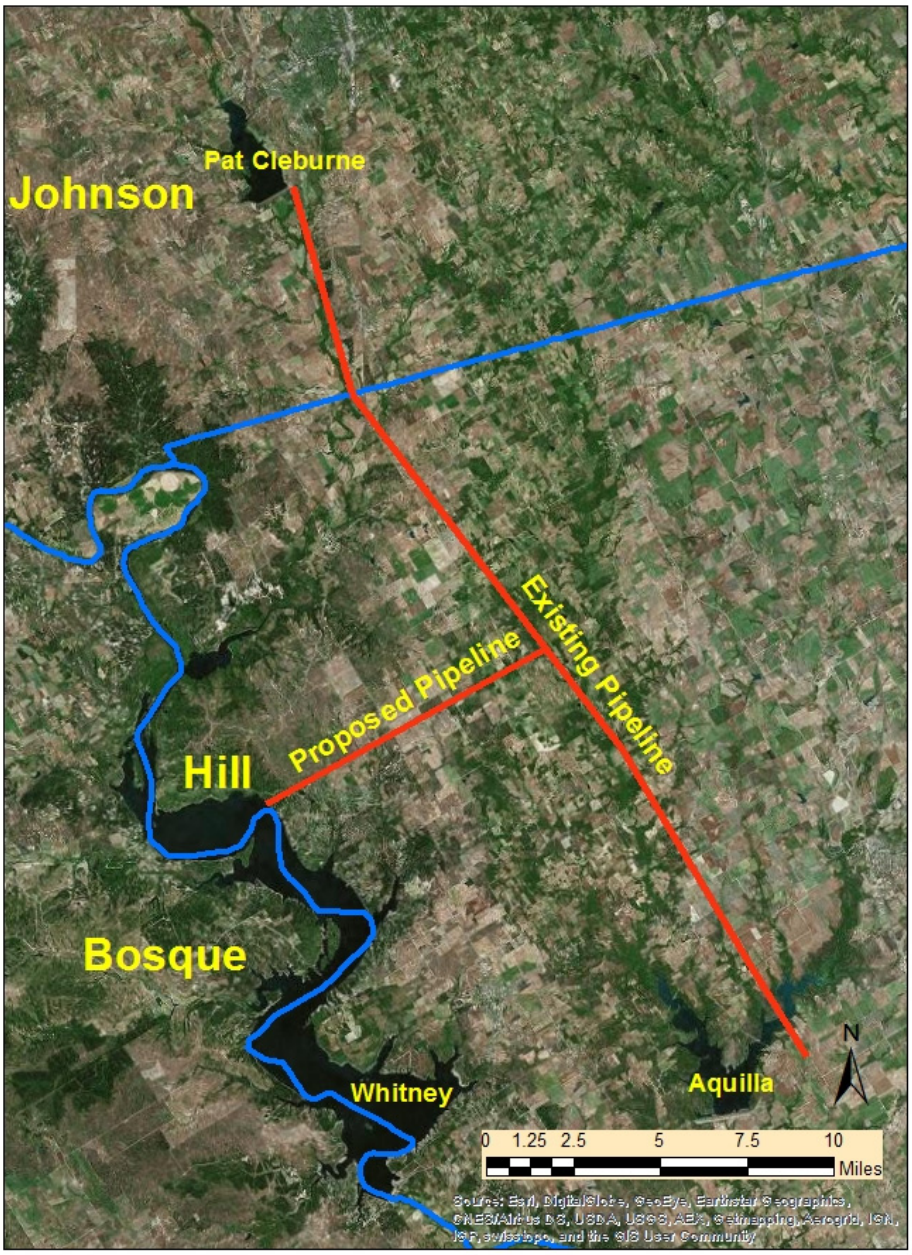



**Figure 2. Whitney Pipeline Study Area**

## PROJECT DATA

Aquilla Lake and Dam (Figure 3) were constructed by the USACE as part of the overall Flood-Risk Management (FRM) project in the Brazos River basin under the Flood Control Act of 1968, Public Law 90-483 (82 Stat. 741) 90th Congress, approved August 13, 1968. This authorization was based on the recommendation of the Chief of Engineers in Senate Document Numbered 52 and states:

> *The project for the Aquilla Dam and Reservoir, Aquilla Creek, Texas, is hereby authorized substantially in accordance with the recommendations of the Chief of Engineers, in Senate Document Numbered 52, Ninetieth Congress, at an estimated cost of $23,612,000.*

The document authorizes four purposes for Aquilla Lake: flood control, M&I water supply, general recreation, and fish and wildlife enhancement. Access and facilities are provided for minimum recreation, but water is not controlled for that purpose. The resulting cost allocation for the project is shown in Table 1.

**Table 1. Cost Allocation for Construction of Aquilla Lake and Dam**

| | Flood Control | Water Supply | Recreation | Total |
|---|---|---|---|---|
| **Specific Facilities Costs** | 0 | 0 | $408,000 | $408,000 |
| **Joint Use Facilities Costs** | $28,225,100 | $9,499,000 | $1,886,900 | $39,611,000 |
| **Interest During Construction** | $2,293,300 | $1,214,900 | $160,300 | $3,668,500 |
| **Total Allocation Investment** | $30,518,400 | $10,713,900 | $2,455,200 | $43,687,500 |
| **Allocation Percentage** | 69.9% | 24.5% | 5.6% | 100% |

The major structural components of Aquilla Dam consist of a rolled fill earthen embankment, a 10-foot diameter concrete outlet works gated conduit with an invert at elevation 503 ft-msl, and an uncontrolled broad crested weir spillway set at elevation 564.5 ft-msl. Table 2 includes additional pertinent data related to Aquilla Lake.

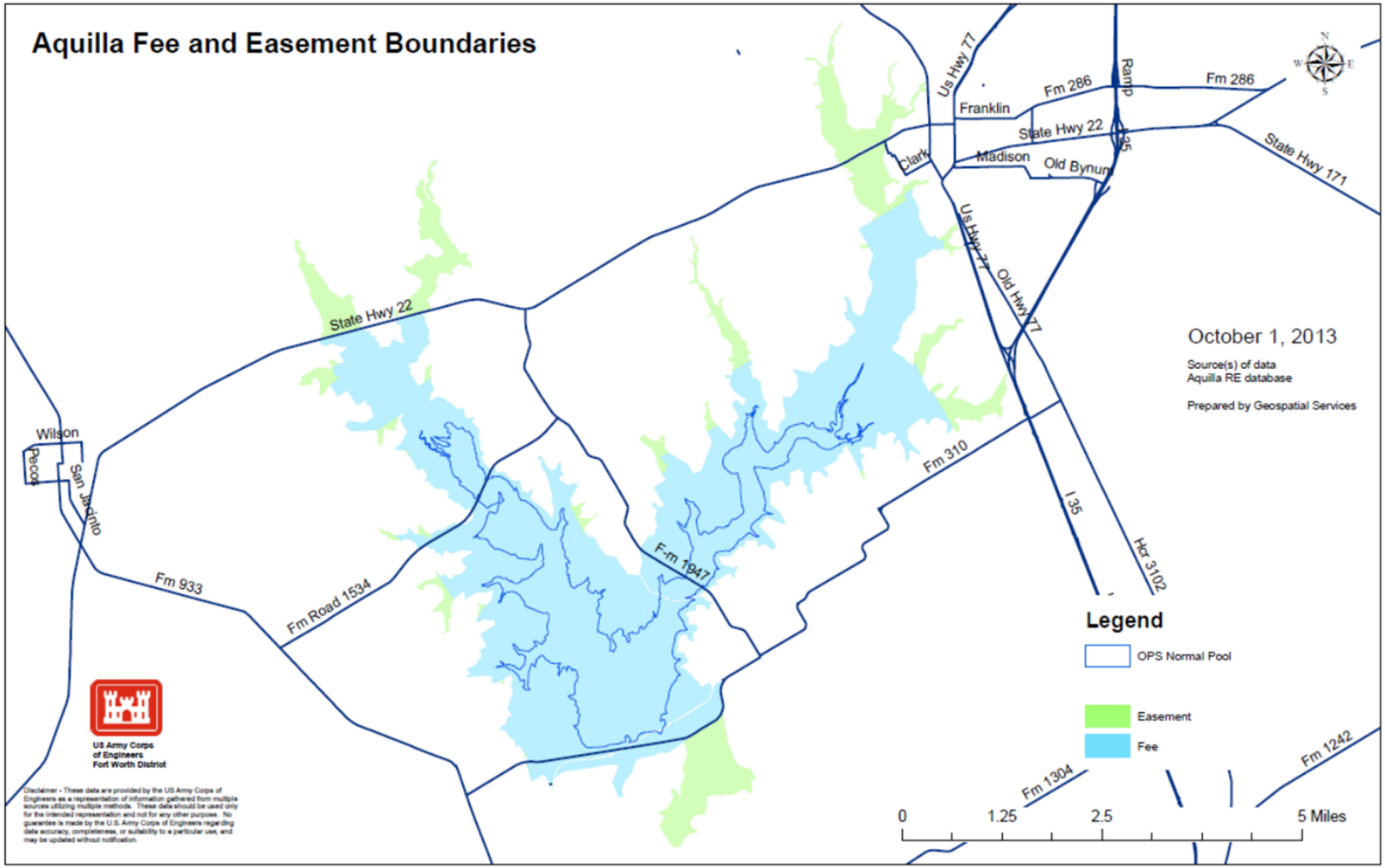



**Figure 3. Aquilla Lake Project Area**

**Table 2. Aquilla Lake Pertinent Data**

| Feature | Elevation (feet NGVD) | Area (acres) | Capacity (acre feet) | Equivalent Runoff (inches) |
|---|---|---|---|---|
| **Top of Dam** | 582.5 | ------ | ------ | ------ |
| **Spillway Crest** | 564.5 | ------ | ------ | ------ |
| **Top of Flood Control Pool** | 556.0 | 6,999 | 136,910 (1,3) | 10.2 |
| **Top of Conservation** | 537.5 | 3,060 | 44,577 (1, 3) | 3.3 |
| **Sediment Storage** | ------ | ------ | 25,700 (2) | 1.9 |
| **Flood Control Storage** | 537.5-556.0 | ------ | 92,333 (3) | 6.9 |
| **Conservation Storage** | ≤ 537.5 | ------ | 44,577 (3) | 3.3 |
| **Streambed** | 478.0 | ------ | ------ | ------ |

(1) Cumulative total (2) Total estimated sedimentation 1976 to 2076 (3) Based on 2008 survey

- Year Complete: 1983
- USACE Parks/Accesses: 6 (1,101 acres)
- Drainage Area: 252 square miles
- Length of Dam: 11,890 feet
- Fee Information: 10,212 acres at or below 564.5 feet (NGVD)

Water Supply has been a critically important purpose of the lake since impoundment. According to the Water Supply Agreement between the U.S. Government and BRA, dated April 5, 1976, BRA has the right to the total useable storage below elevation 537.5 ft-msl (estimated in 1976 to contain 33,600 AF after adjusting for expected future sedimentation) in Aquilla Lake for M&I water supply, subject to availability of water. The U.S. Government reserves the right to draw down the lake elevation to 537.5 ft-msl in the course of FRM operations.

The Brazos River Authority is permitted by the Texas Commission on Environmental Quality (TCEQ) to divert 13,896 AF annually from Aquilla Lake for M&I purposes. Comparisons of capacities at conservation pool elevation derived from previous surveys suggest Aquilla Lake loses between 97 AF per year and 269 AF per year of conservation storage space due to sedimentation. The loss is equivalent to 0.39 to 1.07 AF per square mile of drainage area.

# CHAPTER 2: INVENTORY AND FORECAST*

This chapter describes the study area in the context of site conditions, environmental setting, and habitat evaluation for existing conditions and expected future conditions if no Federal action is taken.

## CLIMATE

The Aquilla Creek watershed experiences a continental type of climate characterized by a wide range between annual extremes of temperature. The watershed has cool winters and hot, humid summers. Tropical air masses from the Gulf of Mexico play a dominant role in the climate from late spring to early fall. Polar air masses determine the winter climate, occasionally causing snowfall and freezing temperatures. The mean annual precipitation is approximately 36 inches. However, seasonal rainfall is largely the result of thunderstorm activity, and amounts vary in intensity and location. Heavy showers of short duration may occur at any time of year.

Being over 500 feet above sea level, sea level rise is not an issue. Climate change, however, may affect reservoir yields in terms of increased evaporation, reduced rainfall, and increased rainfall intensity. Some forecasts predict an increase in average temperature of 4 to 6 degrees Fahrenheit and a 10 to 15 percent decline in precipitation for the region over the 50-year period of analysis. Additionally, long range forecasts predict that while precipitation will be less frequent, the storms themselves are likely to be of higher intensity. Under these conditions, storage for infrequent but intense runoff becomes increasingly important to sustain water supply yields.

## REGIONAL GEOLOGY, SOILS, AND TOPOGRAPHY

The Aquilla Lake drainage basin lies predominantly within the Eastern Cross Timbers subdivision of the West Gulf Coastal Plain physiographic province. The Eastern Cross Timbers is formed on erosion prone sandstone and shale beds of the Woodbine Formation, which overlies the formations of the Grand Prairie. The Woodbine and soils developed on this formation support a moderate growth of timber, giving rise to the name of this subdivision. The Woodbine Formation is comprised of a basal sandstone member, a middle shale member, which is the thickest member containing a few scattered sandstone beds, and an upper member composed of massive sand and sandstone beds with shale interbeds. The sandstone beds are comparatively thin in the lower reaches of Aquilla Creek but thicken in an upstream direction. The total thickness of the Woodbine Formation is about 125 feet (Aquilla EIS, 1974).

Overburden soils mantling the bedrock in the Aquilla Creek Valley consist of clay underlain by a few feet of sandy or gravelly clay. Usually, only a thin soil cover is present on the valley slopes, but its thickness varies from about 20 to 30 feet or more in the central part of the valley. Soils mantling the bedrock along Hackberry Creek are chiefly clay with a thin basal clayey, sandy gravel. Thickness of these materials varies from a few feet to as much as 20 feet (Aquilla EIS, 1974).

The topography of the watershed, the soil characteristics, and the nature of the rainfall lend themselves to flash flooding. These flash floods have the potential to occur any time of year, but are more prominent in the late spring and fall.

### *PRIME FARM LANDS*

Soils in the western portion of the study area transition from gravelly soils near Aquilla Lake to clay loam and clay soils that support cultivated fields between Whitney and Aquilla Lakes. Approximately 45 percent of the soils located within the study area are comprised of soils designated as prime farmland soils by the Natural Resources Conservation Service (NRCS).

### *DAM COMPOSITION AND MONITORING*

The dam is founded on clay shale materials interbedded with limestone and underlain by limestone with interbedded shale. The embankment itself is constructed as three zones of materials topped with a clay cap for improved subgrade capacity. The innermost layer of the dam is an impervious core of clay materials. The core is surrounded by compacted fill made up of clay and clayey sands. The outermost layer is semi-compacted fill excavated from the spillway and outlet works during construction.

The embankment is monitored using a system of piezometers, relief wells, and collection weirs. Seepage is discharged through laterals that exit the headwall for flow measurements. Instrumentation evaluations indicate the project is performing as intended. A periodic inspection and assessment of the dam was conducted in June 2016. The next inspection is scheduled for 2021, and the next assessment is scheduled to occur in 2026.

## LAND USE

The floodplain use is primarily agricultural with woody vegetation adjacent to the creek channels. Almost half of the land in Hill County is used for field crops. Approximately one third of the land is pasture. Land use classified as urban and open water combined to only account for approximately six percent of the total land use in Hill County.

There are approximately 6,860 acres of Natural Resources Management Areas (NRMA's) surrounding the lake area that are managed primarily for wildlife habitat. In general these areas have been allowed to develop naturally during the 33-year life of the project. The land management approach for the NRMA's at Aquilla Lake is not expected to change substantially over the period of analysis for this study.

## DEMOGRAPHICS

### *HILL COUNTY*

According to the 2010 census, Hill County has a population of 35,089, with growth projected to reach 45,989 by 2070 (2016 Brazos G Regional Water Plan, 2015). The annualized growth rate is 0.45 percent. The population is predominantly white (74 percent). Seventy-nine percent of the population has earned a high school diploma (or equivalent), with 49 percent attaining some higher level of education.

According to the Texas Workforce Commission the largest employment sector is retail trade with 24 percent of total employment, followed by healthcare and social assistance with 19 percent, accommodation and food services with 15 percent, and manufacturing with 12 percent of total employment. The retail sector also comprises the largest number of establishments, with 25 percent of the total number, followed by accommodation and food services with 11 percent, other services with 10 percent, and health care and social services with 8 percent.

Hill County has more households in lower income ranges than the state average, with most of the households having incomes between $15,000 and $74,999. The median household income is $39,450, and approximately 17 percent of population is below the poverty level.

### *JOHNSON COUNTY*

Aquilla Lake is a significant source of water supply for Johnson County through the contract between BRA and the City of Cleburne. Aquilla Water Supply District customers, Parker Water Supply Corporation (WSC) and Files Valley WSC, serve a small portion of Johnson County as well.

The population of Johnson County according to the 2010 census is 150,934 with growth projected to reach approximately 325,967 by 2070 (2016 Brazos G Water Plan, 2015). Much of the population growth in Johnson County is expected to be attributed to the recent completion of the Chisholm Trail Parkway (CTP), which provides a direct linkage between Cleburne and downtown Fort Worth. The annualized growth rate is 1.29 percent. The population is predominantly white (76 percent). Eighty-three percent of the population has earned a high school diploma (or equivalent), with 49 percent attaining some measure of higher level education.

Retail trade provides the greatest employment, with 15 percent of total employment, followed by manufacturing with 14 percent, health care and social assistance with 12 percent, accommodation and food services with 10 percent and transportation and warehousing with 8 percent. In terms of number of establishments, retail trade comprises 15 percent of the total number of establishments, followed by construction with 13 percent, other services with 11 percent, health care and social assistance with 9 percent, and accommodation and food services with 8 percent.

Information from the 2010 census indicates household incomes for Johnson County and the state overall fall predominantly between $25,000 and $149,999. The median household income for Johnson County is $57,016, and approximately 11 percent of population is below the poverty level.

## HYDROLOGY AND HYDRAULICS

The watershed is almost entirely rural with a few small communities and roads. As a result the watershed is predominantly composed of pervious surfaces. While some population growth is projected (less than 1 percent per year), significant residential and commercial development accompanied by stream channelization would need to occur to affect any change on run-off potential. As a result the anticipated urbanization effects on hydrology for the study are in the future and are considered statistically insignificant.

The spillway at Aquilla Dam is at elevation 564.5 ft-msl. The top of the flood control pool is 556 ft-msl with the top of conservation pool at 537.5 ft-msl. The spillway crest elevation has an approximate exceedance probability of 1/500, or 0.2 percent Annual Chance Exceedance (ACE). For events that do not overtop the spillway, the outflow is limited to 3,000 cubic feet per second (cfs) by a gated outlet works. Any flooding downstream is a result of local run-off and run-off from Cobb Creek which confluences with Aquilla Creek approximately 3.5 stream miles downstream of Aquilla Dam.

## WATER CONTROL PLAN

The USACE Brazos River Basin flood-risk management projects are operated as a system with the primary goal of minimizing downstream flood damages. Flood releases from Aquilla Dam are coordinated with releases from the other eight USACE projects in the Brazos River Basin as well as other reservoirs within the basin such that releases are made once the capacity is available downstream. Lake levels are lowered to conservation pool elevation in an expeditious manner to provide available flood storage for future events. If the Aquilla Lake elevation is forecasted to rise above the spillway crest elevation of 564.5 ft-msl, releases and spillway discharges are monitored to ensure that releases through the outlet conduit do not result in exceedance of capacity limits at the downstream control points. By elevation 565.7 feet, the spillway discharge is 3,000 cfs, and all gates are closed. Additional information on capacities and operation is provided in Appendix K, Reservoir Control.

## RECREATION

Recreation at Aquilla Lake is considered to be a secondary purpose. Even so, the official visitation of record in 2012 is estimated to be approximately 127,000, who enjoyed outdoor activities such as hiking, boating, hunting, fishing, and swimming.

Only minimal recreation facilities, four areas, were constructed as part of project implementation. Existing recreation areas at Aquilla Lake include two boat ramps and associated amenities, a fishing platform at the outlet works, a USACE operated access area. Multiple access areas are also maintained for hunting and fishing. The boat ramps generate the highest annual visitation at Aquilla Lake. Both boat ramps are single lane and have vault-type masonry restrooms and paved parking lots. The boat ramp at Dairy Hill also has a courtesy boat dock. Visitor totals year to year fluctuate greatly at Aquilla Lake as a result of floods and droughts. One of the four recreation areas, Hackberry Creek, had been leased to Hill County. They have declined to continue the lease, so the facility is permanently closed.

In contrast, recreation facilities at Whitney Lake, approximately 27 miles away, include thirteen USACE parks, Lake Whitney State Park, four marinas, and 28 boat ramps. Total annual visits (person-trips) were 1,558,313 in 2012 and the recreation activities included picnicking, camping, swimming, water skiing, boating, sightseeing fishing and other miscellaneous activities.

# AQUATIC RESOURCES

## *AQUILLA LAKE SURFACE WATER*

At the conservation elevation of 537.5 ft-msl, water depth averages 16 feet in the main body of the lake. Because of the shallow depth, water temperatures in Aquilla Lake fluctuate substantially with the season.

Aquatic vegetation adjacent to the shoreline in the main body of the lake is relatively sparse and consists mainly of cocklebur *(Xanthium strumarium)* and buttonbush *(Cephalanthus occidentalis)*. The majority of the vegetation directly adjacent to the shoreline in the main body of the lake is switchgrass *(Panicum virgatum)*. The switchgrass remains from the relatively flat grasslands that were adjacent to the creeks before the reservoir was impounded and thrive in the moist environment provided adjacent to the lake surface. Aquatic vegetation is more prevalent in the shallower areas upstream in both arms of the lake and consists of rattlebush *(Sesbania sp.)*, cocklebur *(Xanthium strumarium)*, peppervine *(Ampelopsis arborea)* and teal lovegrass *(Eragrostis hypnoides)*.

The Hackberry Creek arm of the lake tends to be gently rolling to almost flat. The area downstream of the FM 1947 Bridge was cleared of timber during the construction of the reservoir. Above the bridge, standing timber along the inundated creek channels and fence lines contribute to excellent fishery production. The water tends to be very shallow over the flat terrain, making it attractive to waterfowl for feeding and resting.

The Aquilla Creek arm has more of a sloping floodplain with stands of Post Oak, Blackjack Oak, and other species extending along the shorelines all the way to the inundated creek channels creating favorable fish habitat. Aquilla Creek was cleared of timber from the Old School Boat Ramp Area to the dam.

Fish species within the reservoir include largemouth bass *(Micropterus salmoides)*, blue catfish *(Ictalurus furcatus)*, channel catfish *(Ictalurus punctatus)*, white crappie *(Pomoxis maculatus)*, white bass *(Morone chrysops)*, and prey species such as sunfish species *(Lepomis sp.),* threadfin shad (*Dorosoma petenense*), gizzard shad (*Dorosoma cepedianum*) (TPWD 2015).

Aquilla Lake has both a 13exicana zone and a littoral zone. The 13exicana zone is the deep water area identified by the characteristic that light generally does not penetrate to the bottom of the lake. The littoral zone is the shallow area of the lake, frequently near the shoreline. These zones are more fully described in Appendix B, Environmental Resources. The deeper water makes up about 2,280 acres, while the littoral zone, or shallow area encompasses approximately 880 acres. Within these zones are different physical, chemical, and biological processes, along with varying species of fish, vegetation, and benthic organisms.

## *FLOODPLAINS*

Floodplains in the study area are located along the banks of the streams and rivers in the study area and along the shoreline of Aquilla Lake. Since the lake is in a rural area there is little known

development encroaching on the floodplains within the study area.

Executive Order 11988 requires federal agencies to avoid "to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative." In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce risk of flood loss, to minimize impact of flooding on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities" for:

- Acquiring, managing, and disposing of federal lands and facilities;
- Providing federally undertaken, financed, or assisted construction and improvements; and
- Conducting federal activities and programs affecting land use, including, but not limited to water and related land resources planning, regulation, and licensing activities.

### *GROUNDWATER*

Hill County is encompassed within the Northern Trinity/Woodbine aquifer system. The Trinity/Woodbine is one of the most extensive sources of groundwater in Texas and has supplied the vast majority of groundwater in the region for more than a century, especially near population centers such as Temple, Waco, Fort Worth, Dallas, and Sherman. Inflow to the Trinity and Woodbine aquifers occurs through the infiltration of precipitation in outcrop areas, interformational leakage, and through the interaction between surface-water bodies (streams, rivers, lakes) and the underlying aquifers. Artesian pressure declines of up to about 800 to 1,000 feet have occurred in major historical pumpage centers located in Dallas, Tarrant, and McLennan Counties. Despite the large artesian declines recorded in downdip areas, outcrop water levels have remained relatively constant during the last 50 years, indicating that there has been little reduction in the amount of water in storage in the Northern Trinity/Woodbine system. Decreases in artesian storage or water table storage that have occurred are insignificant compared to the amount of water still present in the aquifer and the overall water budget of the aquifer.

The current groundwater model indicates that a large majority (~90 percent) of the current discharge from the aquifer is occurring through natural, near-surface mechanisms, primarily evapotranspiration and baseflow to streams, springs, and seeps, not pumpage. However, the percentage is dependent on the amount of recharge that is occurring. The actual amount of this natural discharge and recharge are difficult to measure directly, but because of the large outcrop area and the stability of outcrop water levels it is reasonable to assume that a large percentage of the current recharge to the aquifers is being rejected through natural, near-surface mechanisms.

### *WETLANDS AND WATERS OF THE U.S.*

Wetlands associated with the current conservation pool at Aquilla Lake are located along the fringe of the lake in areas that are inundated frequently enough to support hydric soils and wetland vegetation species. In addition to fringe wetlands around the lake, wetlands are located in the shallow areas along tributary creeks and streams in the upper reaches of the reservoir.

The study area does not contain navigable waters of the U.S. (covered under Section 10 of the Rivers and Harbors Act of 1899).

Executive Order 11990 requires that governmental agencies, in carrying out their responsibilities, provide leadership and "take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance natural and beneficial values of wetlands." Each agency is to consider factors relevant to a proposed project's effect on the survival and quality of the wetlands by maintenance of natural systems, including conservation and long-term productivity of existing flora and fauna, species and habitat diversity and stability, hydrologic utility, fish and wildlife. If no practicable alternative can be demonstrated agencies are required to provide for early public review of any plans or proposals for new construction of wetlands.

### *STREAM AQUATIC HABITAT*

In-stream habitats of Aquilla Lake are located within four major tributaries: Aquilla Creek, Rocky Branch, Jack's Branch, and Hackberry Creek. Historically, Aquilla Creek and Hackberry Creek were classified as intermittent streams. However, supplemental flows from a water treatment facility upstream of the lake provide perennial flows to Hackberry Creek. Jack's Branch and Rocky Branch are classified as ephemeral tributaries, or those which only flow for a short amount of time, dependent upon seasonal flow and/or flooding circumstances. The four tributaries are contained within deeply incised channels. Due to the intermittent nature of Aquilla Creek, Jack's Branch, and Rocky Branch, in-stream habitat is limited and consists primarily of isolated, stagnant pools that are replenished during rainfall events or rising lake levels. The in-stream habitats of Hackberry Creek consist of very low flow pools resulting from log jams and beaver activity.

Table 3 includes a summary of the in-stream habitat associated with the Aquilla Lake project area, including the four major tributaries. Linear feet and acreage were calculated with Geographic Information Systems (GIS) analysis, and includes the area from the current conservation pool elevations up to the fee boundary area. GIS analysis also assumed a 25-foot buffer on each side of the stream to develop existing conditions acreage.

**Table 3. Summary of In-Stream Habitat Areas Associated with Aquilla Lake**

| Stream Name | Water Identification | Hydraulic Characteristic | Total Linear Feet from Conservation Pool to Fee | In-Stream Acreage |
|---|---|---|---|---|
| **Aquilla Creek** | Tributary | Intermittent | 20,692 | 24.5 |
| **Rocky Branch** | Tributary | Ephemeral | 7,275 | 18.7 |
| **Jack's Branch** | Tributary | Ephemeral | 4,865 | 9.7 |
| **Hackberry** | Tributary | Perennial | 48,283 | 216.3 |

In addition to the creeks draining into Aquilla Lake, two creeks bisect the pipeline portion of the study area between Whitney and the existing pipeline between Aquilla and Pat Cleburne Lakes: Cedar Creek and Bear Creek. These creeks are intermittent supporting forested riparian habitats.

## WATER QUALITY

Due to the clay soils and predominantly agricultural land use surrounding Aquilla Lake, the water is generally turbid and high in suspended solids. None of the lakes tributaries or the reservoir itself appears on the TCEQ 303 (d) list of impaired water bodies. There was however, concern over high levels of the herbicide Atrazine in the reservoir in the late 1990s which caused the reservoir to be listed as an impaired water body (TCEQ Website 2009). The presence of Atrazine was from farming activities around the lake and subsequent runoff of the herbicide during large rain events.

The high levels of the herbicide triggered projects to address agricultural sources of the herbicide by the TCEQ, the Texas State Soil and Water Conservation Board (SWCB) and other agencies. The campaign to restore water quality in Aquilla Lake drew multiple partners, ranging from a host of government entities to local farmers. Through education, cooperation and improved farming practices over the last ten years the levels of Atrazine in the reservoir are down by about 60 percent from the levels of the late 1990's.

Even though the Lake is no longer listed as an impaired water body, it is listed on the TCEQ's 305 (b) list for several concerns. The 305(b) list is a state-wide assessment of all the waters in the state, regardless of status on the 303(d) list. These concerns include arsenic in sediment; of the Hackberry Creek arm of Lake Aquilla and nitrate in the waters at the south end of the reservoir near the dam, the Aquilla Creek arm, and the Hackberry Creek Arm (TCEQ, 2014). These are legacy pollutants that trace back, according to TCEQ, to bad practices in the 1960s and 70s. They tend to be encapsulated in the sediment column and have little effect on the quality of the water within the lake.

Whitney Lake chloride levels are approximately 435 parts per million (ppm) and total dissolved solids (TDS) concentrations are approximately 1,255 ppm. These levels are significantly higher that Aquilla Lake, and also higher than the water quality standards established by TCEQ. (300 and 1000, respectively. Sulfate concentrations in Whitney Lake (220 ppm) are lower than concentrations in Aquilla Lake.

## VEGETATION

The Eastern Cross Timbers natural vegetational area is characterized historically as a narrow band of woody vegetation between the Blackland Prairie and the Grand Prairie occurring largely on sandy soil formations. Vegetation composition is variable, ranging from open savanna with oak overstory to dense brush. Woody overstory consists primarily of post oak *(Quercus 16exicana)* and blackjack oak *(Quercus marilandica)*. In addition to the characteristic oaks, other woody species commonly found include cedar elm *(Ulmus crassifolia)*, hackberry *(Celtis spp.)*, pecan *(Carya illinoensis)*, juniper *(Juniperus spp.)*, and mesquite *(Prosopis grandulosa)*. Common grasses include hairy gramma *(Bouteloua 16exican)*, side-oats gramma *(Bouteloua cirtipendula)*, tall dropseed *(Sporobolus composites)*, switch grass *(Panicum virgatum)*, Canada wildrye *(Elymus 16exicana16e)*, and Texas winter grass *(Nassella Leucotricha)* (Correll & Johnson 1970). Past mismanagement and cultivation have caused many uplands to be populated by scrub-type oak, mesquite, and juniper with mid- and short-grasses beneath. (Hatch et al. 1990)

Six terrestrial wildlife habitat types (or landcover) were observed and described with the assistance of the United States Fish and Wildlife Service (USFWS) (Figure 4). The study area consists of approximately 3,164 acres (30.9 percent) of open water, 2,802 acres (27.3 percent) of upland forests, 2,043 acres (19.9 percent) of shrubland, 1,199 acres (11.7 percent) of grassland, 366 acres (3.6 percent) of savanna, 334 acres (3.3 percent) of riparian woodland, and 113 acres (1.1 percent) of wetlands. Additionally, 231 acres (2.2 percent) consists of structures or other disturbed areas such as highway crossings, the USACE project office complex, the dam itself, and recreation areas including boat ramps and associated amenities.

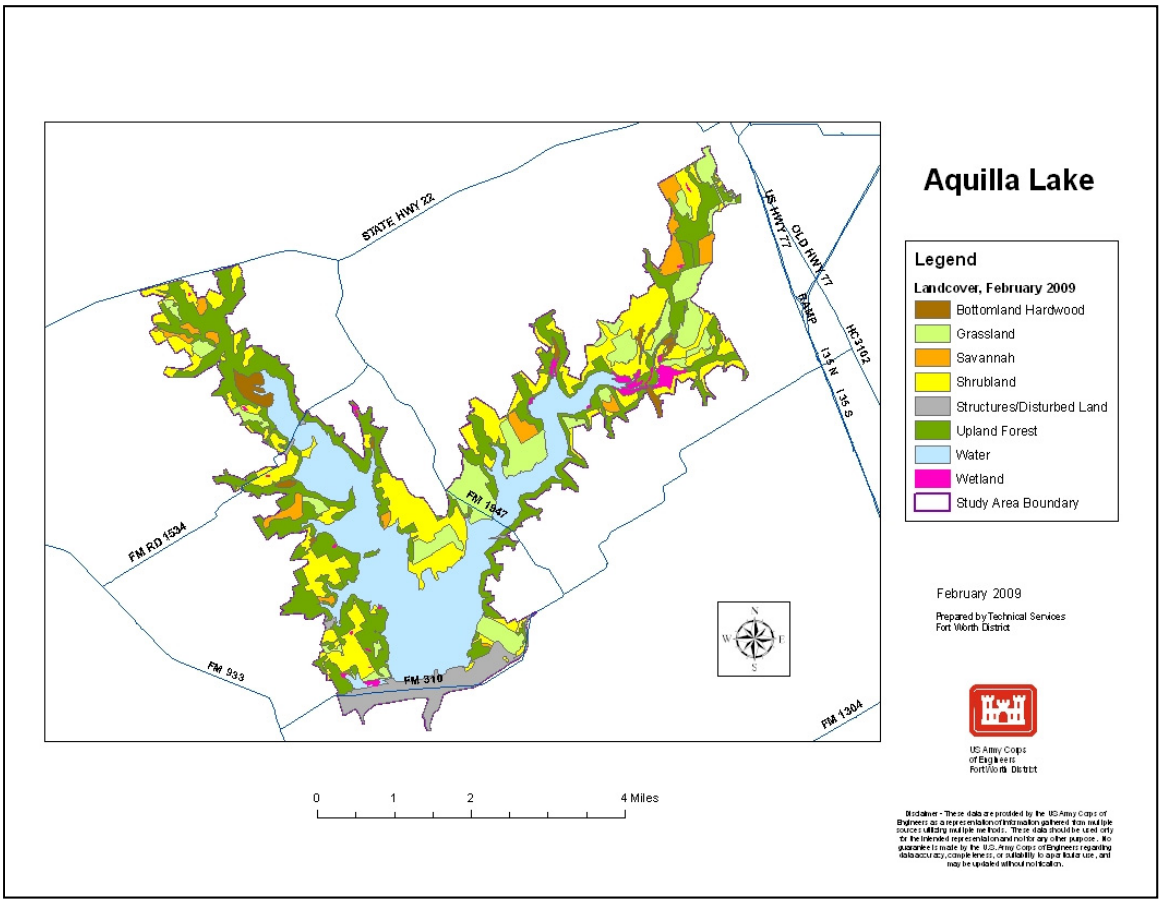



**Figure 4. Aquilla Lake Landcover**

## WILDLIFE

The study area is used by both resident and migratory wildlife species. Migratory waterfowl and shorebirds utilize the reservoir, its tributaries, and local herbaceous wetlands for foraging and brood rearing. The woodlands are used by a variety of migratory and resident passerine, owl, and hawk species. Common bird species observed in the study area are sparrow, northern mockingbird *(Mimus polyglottos)*, American robin *(Turdus migratorius)*, northern cardinal *(Cardinalis cardinalis)*, blue jay *(Cyanocitta cristata)*, Carolina chickadee *(Parus carolinensis)*, scissor-tailed flycatcher *(Tyrannus forficatus)*, downy woodpecker *(Picoides pubescens)*, common crow *(Corvus brachyrhynchos)*, American kestrel *(Falco sparverius)*, barred owl *(Strix varia)*, and red-tailed hawk *(Buteo*

*jamaicensis)*. Twenty-three species on the USFWS's *Birds of Conservation Concern (BCC)* list may utilize the habitat types within the study area. These are listed under "*Birds of Conservation Concern*" in Appendix B: Environmental Resources. Mammal species that sometimes utilize habitat in the study area include white-tailed deer (*Odocoileus virginianus*), raccoon *(Procyon lotor)*, striped skunk *(Mephitis mephitis)*, opossum *(Didelphis virginiana)*, coyote *(Canis latrans)*, bobcat *(Lynx rufus)*, eastern cottontail *(Sylvilagus floridanus)*, foxsquirrel *(Sciurus niger)*, and small rodents. Various species of frogs and turtles are found within the reservoir and wetlands, while lizards and snakes are found throughout the study area. Fish species within the reservoirs include largemouth bass *(Micropterus salmoides)*, blue catfish *(Ictalurus furcatus)*, channel catfish *(Ictalurus punctatus)*, white crappie *(Pomoxis maculatus)*, white bass *(Morone chrysops)*, and various sunfish species *(Lepomis sp.)* (TPWD 2008). A list of faunal species that were observed during field investigations is included on each site observation sheet in Appendix M with the USFWS Planning Aid Report.

## THREATENED AND ENDANGERED SPECIES

The federally listed threatened or endangered species known to occur in Hill County include the endangered whooping crane *(Grus 18exicana18)*, black-capped vireo *(Vireo atricapilla)*, and golden-cheeked warbler *(Dendroica chrysoparia)*. Two candidate species for listing, the smalleye shiner *(Notropis buccula)* and sharpnose shiner *(Notropis oxyrhynchus)* have also been recorded in Hill County.

The whooping crane may be encountered in all of the north central Texas counties during its migration. Autumn migration normally begins in mid-September, with most birds arriving on the wintering grounds at Aransas National Wildlife Refuge between late October and mid-November. Spring migration occurs during March and April. Whooping cranes prefer isolated areas away from human activity for feeding and roosting, with vegetated wetlands and wetlands adjacent to cropland being utilized along the migration route. Foods consumed usually include frogs, fish, plant tubers, crayfish, insects, and waste grains in harvested fields. It is possible that whooping cranes may temporarily utilize habitats present within the study area during their annual migration but an encounter would be a rare occurrence. It is unlikely that continuing any of the current activities would have an adverse impact on this species.

The habitat evaluation team did not encounter any habitats that appeared suitable for nesting golden-cheeked warblers or black-capped vireos. Therefore, it is not likely that either species would be present within the study area or that any adverse impacts would to occur due to project actions.

The bald eagle *(Haliaeetus leucocephalus)* was removed from the Federal threatened and endangered species list effective August 8, 2007. However, bald eagles are still afforded safeguards under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

The smalleye and sharpnose shiners are candidate species with no current federal protections. However, the USFWS recommend that potential impacts to these species be considered during project planning. USFWS records indicate that both of these species historically occurred in Hill County within the Brazos River area now occupied by Whitney Lake. There are no current records of either species' presence within the Aquilla Lake study area. Therefore, no impacts to either species is anticipated to occur.

In addition to federal species of concern, there are also various state species of concern known to occur in Hill County. The American Peregrine Falcon (*Falco peregrines anatum)* is a year-round resident and local breeder in Texas, and is state listed as Threatened. The Interior Least Tern *(Sterna antillarum athalassos)* is state listed as endangered, and is known to nest along sand and gravel bars within braided streams and rivers. The Peregrine Falcon *(Falco peregrines)*, also state threatened, breeds in Texas. Both the White-faced Ibis *(Plegadis chihi)* and the wood stork *(mycteria 19exicana19)* utilize freshwater marshes for feeding and nesting. Two state listed threatened mollusks are known to occur in the streams and rivers of the Brazos, the Smooth pimpleback *(Quadrula houstonensis)* and the Texas fawnsfoot *(Trunchilla macrodon)*. Although habitat for these mussel species occurs within the study area, the TPWD Natural Diversity Database does not identify any species occurrences within the study area.

## INVASIVE SPECIES

Executive Order (EO) 13112, dated February 3, 1999 directs federal agencies to expand and coordinate their efforts to combat the introduction and spread of invasive species (i.e. noxious plants and animals not native to the U.S.). Non-native flora and fauna can cause significant changes to ecosystems, upset ecological processes and relationships, and cause harm to our nation's agricultural and recreational sectors. Numerous factors can facilitate the spread of plant and animal species outside their natural range, both domestically and internationally.

Until the National Invasive Species Council defines an approved national list of invasive plants, known invasive plants are defined as those on the official noxious weed list of the state in which the activity occurs. In Texas, the Texas Department of Agriculture defines and regulates prohibited and restricted weed seeds in accordance with Texas Agriculture Code (TAC), Chapter Section 61.008 (Texas Seed Law). Consistent with TAC Title 4, Part 1, Chapter 9, subchapter T, Section 19.300(a), a noxious weed know to occur in the project area is hydrilla (Hydrilla verticillata), which was identified as impacting roughly 10 acres of surface water in 2005.

A second invasive species known to occur in the project area is the red imported fire ant (Solenopsis invicta), which occurs on 100 percent of the project's terrestrial lands.

## AIR QUALITY

Air quality is defined by ambient air concentration of specific pollutants determined to be of concern with respect to the health and welfare of the general public. Under the Clean Air Act Amendments of 1990, the EPA established National Ambient Air Quality Standards (NAAQS), including six "criteria pollutants:" lead (Pb), ozone ($O_3$), sulfur dioxide ($SO_2$), oxides of nitrogen ($NO_X$), carbon monoxide (CO), and particulate matter less than 10 microns in diameter (PM10). Areas that exceed a Federal air quality standard are designated as non-attainment areas.

The nearest area listed as a non-attainment area by the EPA is the Dallas Fort Worth Nonattainment Area, which is located approximately 60 miles north of Hill County. Hill County and Aquilla Lake are not expected to be designated as non-attainment in the duration of the forecast period.

There are relatively few industrial and commercial businesses in the county that could potentially have a negative effect on air quality. The predominant industries in the county are agriculture and farming. Due to the fact that the Hill County area is not highly industrialized and in a predominantly rural setting, the air quality in the region is generally considered to be good.

## TERRESTRIAL HABITAT EVALUATIONS

### *METHODS*

An interagency biological team, including USACE, Texas Parks and Wildlife Department (TPWD), and the USFWS, conducted a habitat evaluation of the study area in July 2008. The USFWS Habitat Evaluation Procedures (HEP) (USFWS, 1980) were used to analyze and describe the various existing habitats in the study area. The team collected field data in July 2008. HEP data was collected at 42 sites (Figure 5) randomly selected within the six terrestrial habitat types in the study area: riparian woodlands, grasslands, upland deciduous woodlands, shrubland, savanna, and herbaceous wetlands.

Thirteen wildlife indicator species were selected to represent the wildlife communities that use the six habitats evaluated (Table 4). The raccoon, fox squirrel, Carolina chickadee, barred owl, wood duck *(Aix sponsa),* and downy woodpecker were selected to represent those species that use riparian woodlands. The raccoon, green heron *(Butorides striatus),* and wood duck were selected to represent the wildlife community in herbaceous wetlands. The eastern meadowlark *(Sturnella magna),* eastern cottontail, fox squirrel, scissor-tailed flycatcher, and American kestrel were selected to represent the wildlife communities in the savanna. The eastern cottontail, scissor-tailed flycatcher, northern bobwhite, and racer *(Coluber constrictor [snake])* were selected to represent the wildlife communities in shrubland. The downy woodpecker, raccoon, Carolina chickadee, barred owl, and fox squirrel were selected to represent the upland deciduous forest community. The eastern meadowlark, eastern cottontail, and American kestrel were selected to represent the wildlife communities in grasslands.

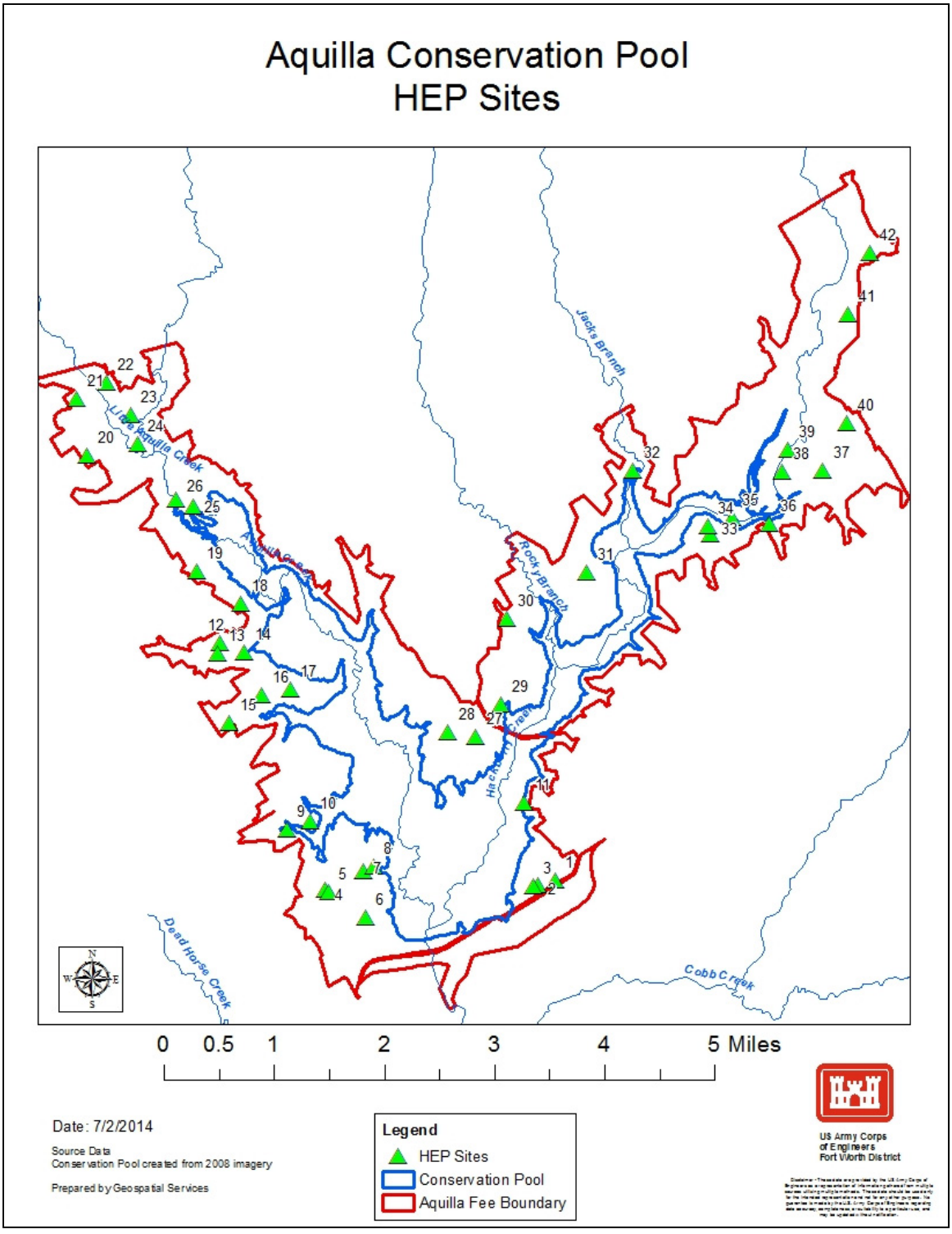



**Figure 5. Habitat Evaluation Sites for Aquilla Lake**

**Table 4. Indicator Species for HEP Evaluations for Aquilla Lake**

| Indicator Species | Habitat Type | | | | | |
|---|---|---|---|---|---|---|
| | Riparian | Grassland | Shrubland | Savanna | Herbaceous | Upland |
| **Raccoon** | X | | | | X | X |
| **Fox Squirrel*** | X | | | | | X |
| **Carolina chickadee** | X | | | | | X |
| **Barred owl*** | X | | | | | X |
| **Wood duck*** | X | | | | X | |
| **Downy woodpecker*** | X | | | | | X |
| **Green heron** | | | | | X | |
| **Eastern meadowlark*** | | X | | X | | |
| **Eastern cottontail*** | | X | X | X | | |
| **Scissor-tailed flycatcher** | | | X | X | | |
| **Northern bobwhite*** | | | X | | | |
| **Racer (snake)** | | | X | | | |
| **American kestrel** | | X | | X | | |

* Models approved for use by the USACE ECO-PCX

HEP requires the use of Habitat Suitability Index (I) models developed for each indicator species. The I models contain a list of structural habitat composition variables that are contained in optimum habitat. All the variables for each species representing each habitat are compiled and measured in the field. These variables are measured or estimated within a tenth-acre data plot within the habitat they represent. They are used as indicators of habitat condition or value.

Of the thirteen I models utilized for habitat evaluations, seven are approved for use by the USACE Ecosystem Restoration Planning Center of Expertise (ECO-PCX) and are listed on the Ecosystem Restoration Model Library approval list. Approval indicates the model is presently approved for regional and/or nationwide use in accordance with documented geographic range, best practices and its designated limitations. Additionally, the ECO-PCX is comfortable with application of the planning model and/or the model has been reviewed with concerning the model and its documentation being resolved to the satisfaction of the PCX (USACE Ecosystem Restoration Gateway – Ecosystem Restoration Model Library). While all thirteen I models are not approved, the seven approved models offer analysis of all six habitats under evaluation.

Baseline habitat conditions are expressed as a numeric function (I value) ranging from 0.0 to 1.0, where 0.0 represents no suitable habitat for an indicator species and 1.0 represents optimum conditions for the species. I values ranging from 0.01 to 0.24 are considered “poor” habitat, 0.25 to 0.49 are considered “below average” habitat, 0.50 to 0.69 are “average” habitat, 0.70 to 0.89 are

"good" habitat, and 0.90 to 1.00 are considered "excellent" habitat. Habitat units (Hus) are calculated by multiplying the I for each habitat by the amount of acres of that specific habitat.

## *RESULTS*

A complete list of plant and animal species observed, detailed scores for variables, photo information, and site observation sheets are contained in Appendix M, USFWS Coordination, Planning Aid Report.

Table 5. The Upland Deciduous Forest scored an overall habitat value of "good," while grasslands scored and overall "below average" value. The other four habitat evaluations scored "average." An in-depth discussion of each habitat precedes the summary table including acreages and percent of project areas.

### RIPARIAN WOODLANDS

Riparian woodlands are primarily located along the various inflows to the reservoir. Many of these woodlands are periodically flooded and are predominately composed of cedar elm, green ash *(Fraxinus pennsylvanica)*, pecan, black willow *(Salix nigra)*, and box elder *(Acer negundo)*. Other trees species present include bur oak *(Quercus macrocarpa)*, red mulberry *(Morus rubra)*, honey locust *(Gleditsia triacanthos)*, cottonwood *(Populus 24exicana)*, and sugar hackberry *(Celtis laevigata)*. Considering the relative newness of the reservoir (1983), it is likely that areas along the shoreline will develop further riparian woodland characteristics as vegetation matures. (USFWS, Planning Aid Report 2009)

There are seven data sites in riparian woodlands in the study area. Most of the riparian sites are dominated by overstory trees that are at the lower extent of that which would be considered optimal (> 12 inches diameter breast height (dbh)). The most limiting factor for raccoon habitat was the temporal availability of water in three of the data plots. The winter food requisite was the most limiting factor for fox squirrels. The required number of mast producing trees greater than 10 inches dbh needed for optimum fox squirrel habitat was absent in four of the seven data sites, and grain availability was too low in all of the data sites. Each of the life requisites was well above average or excellent for the Carolina chickadee. This was consistent across each of the data sites. The value of this cover type was poor for the wood duck and below average throughout the study area due to the low number of potentially suitable nest cavity trees and the lack of brood and winter cover across all cover types. The average I value for the riparian woodland within the study area is 0.67 (average habitat value) with 223.78 Hus.

**Table 5. Average I Values and Hus for Aquilla Lake**

| Indicator species | Riparian woodland | Upland deciduous forest | Herbaceous wetland | Grassland | Shrubland | Savanna |
|---|---|---|---|---|---|---|
| **Barred owl*** | 0.71 | 0.45 | | | | |
| **Carolina chickadee** | 0.95 | 0.93 | | | | |
| **Raccoon** | 0.71 | 0.80 | 0.71 | | | |
| **Wood duck*** | 0.03 | | 0.03 | | | |
| **American kestrel** | | | | 0.43 | | 0.43 |
| **Fox squirrel*** | 0.61 | 0.55 | | | | |
| **Downy woodpecker*** | 1.00 | 0.95 | | | | |
| **Green heron** | | | 0.87 | | | |
| **Eastern cottontail*** | | | | 0.46 | 0.46 | 0.46 |
| **Scissor-tailed flycatcher** | | | | | 1.00 | 1.00 |
| **Eastern meadowlark*** | | | | 0.54 | | 0.85 |
| **Racer (snake)** | | | | | 1.00 | |
| **Northern bobwhite*** | | | | | 0.09 | |
| **I Average** | 0.67 Average | 0.74 Good | 0.54 Average | 0.48 Below Average | 0.63 Average | 0.54 Average |
| **Habitat Units** | 223.78 | 2073.48 | 61.02 | 575.52 | 1287.09 | 197.10 |

* Models approved for use by the USACE ECO-PCX
Source: USFWS Planning Aid Reports 2009 and 2011

UPLAND DECIDUOUS FOREST

Deciduous forests are upland hardwood areas dominated by trees and with a minimal tree canopy cover of 25 percent. White-tailed deer *(Odocoileus virginianus)*, small mammals, turkey *(Meleagris gallopavo)*, bobwhite quail *(Colinus virginianus)*, and many other species of birds utilize these stands for food and/or cover. Upland deciduous forests were evaluated at six data sites. Cedar elm, post oak, and hackberry dominate this cover type. Other tree species associated with this forest type include mesquite, eastern red cedar *(Juniperus virginiana)* and blackjack oak. The shrub layer consists of gum bumelia *(Bumelia 25exicana25e)*, hackberry, cedar elm, post oak, red mulberry, deciduous holly *(Ilex decidua)* and coralberry *(Symphoriacarpos orbiculatus)*.

The I values for each species for this cover type range from below average for the barred owl, average for the fox squirrel, good for the raccoon, to excellent for the Carolina chickadee and downy woodpecker. The most limiting factors in this cover type are (1) the lack of large trees required by the fox squirrel and barred owl; (2) tree canopy closure required by the barred owl, and (3) a lack of

mast producing trees required by the fox squirrel. The upland deciduous forest average I value within the study area is 0.74 (good habitat value) with 2073.48 Hus.

### HERBACEOUS WETLANDS

Herbaceous wetlands are wetland areas dominated by non-woody vegetation. These wetlands provide food and cover for fish, resident and migratory birds, small mammals, invertebrates, and the predators that feed on these species. Wetlands are important nesting habitat for wading birds and waterfowl. This cover type is comprised primarily of reservoir, creeks, and seasonally flooded areas. Some of these wetlands are permanent, but most are likely seasonal.

There were eight data sites in herbaceous wetlands. I values ranged from good for the green heron and raccoon to poor for the wood duck. Poor cover and the number of potential nest cavities for the wood duck were the limiting factors in this cover type. The most limiting factor for the raccoon was the seasonable availability of water. The herbaceous wetland average I for the study area is 0.54 (average habitat value) with 61.02 Hus.

### GRASSLANDS

Grasslands are dominated by grasses, native or introduced, that are not regularly planted or mowed, and have a minimal canopy cover of 25 percent. Much of the grassland within the study area would be classified as unmanaged grasslands when considering the residual effects of prior agricultural uses. Unmanaged grasslands are fallow fields also containing a combination of native and introduced grasses, forbs, and trees, but the composition is different from those in native grasslands indicative of this ecoregion. The grass species found in the data plots were coastal 26exican *(Cynodon dactylon)*, littlebluestem *(Schizachyrium scoparium)*, inland seaoats *(Chasmanthium latifolium)*, Canada wildrye, switchgrass *(Panicum virgatum)*, panic grass *(Dichanthelium sp.)* Johnsongrass *(Sorghum halepense)*, and sideoats gramma *(Bouteloua cirtipendula)*.

There were seven data sites in grasslands in the study area. The I values ranged from 0.43 for the kestrel, 0.46 for the eastern cottontail, to 0.54 for the eastern meadowlark. The American kestrel is a multi-cover type species, and the value of each cover type applicable to this species is weighted within an overall value for the species within the entire study area. The I value in grassland alone was 0.96, considerably higher than the overall study area-wide value of 0.43. Likewise, the eastern cottontail is a multi-cover type species. The I value for eastern cottontail in grassland alone was 0.64, somewhat higher than the overall study area-wide value of 0.46. However, I values for multi-cover type species must be expressed as a single value giving appropriate weight to each of the cover types present which may be utilized by that species. The most limiting factor for cottontails in grasslands throughout the study area is insufficient cover, such as shrubs, trees, or persistent herbaceous plants. An insufficient number of large nest and perch trees are the most limiting factors for the eastern meadowlark. Each of these deficiencies may be at least partially due to the prior agricultural use and slow recovery time of these now fallow fields. The average I value for grasslands within the study area is 0.48 (slightly below average habitat value) with 575.52 Hus.

## SHRUBLANDS

Shrublands are defined as non-wetland areas dominated by shrubs and with a minimum shrub canopy cover of 25 percent. Shrublands provide open space, a seed and insect food source for passerines, forage for cottontails, and cover for escape and nesting by means of tall grass, scattered brush piles, and shrubs for a variety of animals. Red-tailed hawks hunt for prey in shrublands. The grass species found in the data sites are Johnsongrass, coastal 27exican, Canada wildrye, panicgrass, and switchgrass. The predominant shrub species are mesquite, cedar elm, hackberry, gum bumelia, eastern redcedar, Chickasaw plum *(Prunus angustifolia)*, and western soapberry *(Sapindus saponaria)*.

There were seven survey sites in shrublands. The shrubland I values per species ranged from poor for northern bobwhite (0.21) to optimal for scissor-tailed flycatcher (1.0), eastern cottontail (1.0), and racer (1.0). The overall HSIs for multi-cover type species evaluated in shrublands total 0.09 for northern bobwhite and 0.46 for eastern cottontail. The shrubland I value for both of these species was higher than the overall value of all cover types utilized by these species within the entire study area. The most limiting factors for northern bobwhites within shrublands are the lack of bare open ground allowing access to seeds while foraging, and the lack of canopy cover of woody shrubs less than two meters in height needed for cover. The average I for shrubland was 0.63 with 1,287.09 Hus.

## SAVANNA

Savanna is a non-wetland area with a shrub and/or tree canopy cover between 5 to 25 percent, but with a total canopy cover of all vegetation greater than 25 percent. The area between the trees and shrubs is typically dominated by grasses or other herbaceous vegetation. Savannas provide open space, a food source for passerines and the eastern cottontail, and cover for escape and nesting by means of tall grass, scattered brush piles, and shrubs for a variety of animals.

Unmanaged savannas such as those within the study area typically consist of fallow fields also containing a combination of native and introduced grasses, forbs, and trees, but the composition is different from those in the short grass areas. The grass species found in the data plots were Johnsongrass, little bluestem, Canada wildrye, coastal 27exican, switchgrass, sideoats gramma, and three awn. Tree and shrub species found within the savanna sites include mesquite, hackberry, hawthorne *(Crataegus sp.)*, gum bumelia, coralberry, Mexican plum *(Prunus 27exicana)*, honey locust, and deciduous holly.

There are seven data sites in this cover type. The I for this cover type was optimal (1.0) for scissor-tailed flycatcher, good (0.85) for eastern meadowlark, and below average for eastern cottontail (0.46) and kestrel (0.43). The overall HSIs for multi-cover type species evaluated in savannas total 0.46 for northern bobwhite and 0.64 for eastern cottontail. The savanna I value for kestrel was higher than the overall value of all cover types utilized by this species within the entire study area. However, the limiting factor for savannas throughout the study area is the insufficient persistent herbaceous plants which provide essential winter cover for cottontails. The average I for savanna is 0.54 (average habitat value) with 197.10 Hus.

# AQUATIC HABITAT EVALUATIONS

## *METHODS*

To establish a baseline for project evaluation, the study team quantified the existing value of the aquatic resources within the lake's littoral zone area and in the upstream tributary areas that could be potentially impacted by modifications associated with the proposed reallocation project. USFWS provided direction into appropriate survey methods for the area, thus, a regionalized Index of Biotic Integrity (IBI) assessment was utilized to evaluate and describe the various existing aquatic habitats in the study area (Linam et.al. 2002). Various metric scoring criteria are used for evaluation among the sites chosen to sample, including:

- Total number of fish species
- Number of native cyprinid species
- Number of benthic invertivore species
- Number of sunfish species
- Percent of individuals as tolerant species
- Percent of individuals as omnivores

Each of the metrics is scored with values ranging from low (1) to high (5). In turn, aquatic life use values are determined by adding each metric score for a total score. These aquatic life use values can range from limited to exceptional. The total score for aquatic life use subcategories within the Subhumid Agricultural Plains (Ecoregions 27, 29, and 32), which includes the Aquilla Lake area, were as follows: >49 = Exceptional; 41-48 = High; 35-40 = Intermediate; and <35 = Limited (Linam *et al.* 2002).

An interagency biological team, including USACE and USFWS, conducted an aquatic habitat evaluation of the aquatic study area at Aquilla Lake. The team collected field data in August 2011. A fisheries survey and IBI evaluation was conducted on three tributaries of the lake – Aquilla Creek, Jack's Branch, and Hackberry Creek, within the areas that would be directly impacted by implementation of the proposed activities. See Figure 6 for location of IBI aquatic habitat evaluation sites. Rocky Branch, also a main tributary of Aquilla Lake, was completely dry during the sampling period, so no samples were taken on this tributary.

## *RESULTS*

Aquilla Creek is considered a 3rd order perennial stream, with an average width of 30 feet (9 meters) and an average water depth of 3 feet (1 meter). Substrate was dominated by clay and silt with areas of abundant organic debris.

Jack's Branch is a 1st order stream, with an average width of about 18 feet (5.5 meters) and an average water depth averaged of 4 feet (1.2 meters). Substrate was dominated by clay and silt with areas of abundant organic debris.

Hackberry Creek is a 3rd order stream, with an average stream width of 25 feet (7.6 meters). Water depth average is about 3 feet (1 meter) and substrate is dominated by clay and silt with areas of abundant organic debris.

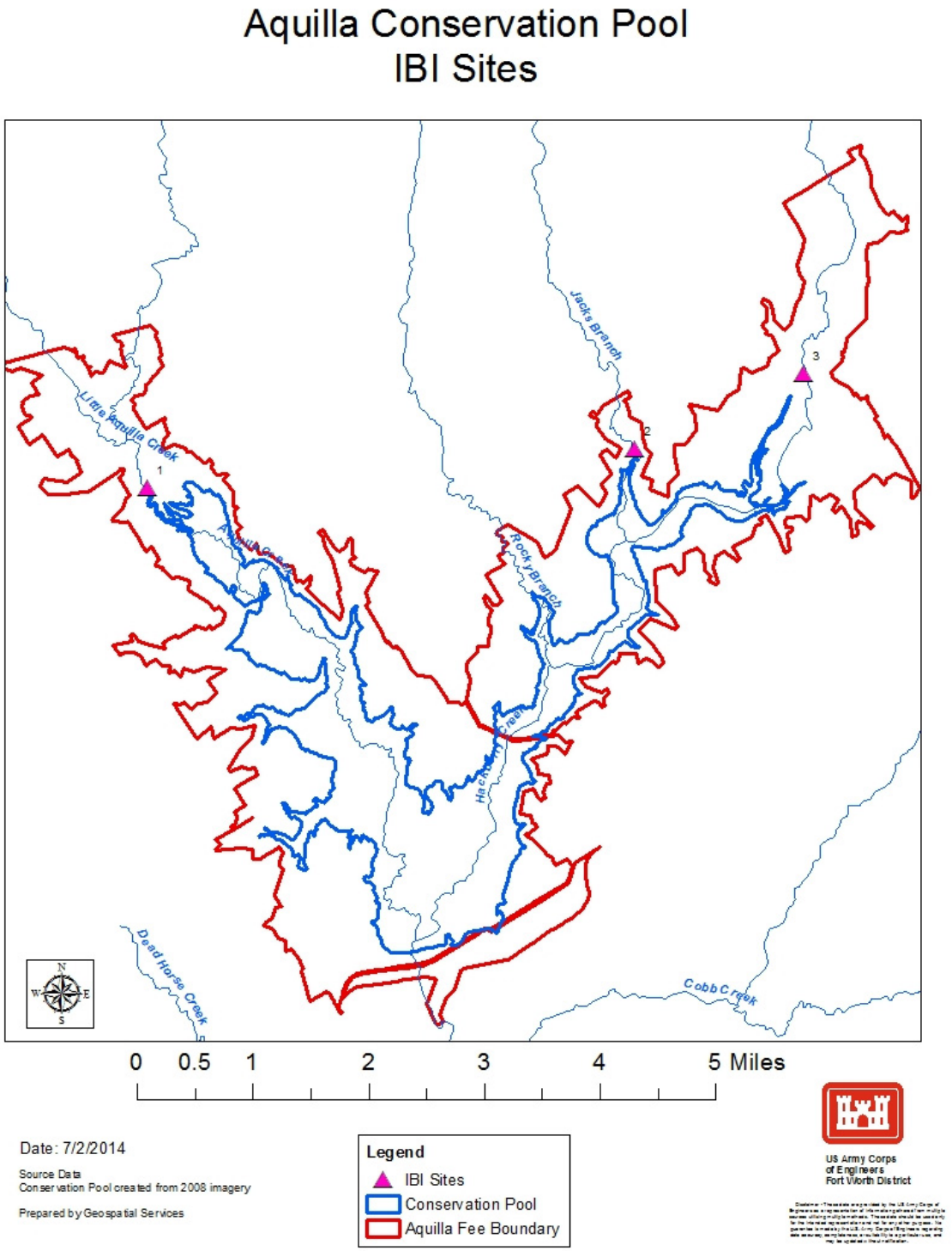



**Figure 6. IBI Evaluation Sites for Aquilla Lake**

In-stream habitat at the Aquilla Creek and Jack's Branch sites consisted of disconnected, deeply incised stagnant pools, while the Hackberry Creek site also has a deeply incised channel with a long, continuous pool, likely because it is fed by releases from an upstream wastewater treatment plant. No riffle or run habitat existed at any of the sampling sites. All sites had numerous in-stream obstacles, such as logs, fallen branches, and root wads.

A total of 935 fishes, comprising 14 identifiable species from 8 families, were collected from the Aquilla Lake tributaries 3 main sampling sites. The complete results, including fish composition, are detailed in the USFWS Supplemental Planning Aid Letter Report. The regional IBI assessment results demonstrated a limited aquatic life use value for the fish community sampled at Aquilla Creek (score of 33) and a high aquatic life use value for the fish assemblages at Jack's Branch and Hackberry Creek (scores of 47 and 43). The mean IBI score for the three sites characterized the study area as high (mean score of 41) and the fish community within the overall study area was characterized as high (score of 45) (see Table 6).

**Table 6. Regional IBI Metric Calculations (IBI Score) for Overall Study Area**

| | | | |
|---|---|---|---|
| 1. Total # of fish species: | 14 (5) | 7. % of individuals as invertivores: | 87 (5) |
| 2. # of native cyprinid species: | 1 (1) | 8. % of individuals as piscivores: | 7 (3) |
| 3. # of benthic invertivore species: | 4 (5) | 9a. # of individuals/seine haul: | 72 (3) |
| 4. # of sunfish species: | 5 (5) | 9b. # of individuals/minute of electro-fishing: | na |
| 5. % of individuals as tolerant species (excluding mosquitofish): | 36 (3) | 10. % of individuals as non-native species: | <1 (5) |
| 6. % of individuals as omnivores: | 6 (5) | 11. % of individuals with disease or other anomaly: | 0 (5) |
| **IBI Total Score: 45 (High)** | | | |

Source: (USFWS, Supplemental Planning Aid Letter, 2011)

The regionalized IBI assessment results demonstrated a limited aquatic life use value for the fish community sampled at Aquilla Creek (score of 33) and a high aquatic life use value for fish assemblages at Jack's Branch and Hackberry Creek (scores of 47 and 43, respectively). The fish community within the overall study area was characterized as high, with a score of 45 and the mean IBI score for the three sites also characterized the study area as high, with a mean score of 41.

Considering the limited flow conditions and lack of riffle or run aquatic habitat available at each site, the overall fish community score of 45 seems to be more representative of the reservoir itself. If it were not for migration from the reservoir, there would likely be no fish in the pools found in Aquilla Creek and Jack's Branch. Hackberry Creek is likely to be continually connected to the reservoir allowing for fish migration, but the lack of any in-stream structure would limit the diversity of the fish populations on its own.

In order to make the aquatic habitat index values in the IBI comparable to the I values in HEP for evaluation purposes, aquatic habitat index values from 0.0 to 1.0 were calculated by dividing the total score from the sampling location by the total points possible from the statewide IBI. This provided a normalized value of 0.75 that could then be compared to the I values of the other habitat types.

Habitat units are then calculated by multiplying the normalized IBI by the number of acres of aquatic habitat, in this case 0.75 X 3,060 = 2,295 IBI Hus.

## *FUTURE WITHOUT PROJECT CONDITIONS*

A large scale flood event was not considered when evaluating how the habitats on the project site would change over time. It is impossible to predict when or even if a large scale event will occur at a given site. However, it is expected that a large flood event such as the 1 percent ACE would have negative effects on the plant communities immediately surrounding Aquilla Lake, as has happened at other reservoirs that have experienced flooding of this size. The magnitude of those negative effects would depend on several factors that cannot be predicted such as the time of year the flood happens and the duration of inundation based on the release rate of flood waters from the reservoir.

### RIPARIAN WOODLANDS

The trend of conversion or influence of adjoining streams on the project site to create areas of riparian woodland is expected to continue into the future. It is estimated that the total conversion of upland deciduous forests to seasonally and temporarily flooded woodland will be approximately 50 acres over the 50 years.

Due to the initial impoundment of the reservoir and the loss of the highest quality bottomland hardwood and riparian woodlands, and the agricultural and land use practices that occurred prior to the flooding of the lake, the habitat that exists now is considered to be only of average habitat value, with an average I of 0. 67. It is expected that due to the limited habitat management at Aquilla Lake that the habitat quality over the next 50 years will increase only minimally due to the increased patch size of the riparian woodlands and the continued maturation of the areas that currently exist. The estimated I for this habitat type at year 50 is expected to be 0.70, which is on the lowest end the I scale for good habitat value. This will increase the Hus for Riparian (Floodplain) Woodlands from 223.78 for the existing conditions to a value of 268.80 at year 50. Tables 7 to 13 show the Average Annual Habitat Units (AAHUs) for each vegetation type over the 50-year period of analysis, as well as the calculations of the size and quality of habitat on the project site for 1-, 5-, 10-, 25- and 50-year without project conditions.

**Table 7. Future without: Riparian (Floodplain) Woodland Habitat Unit Projections for Aquilla Lake**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| **Interval (years)** | **0** | **1** | **4** | **5** | **15** | **25** |
| **I** | 0.67 | 0.67 | 0.67 | 0.68 | 0.68 | 0.7 |
| **Acres** | 334.4 | 334.4 | 339.4 | 344.4 | 359.4 | 384.1 |
| **Target year HU** | 223.78 | 223.78 | 227.13 | 233.92 | 244.12 | 268.8 |
| **Interval HU** | | 223.78 | 901.82 | 1,152.58 | 3,585.30 | 6,409.42 |
| **Cumulative Hus** | | | | | | 12,272.90 |
| **Average Annual** | | | | | | 245.46 |

UPLAND DECIDUOUS FOREST

Due to the increased backwater effect of maintaining a higher pool elevation, approximately 50 acres of upland deciduous forest is expected to be converted to floodplain woodlands over the next 50 years. This loss is expected to be offset by the conversion of shrubland or savanna habitat to upland deciduous forest habitat over the next 50 years resulting in no net loss of acreage for this habitat type.

It is expected that the overall habitat quality will remain relatively unchanged with only slight decreases over the next 10 to 25 years due to the lower quality of the early successional forest land from the conversion of shrubland and savanna habitat to upland forest. As this newly converted land matures over the next 25 to 50 years the average I for the upland forest habitat is expected to increase to a value back to the level of the currently existing habitat which is 0.74.

The Hus for upland forest for the existing conditions is 2073.78. This value will decrease slightly at year 5 and 10 to 2045.46 due to the lower I values for the newly converted forest land, but will increase due to maturation of the newly converted forest back to existing condition levels at years 25 and 50. Table 8 shows the calculations of the size and quality of habitat on the project site for 1-, 5-, 10-, 25- and 50-year without project conditions, as well as the AAHUs.

**Table 8. Future without Project Upland Deciduous Forest Habitat Unit Projections for Aquilla Lake**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| **Interval (years)** | **0** | **1** | **4** | **5** | **15** | **25** |
| **HIS** | 0.74 | 0.74 | 0.73 | 0.73 | 0.74 | 0.74 |
| **Acres** | 2,802.00 | 2,802.00 | 2,802.00 | 2,802.00 | 2,802.00 | 2,802.00 |
| **Target year HU** | 2,073.4 | 2,073.4 | 2,045.4 | 2,045.46 | 2,073.48 | 2,073.48 |
| **Interval HU** | | 2,073.4 | 8,237.8 | 10,227.3 | 30,892.0 | 51,837.00 |
| **Cumulative Hus** | | | | | | 103,267.7 |
| **Average Annual Hus** | | | | | | 2,065.35 |

HERBACEOUS WETLANDS

The acreage of herbaceous wetlands at the project site is not expected to change significantly over the next 50 years. However, the quality of this habitat type is expected to increase due to the maturation of the adjacent trees and potential cover area for the wood duck. The maturation of the adjacent trees will significantly increase the average I value for the wood duck causing the overall average I value for wetlands to increase to 0.65 over the 50-year time span.

Due to the increase in average I values for the wood duck, the HU'S for wetland areas will increase from 61.01 for the existing conditions to 73.45 HU'S at year 50. Table 9 shows the calculations of the size and quality of habitat on the project site for 1-, 5-, 10-, 25- and 50-year without project conditions, as well as the AAHUs.

**Table 9. Future without Project Herbaceous Wetland Habitat Unit Projections for Aquilla Lake**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| **Interval (years)** | **0** | **1** | **4** | **5** | **15** | **25** |
| **I** | 0.54 | 0.54 | 0.57 | 0.6 | 0.62 | 0.65 |
| **Acres** | 112.98 | 112.98 | 112.98 | 112.98 | 112.98 | 112.98 |
| **Target year HU** | 61.02 | 61.02 | 64.41 | 67.8 | 70.06 | 73.44 |
| **Interval HU** | | 61.02 | 250.86 | 330.53 | 1,033.95 | 1,793.88 |
| **Cumulative Hus** | | | | | | 3,470.23 |
| **Average Annual** | | | | | | 69.4 |

GRASSLAND

Due to the limited management at Aquilla Lake, it is expected that the overall acreage of grasslands on the project site will decrease over the next 50 years due to their conversion to shrub savanna or tree savanna habitat. This will decrease the overall acreage from 1198 for existing conditions to 898 acres at year 50.

Due to the encroachment of woody species into the grasslands over the next 50 years resulting in decreased patch size for this habitat it is expected that the average I value for grassland will decrease slightly to 0.45 at year 50. The Hus are also expected to decrease over the next 50 years to 404.55 due to the loss of acreage and habitat value for this habitat type.

Table 10 shows the calculations of the size and quality of habitat on the project site for 1-, 5-, 10-, 25- and 50-year without project conditions, as well as the AAHUs.

**Table 10. Future without Project Grassland Habitat Unit Projections for Aquilla Lake**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| **Interval (years)** | **0** | **1** | **4** | **5** | **15** | **25** |
| **HIS** | 0.48 | 0.47 | 0.46 | 0.45 | 0.45 | 0.45 |
| **Acres** | 1,199.00 | 1,164.00 | 1,079.00 | 1,019.00 | 959.00 | 899.00 |
| **Target year HU** | 575.52 | 547.08 | 496.34 | 458.55 | 431.55 | 404.55 |
| **Interval HU** | | 561.30 | 2,086.84 | 2,387.23 | 6,675.75 | 10,451.25 |
| **Cumulative Hus** | | | | | | 22,162.37 |
| **Average Annual Hus** | | | | | | 445.84 |

SHRUBLANDS

Due to the limited habitat management at Aquilla Lake the evolution of grassland to tree savanna to shrubland is expected to continue over the next 50 years. Shrubland acreage at the project site is expected to increase to 2082 acres at year 50. Due to the increased patch size and other factors it is expected that the average I for shrubland will increase slightly to 0.67 at year 50. Hus for shrubland

are expected to increase to 1394.94 due to the increase in both acreage and quality of this habitat type. Table 11 shows the calculations of the size and quality of habitat on the project site for 1-, 5-, 10-, 25- and 50-year without project conditions, as well as the AAHUs.

**Table 11. Future without Project Shrublands Habitat Unit Projections for Aquilla Lake**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| **Interval (years)** | **0** | **1** | **4** | **5** | **15** | **25** |
| **I** | 0.63 | 0.63 | 0.64 | 0.65 | 0.66 | 0.67 |
| **Acres** | 2,043.00 | 2,043.00 | 2,048.00 | 2,058.00 | 2,070.00 | 2,082.00 |
| **Target year HU** | 1,287.09 | 1,287.09 | 1,310.72 | 1,337.70 | 1,366.20 | 1,394.94 |
| **Interval HU** | | 1,287.05 | 5,195.93 | 6,622.03 | 20,282.10 | 34,519.16 |
| **Cumulative Hus** | | | | | | 67,896.34 |
| **Average Annual Hus** | | | | | | 1,357.93 |

SAVANNA

Once the existing savannas have matured beyond the 25 percent thresholds they are considered shrublands. The maturation trend is expected to continue over the next 50 years. Savanna habitat is expected to increase to 576.37 acres at year 50. The average I is expected to increase slightly over a 50-year period to 0.58 due to increased patch size and additional diversity of species and maturation of existing conditions. The Hus are also expected increase to 334.08 due to the increase in both acreage and quality of this habitat type. Table 12 shows the calculations of the size and quality of habitat on the project site for 1-, 5-, 10-, 25- and 50-year without project conditions, as well as the AAHUs.

**Table 12. Future without Project Savanna Habitat Unit Projections for Aquilla Lake**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| **Interval (years)** | **0** | **1** | **4** | **5** | **15** | **25** |
| **I** | 0.54 | 0.54 | 0.55 | 0.56 | 0.57 | 0.58 |
| **Acres** | 365.46 | 397.46 | 474.96 | 519.96 | 552.86 | 576.37 |
| **Target year HU** | 197.1 | 214.38 | 261.25 | 291.2 | 315.21 | 334.08 |
| **Interval HU** | | 205.74 | 950.74 | 1,380.75 | 4,547.25 | 8,115.17 |
| **Cumulative Hus** | | | | | | 15,199.65 |
| **Average Annual Hus** | | | | | | 303.99 |

WATER/AQUATIC HABITAT

The current surface water acreage of Aquilla Lake is 3164 acres. This value is expected to remain constant under normal conditions. Without the project, lake conditions would remain under current operations, therefore aquatic habitat would remain as is, with little to no changes. The IBI aquatic assessment normalized average value for the open water habitat in the project area is 0.45. Table 13 shows the Average Annual Habitat Units over the 50-year period of analysis, as well as the

calculations of the size and quality of the Water/Aquatic habitat in the study area for 1-, 5-, 10-, 25- and 50-year without project conditions.

**Table 13. Future Without Project Aquatic Habitat Unit Projections for Aquilla Lake**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| **Interval (years)** | **0** | **1** | **4** | **5** | **15** | **25** |
| **HIS** | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| **Acres** | 3,164.00 | 3,164.00 | 3,164.00 | 3,164.00 | 3,164.00 | 3,164.00 |
| **Target year HU** | 1,423.80 | 1,423.80 | 1,423.80 | 1,423.80 | 1,423.80 | 1,423.80 |
| **Interval HU** | | 1,423.80 | 5,695.20 | 7,119.00 | 21,357.00 | 35,595.00 |
| **Cumulative Hus** | | | | | | 71,190.00 |
| **Average Annual Hus** | | | | | | 1,423.80 |

Table 14 provides a summary of Annual Average Habitat Units (AAHUs) for all habitat types.

**Table 14. Future without Project Condition Annual Average Habitat Units**

| Habitat Type | AAHUs |
|---|---|
| **Riparian Woodland** | 245.46 |
| **Upland Deciduous Forest** | 2,065.35 |
| **Herbaceous Wetland** | 69.40 |
| **Grassland** | 445.84 |
| **Shrublands** | 1,357.93 |
| **Savanna** | 303.99 |
| **Aquatic** | 1,423.80 |
| **Total** | 5,911.77 |

## CULTURAL RESOURCES

A cultural resources survey and site assessment was conducted in November 2010. Thirty-nine sites were revisited and assessed, and ten previously unsurveyed areas were assessed. The ten new areas were found to be highly eroded with steep gradients, or in wetland settings. Two of these areas yielded previously unknown sites containing pre-historic lithic scatter. Additionally, a site lying outside the survey areas was discovered consisting of a hand-dug, stone-lined well within a concrete box. Only one of the new sites is recommended for additional work to determine eligibility for listing in the National Register of Historic Places. Of the 39 sites assessed in this report, five are recommended as being potentially eligible for listing in the National Register of Historic Places (under Criterion D) pending additional investigations. Three of the five potentially eligible sites will be adversely impacted by a 4.5-ft pool raise and therefore warrant additional investigations. Additional information can be found in Appendix H.

## HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

A search of available environmental records was conducted in December 2011 to identify any hazardous substances that may have been released to soil, groundwater, or surface water, and to assess their potential impacts on reallocation. No sites were identified where hazardous substances or petroleum products had been released, and no water, oil, or gas well locations were identified within the search area.

# CHAPTER 3: PLAN FORMULATION

Plan formulation supports the USACE water resources development mission. A systematic and repeatable planning approach is used to ensure that sound decisions are made. The Principles and Guidelines describe the process for Federal water resource studies. It requires formulating alternative plans that contribute to Federal objectives. This chapter documents the need for water reallocation, the preliminary screening of reallocation alternatives, and the final reallocation alternatives to evaluate in detail. The evaluation of alternatives was guided by USACE's Environmental Operating Principles (EOP) and compliance with the Campaign Plan.

## PROBLEMS AND OPPORTUNITIES

Problem: Stated earlier in the report, needs among BRA customers with contracts at Aquilla Lake is driven primarily by growth in and around the city of Cleburne with projected needs above currently available supplies by 2020. The projected 2020 needs range from approximately 2,800 to 3,700 AF per year (Table 22). The needs are projected to increase to approximately 4,000 to 9,000 AF per year by 2040. The needs by 2070 are projected to be anywhere from 7,500 to 30,000 AF per year. There is insufficient water supply to meet the demands resulting from projected population growth.

Based on the 2016 Brazos G Regional Water Plan, Aquilla Lake is currently permitted by the TCEQ to provide 13,896 AF annually for M&I water supply. The actual firm yield of the Lake is declining slightly due to sediment accumulation. Comparisons of capacities at conservation pool elevation derived from current and previous surveys suggest Aquilla Lake loses between 97 and 269 AF per year of conservation storage space due to sedimentation. According to the WSA between the U.S. Government and BRA dated April 5, 1976, BRA has the right to the total useable storage below elevation 537.5 ft-msl (estimated in 1976 to contain 33,600 AF after adjusting for expected future sedimentation) in Aquilla Lake for M&I water supply, subject to availability of water. Since Aquilla Lake began impounding water in 1983, over 7,800 AF of storage has been lost to sedimentation within the conservation pool. At the time of design, the projected 100-year sedimentation was 25,700 AF, meaning the actual rate of accumulation is slightly less than projected. Reallocating storage from the flood control pool to the conservation pool would restore storage lost to sedimentation, plus provide additional new water supply storage.

With the exception of the City of Cleburne, municipal water demand is expected to be relatively flat over the planning period, consistent with the projected population growth. The 2020 demand from Aquilla Lake for all users except Cleburne is expected to be 6,512 AF in 2020 and is forecasted to be approximately 5,953 AF per year in 2070. Cleburne's potential demand from Aquilla is expected to grow from 15,905 AF in 2020 to 42,611 AF per year by 2070 based on the population projections under the Cleburne Long Range Water Supply Plan. Total supply at Aquilla Lake is expected to also be relatively flat with 18,877 AF in 2020 and decreasing slightly to 18,532 AF in 2070. Conservation and re-use plans are expected to reduce water usage through to 2070. A large portion of this reduction is attributed to the 1991 and 2014 State Water-Efficient Plumbing Acts, which are expected to effectively reduce gallons per capita day (gpcd) usage rates over time.

Industrial demand for water is expected to increase moderately in Hill County and significantly in Johnson County. This includes demand for manufacturing and steam-electric generation. Hill County's current demand is approximately 45 AF per year for manufacturing, and demand is forecasted for 2070 at 70 AF per year. Johnson County's current demand is approximately 2,517 AF per year for manufacturing, and demand is forecasted for 2070 at 4,375 AF per year. Additionally, there is no current usage for steam-electric generation, but it is currently being developed in Johnson County and is expected to generate a demand for 7,000 AF per year beginning in 2020 and continuing beyond 2070.

Demands associated with Aquilla Water Supply District (AWSD) are contracted water supply obligations to supply water to the City of Hillsboro and several surrounding water supply corporations. The shortage represented in 2020 is due to contractual obligations to the City of Hillsboro which ends within the 2020 decade. It is anticipated that AWSD will be short 559 AF per year in meeting its contracted obligations in 2020 due to this contract with the City of Hillsboro. Additionally, AWSD has sought additional long-term water supply from BRA since at least the early 2000s.

Potential impacts from not meeting the projected AWSD shortages include manufacturers in Hill County producing window treatments, cabinets, horticultural machinery, concrete buildings, plastics manufacturing equipment and expanded polystyrene.

The City of Cleburne is expected to experience shortages by 2020. The City has short-term plans to reduce demand through conservation as well as an aggressive reuse program. However, substantial increases in demand from manufacturing industries (manufactured homes, cabinets, exterior concrete fiber siding, conveyor systems, truck bodies, sheet metal fabrication, and work wear textiles) and for steam-electric generation are expected to outstrip supply. The combined shortages from these industries amounts to approximately 5,656 AF per year by 2070. The total 2070 shortage for the City of Cleburne is projected to be approximately 7,500 to 30,000 AF per year (Table 21). Measures considered to resolve the forecasted water supply shortage include conservation, use of other water supply sources, and reallocation of storage in Aquilla Lake.

Opportunities that may be provided by measures to address needs at Aquilla Lake and Cleburne's future water supply shortages are listed below:

- Opportunity 1: Reduce water shortages faced by the BRA in a way that complements other water supply activities while maintaining the authorized project purposes for Aquilla Lake.
- Opportunity 2: Complement local efforts to educate the public on water conservation activities currently practiced, and recommend any additional conservation activities that might be undertaken at a local level.

## GOALS, OBJECTIVES, AND CONSTRAINTS

BRA wishes to execute its charge to develop, manage, and protect the water resources within the Brazos River Basin and to meet future needs of its water supply customers. USACE and BRA have engaged in this study for the specific purpose of determining how best to address any potential needs forecasted for 2020 and beyond.

Objective: Provide a means to help meet, to the extent practicable, the forecasted water demand of BRA Aquilla Lake customers, which is projected to reach 26,070 AF/year or more by 2070.

There are a number of constraints that impact this study effort. Universal constraints are dictated by and documented in law or policy, and they may be Federal, State, or local. These constraints include but are not limited to requirements to not induce flood damages, minimize adverse effects to the environment, and minimize the requirement for acquisition of real estate. One constraint specific to State legislation does bear mentioning for its potential impacts on any project that may be recommended. Texas, as required through Senate Bill 3, has developed environmental flow criteria for water rights permitting in the Brazos River basin. To implement a storage reallocation project at Aquilla Lake, BRA must obtain an amendment to its State water right permit for the additional storage and diversion rights. It is anticipated that the new environmental flow criteria may impact the amount of additional water BRA would be authorized to divert from Aquilla Lake as a result of reallocation.

During plan formulation, the goal was to identify and perform an initial evaluation of preliminary alternatives for water supply. Consideration of all reasonable alternatives is required under the Economic and Environmental Principles for Water and Related Land Resources Implementation Studies. The NEPA requires Federal agencies to incorporate environmental considerations in their planning and decision-making process. The Planning Guidance Notebook, Engineering Regulation (ER 1105-2-100), Appendix B and Appendix C, require the formulation and evaluation of a full range of reasonable alternative plans. Alternatives are formulated to take into account the overall problems, needs, and opportunities afforded by the proposed action. Those alternatives are assessed consistent with the national objective of contributing to NED and protecting the Nation's Environment, and consistent with Federal laws and regulations. The NED objective for water supply is to provide the most cost-effective water supply source to meet the region's future M&I requirements when considering economic, social, and environmental impacts of the potential reallocation. M&I water supply is considered the primary responsibility of the municipalities or other non-Federal entities. However, M&I storage space may be recommended for inclusion in USACE reservoirs pursuant to the Water Supply Act of 1958, as amended. In 2008, Phase I feasibility studies made an assessment of the basin-wide water resource needs for the Middle Brazos River. The studies documented in the form of an Information Paper identified Aquilla Lake as a USACE reservoir where reallocation appeared to be economically efficient. That study also indicated consideration of various reallocation levels for bracketing: a 2.5-foot pool raise, 4.5-foot pool raise and a 6.5-foot pool raise, all reallocating flood storage space to water supply storage.

In order to determine the appropriate reallocation scale, the following section evaluates the water demand, supply and associated need analysis for water users who rely on Aquilla Lake as a source. Identifying the water need for these customers should inform the scale of reallocation as well as additional feasible alternatives.

## WATER DEMAND AND SUPPLY ANALYSIS

The BRA currently holds the storage contract and water right for the supply in Aquilla Lake. BRA provides wholesale water from Aquilla Lake to three primary customers: Aquilla Water Supply District (AWSD), City of Cleburne and Hilco United. The AWSD supports the City of Hillsboro along with a

largely rural population in Hill and Johnson Counties, which are not expected to grow significantly in the short-to-medium term. Hilco United has a small contract for 150 AF per year, which is currently unused as no intake or treatment plant are in place to divert and treat this water. The Hilco United service area for this water supply is mostly rural and is not expected to grow significantly.

In contrast, the City of Cleburne, which is the county seat for Johnson County and has a substantial industrial base, has recently been connected directly to downtown Fort Worth through construction of a tollway, the Chisolm Trail Parkway (CTP). The CTP has substantially reduced commuting time and strengthened Cleburne's position as a "bedroom" community to Fort Worth. As a result, Cleburne's population, and resultant water demand, is expected to grow substantially. Several different sets of population projections for Cleburne have been developed recently which differ in their estimates of the magnitude and immediacy of the projected population growth, but there is agreement among them that the CTP will dramatically alter Cleburne's future. The need for the reallocation of storage at Aquilla Lake is substantially driven by anticipated increases in water demand within the City of Cleburne and its Extra-Territorial Jurisdiction (ETJ.)

Recent population projections for Cleburne are available from a variety of sources:

- Texas Water Development Board (TWDB) (Brazos G Regional Water Plan)
- North Central Texas Council of Governments (NCTCOG)
- Cleburne Comprehensive Plan (Comp Plan)
- Cleburne Long Range Water Supply Plan (LRWSP)

Each of these projections uses different sets of assumptions leading to a wide range of potential population projections for the City of Cleburne. The 2016 Brazos G population projections (TWDB) are fundamentally derived from the census estimates and likewise do not explicitly reflect the "game-changing" nature of the CTP. The remaining sets of projections account for the impact that the CTP will have on population growth with differing orders of magnitude and were evaluated for use in this analysis. Note that in Texas, municipalities are responsible for serving the water needs of their Extra-Territorial Jurisdiction (land outside the city limits but within two miles of the City limits). The population projections developed by the NCTCOG were originally developed for purposes of transportation analysis based on the current city limits and did not include projected population for Cleburne's ETJ. The Cleburne Comprehensive Plan projections as well as the Cleburne LRWSP projections do appropriately include the ETJ population. As part of this analysis, the NCTCOG projections were revised to cover the expanded geography of Cleburne and its ETJ. The population from each traffic zone was clipped to the city of Cleburne's ETJ to determine the percentage of the area within the ETJ. The total population from each traffic zone was then distributed by the percentage within the ETJ to the city of Cleburne. The scenario analysis focuses on the following three sets of population projections.

1. NCTCOG (Revised with 2040 ETJ Estimate)
2. LRWSP
3. Cleburne Comprehensive Plan

Because these sets of projections differ in important ways, all three sets are utilized by this analysis in order to determine the degree to which the need for additional water from Aquilla Lake is "sensitive"

to the magnitude and timing of projected population growth. The population projections for each scenario are included in Table 15. The 2016 Brazos G population projections were included for reference purposes.

**Table 15. City of Cleburne Population Projections**

| Population Scenario | 2010[1] | 2020 | 2030 | 2040 |
|---|---|---|---|---|
| **2016 Brazos G** | 29,337 | 32,501 | 36,195 | 40,006 |
| **1 (NCTCOG)** | 29,337 | 34,284 | 39,231 | 44,178 |
| **2 (LRWSP)** | 29,337 | 37,211 | 51,236 | 70,546 |
| **3 (Comp Plan)** | 29,337 | 44,827 | 68,496 | 104,661 |

All plans use the 2010 Census number as the baseline for their projections

## *DEMAND*

Municipal and commercial demands are based on the projected population estimates multiplied by gallons per capita per day (gpcd) water use projections. Two sets of per capita projections for the city of Cleburne were evaluated for this analysis.

2016 Brazos G Regional Water Plan – Base year 2011 per capita = 172 gpcd. For regional planning the TWDB selected 2011 as a baseline per capita year since it was one of the hottest and driest years recorded for many parts of Texas. This does not take into account that many municipalities, Cleburne included, had implemented their drought contingency plans.

LRWSP – Base year per capita 2006 = 180 gpcd. This year was chosen since it represents the highest recent demand year without drought restrictions in place.

The Brazos G projections assume a level of "passive" savings based on gradual replacement of water-inefficient plumbing fixtures with more efficient models due to plumbing code restrictions. They are also based on drought-year water use and accordingly incorporate Stage 2 or 3 drought water use restrictions on a perpetual basis. Most cities consider these types of drought restrictions to be an atypical response to unusual weather patterns, not a standard way of life. As a result, they incorporate a higher degree of water conservation than is felt to be sustainable. However, these per capita use projections form the basis of the State's water supply planning effort and as such, are utilized in this analysis.

In contrast, the Cleburne LRWSP per capita projections are based on Cleburne's historical use, which includes drought restrictions on outdoor use only during drought conditions. However, historical use does not fully reflect the effect of water savings associated with recent plumbing code changes. Because these savings were felt to be substantially certain to occur, this analysis integrates the "passive" water use reductions into historical per capita use rates to present a second scenario of per capita use. Table 16 compares both sets of per capita projections.

**Table 16. City of Cleburne Municipal and Commercial per Capita**

| GPCD Scenario | Baseline | 2020 | 2030 | 2040 |
|---|---|---|---|---|
| **a (2016 Brazos G)** | 172 | 163 | 159 | 156 |
| **b (LRWSP w conservation)** | 180 | 171 | 167 | 164 |

The City of Cleburne residential and commercial demand was calculated using this equation:

$$Annual\ Residential\ and\ Commercial\ Demand\ (AF\ per\ yr) = \frac{GPCD \times Population \times 365}{325{,}851\ gallons\ per\ AF}$$

The three projected population scenarios were multiplied by the two per capita scenarios to create six municipal and commercial demand scenarios that are labeled by (#) for population and (a or b) for per capita. The municipal and commercial demand for each scenario is included in Table 17. The 2016 Brazos G municipal and commercial demand projections were included for comparison purposes. Cleburne's municipal and commercial demand by 2040 ranges from approximately 19,000 AF per year with the Cleburne Comp Plan population and LRWSP per capita to 7,700 AF per year with the NCTCOG population and 2016 Brazos G per capita.

**Table 17. City of Cleburne Municipal and Commercial Demand (Values in AF per/Year)**

| Municipal Demand Scenario | 2020 | 2030 | 2040 |
|---|---|---|---|
| **2016 Brazos G** | 5,927 | 6,446 | 7,010 |
| **1 (NCTCOG) a (2016 Brazos G)** | 6,252 | 6,987 | 7,741 |
| **1 (NCTCOG) b (LRWSP w conservation)** | 6,559 | 7,338 | 8,137 |
| **2 (LRWSP) a (2016 Brazos G)** | 6,786 | 9,125 | 12,361 |
| **2 (LRWSP) b (LRWSP w conservation)** | 7,119 | 9,584 | 12,994 |
| **3 (Comp Plan) a (2016 Brazos G)** | 8,175 | 12,199 | 18,339 |
| **3 (Comp Plan) b (LRWSP w conservation)** | 8,576 | 12,812 | 19,277 |

Industrial demands were estimated as part of the LRWSP based on discussions with existing industries in the city of Cleburne. The 2016 Brazos G estimates were based on surveys of actual use by industrial users. The difference between these two sets of industrial demands was minimal so a consensus was reached by BRA and the Fort Worth District Corps of Engineers that industrial demands would be based on the 2016 Brazos G Plan. All freshwater and reuse demands for manufacturing and steam electric power in the 2016 Brazos G Plan were placed on the city of Cleburne. Table 18 includes the total manufacturing and steam electric demands, which are slightly more than 9,100 AF per year in 2020 and increase to over 9,600 AF per year by 2040.

**Table 18. 2016 Brazos G Manufacturing and Steam Electric Demand Projections for Cleburne**
**(Values in AF per Year)**

| | 2020 | 2030 | 2040 |
|---|---|---|---|
| **Total Manufacturing and Steam Electric Demand** | 9,119 | 9,364 | 9,615 |

The combined demand on the City of Cleburne by 2040 ranges from 17,300 AF per year to almost 29,000 AF per year as shown in Table 19.

**Table 19. City of Cleburne Total Demand (Values in AF per Year)**

| Demand Scenario | 2020 | 2030 | 2040 |
|---|---|---|---|
| **2016 Brazos G** | 15,046 | 15,810 | 16,625 |
| **1 (NCTCOG) a (2016 Brazos G)** | 15,371 | 16,351 | 17,356 |
| **1 (NCTCOG) b (LRWSP w conservation)** | 15,678 | 16,702 | 17,752 |
| **2 (LRWSP) a (2016 Brazos G)** | 15,905 | 18,489 | 21,976 |
| **2 (LRWSP) b (LRWSP w conservation)** | 16,238 | 18,948 | 22,609 |
| **3 (Comp Plan) a (2016 Brazos G)** | 17,294 | 21,563 | 27,954 |
| **3 (Comp Plan) b (LRWSP w conservation)** | 17,695 | 22,176 | 28,892 |

## *SUPPLY*

The supply analysis was based on supply amounts from the 2016 Region G Plan. Cleburne's supplies include the Trinity Aquifer, Lake Pat Cleburne, Lake Aquilla and currently connected reuse supplies. The supplies from the Trinity Aquifer are based on models of the available groundwater that can be reliably pumped while the surface water supplies are based on the modeled yield, reduced over time for sedimentation. Aquilla Lake supplies for Cleburne were based on the BRA contracted amount. Currently available supply for the city of Cleburne is approximately 12,700 AF per year in 2020 decreasing to 12,600 AF per year by 2040. The City of Cleburne's existing 24-inch raw water line transfers water from Aquilla Lake with a maximum capacity of 7 million gallons per day (mgd), or approximately 7,840 AF per year. The City's current contracted supply at Aquilla Lake (5,300 acre-feet per year) represents about 68 percent of the maximum capacity in the existing raw water line. Table 20 shows the current connected supplies associated with the City of Cleburne.

**Table 20. City of Cleburne Currently Connected Supplies (Values in AF per Year)**

| | 2020 | 2030 | 2040 |
|---|---|---|---|
| **Trinity Aquifer** | 1,292 | 1,292 | 1,292 |
| **Lake Pat Cleburne** | 4,838 | 4,769 | 4,700 |
| **Lake Aquilla** | 5,300 | 5,300 | 5,300 |
| **Reuse (Johnson County SE)** | 1,344 | 1,344 | 1,344 |
| **Cleburne Connected Supply** | **12,774** | **12,705** | **12,636** |

## *NEED ANALYSIS*

The needs analysis for the City of Cleburne is based on the difference between the demand and the currently connected supplies. Table 21 shows that all scenarios indicate an immediate need in 2020 ranging from approximately 2,500 AF per year to almost 5,000 AF per year. Additionally, the need in 2040 ranges from approximately 4,700 AF per year to over 16,000 AF per year depending on the demand scenario.

**Table 21. City of Cleburne Need**
-Values in AF per Year-

| Demand Scenario | 2020 | 2030 | 2040 |
|---|---|---|---|
| **2016 Brazos G** | -2,272 | -3,105 | -3,989 |
| **1 (NCTCOG) a (2016 Brazos G)** | -2,597 | -3,646 | -4,720 |
| **1 (NCTCOG) b (LRWSP w conservation)** | -2,904 | -3,997 | -5,116 |
| **2 (LRWSP) a (2016 Brazos G)** | -3,131 | -5,784 | -9,340 |
| **2 (LRWSP) b (LRWSP w conservation)** | -3,464 | -6,243 | -9,973 |
| **3 (Comp Plan) a (2016 Brazos G)** | -4,520 | -8,858 | -15,318 |
| **3 (Comp Plan) b (LRWSP w conservation)** | -4,921 | -9,471 | -16,256 |

As mentioned previously the City of Cleburne has recently been connected directly to downtown Fort Worth through the construction of the CTP. While growth is expected to occur along the CTP and in the City of Cleburne as a result, the magnitude and timing of the growth is somewhat uncertain.

At the February 17, 2016, in-person Project Delivery Team (PDT) meeting, the results of the demand scenario and need analysis were reviewed and discussed by BRA, the Fort Worth District Army Corps of Engineers and Freese and Nichols, the consulting firm under contract. In each scenario, there is an immediate need in 2020 for the City of Cleburne ranging from approximately 2,500 AF per year to almost 5,000 AF per year. After discussion, it was decided that since the 2016 Brazos G Plan needs and the NCTCOG scenarios were comparable that the 2016 Brazos G Plan would represent one scenario in the purpose and need. This discussion continued with which scenario best represented a high growth scenario. It was decided that scenario 2a) LRWSP with the 2016 Region G

per capita use was representative of a high growth scenario and would be used alongside the 2016 Brazos G Plan projections for the purpose and need.

Table 22 shows the demand, supply and need for each BRA customer contracted for water from Aquilla Lake from 2020 through 2070. Projections from the 2016 Brazos G Regional Water Plan were used to define the demand, contracted Aquilla Lake supply, and need for AWSD. The result of this analysis indicates that the City of Cleburne is driving the need for additional water supplies due to projected population growth.

**Table 22. Demands, Supplies, and Needs for each BRA Customer at Aquilla Lake**

| | **Demand** | | | | | |
|---|---|---|---|---|---|---|
| | **2020** | **2030** | **2040** | **2050** | **2060** | **2070** |
| Aquilla Water Supply District | 6,512 | 5,953 | 5,953 | 5,953 | 5,953 | 5,953 |
| City of Cleburne | | | | | | |
| 2016 Brazos G | 15,046 | 15,810 | 16,625 | 17,643 | 18,756 | 19,968 |
| 2 (LRWSP) a (2016 Brazos G) | 15,905 | 18,489 | 21,976 | 26,844 | 33,507 | 42,611 |
| **Total Demand** | | | | | | |
| **2016 Brazos G** | **21,708** | **21,913** | **22,728** | **23,746** | **24,859** | **26,071** |
| **2 (LRWSP) a (2016 Brazos G)** | **22,567** | **24,592** | **28,079** | **32,947** | **39,610** | **48,714** |
| | **Supply** | | | | | |
| | **2020** | **2030** | **2040** | **2050** | **2060** | **2070** |
| Aquilla Water Supply District | 5,953 | 5,953 | 5,953 | 5,953 | 5,953 | 5,953 |
| City of Cleburne | | | | | | |
| Trinity Aquifer | 1,292 | 1,292 | 1,292 | 1,292 | 1,292 | 1,292 |
| Lake Pat Cleburne | 4,838 | 4,769 | 4,700 | 4,631 | 4,562 | 4,493 |
| Reuse (Johnson County SE) | 1,344 | 1,344 | 1,344 | 1,344 | 1,344 | 1,344 |
| Aquilla Supply | 11,403 | 11,403 | 11,403 | 11,403 | 11,403 | 11,403 |
| **Total Supply** | **18,877** | **18,808** | **18,739** | **18,670** | **18,601** | **18,532** |
| | **Surplus/Need** | | | | | |
| | **2020** | **2030** | **2040** | **2050** | **2060** | **2070** |
| Aquilla Water Supply District | -559 | 0 | 0 | 0 | 0 | 0 |
| City of Cleburne | | | | | | |
| 2016 Brazos G | -2,272 | -3,105 | -3,989 | -5,076 | -6,258 | -7,539 |
| 2 (LRWSP) a (2016 Brazos G) | -3,131 | -5,784 | -9,340 | -14,277 | -21,009 | -30,182 |
| **Total Need** | | | | | | |
| **2016 Brazos G** | **-2,831** | **-3,105** | **-3,989** | **-5,076** | **-6,258** | **-7,539** |
| **2 (LRWSP) a (2016 Brazos G)** | **-3,690** | **-5,784** | **-9,340** | **-14,277** | **-21,009** | **-30,182** |

## WATER SUPPLY MEASURES

Measures considered to resolve the forecasted water supply shortage include conservation, use of other water supply sources, and reallocation of storage in Aquilla Lake. These were formulated into the preliminary alternatives documented in this section. The array of alternatives was built from a combination of the management measures identified below.

- Conservation Strategies – Conservation happens by either reducing demand for water supply or increasing the efficiency of the available water supply. It is usually not capital intensive and as such is typically the first recommendation made by State agencies to any water supply entity. A variety of conservation strategies were considered in development of the 2016 Brazos G Regional Water Plan. These strategies and their current levels of implementation were reviewed as part of the Aquilla Reallocation study.
- Construct a pipeline from Whitney Lake to Cleburne – The USACE Middle Brazos Systems Assessment conducted from 2005 to 2008 explored the use of other water supply sources within the Brazos River Basin including but not limited to building new reservoirs, construction of pipelines to move water from one area to another, purchasing additional water through contracts with major water providers, obtaining additional water rights, and changing the operational framework for the system of reservoirs managed by BRA and/or USACE. Of those, the most cost effective and therefore most likely alternative to reallocation at Aquilla Lake is to construct a pipeline to transfer water from Whitney Lake to Cleburne.
- Reallocate storage in Aquilla Lake from the flood pool to the conservation pool.

## SCREENING AND ALTERNATIVES

NO-ACTION ALTERNATIVE: The no action alternative would involve no action on the part of the USACE. Reservoir operations at Aquilla would be unchanged. This alternative is used as the basis for comparison for all action alternatives. Aquilla Lake has a capacity of approximately 44,577 AF at the top of conservation pool elevation of 537.5 ft-msl. However, historical sedimentation surveys suggest that the lake loses 97 to 269 AF of conservation storage space per year. The critical period yield is approximately 16,445 AF per year and declining over time due to sedimentation[1]. The BRA holds a water rights permit to divert 13,896 AF per year, which essentially accounts for the entire yield when adjusted for future sedimentation.

CONSERVATION STRATIGIES: There are multiple municipal conservation strategies already in place or planned for the future by entities with contracts for water in Aquilla Lake. These include programs outlined in the Aquilla Water Supply District's and City of Cleburne's Water Conservation Plans. The TWDB estimates these strategies to have a combined cost of $470 per AF of water saved and reduce usage by approximately 1,931 AF by 2070 (2017 Texas State Water Plan (TSWP)). All water supply entities and major water right holders in the state of Texas are required by Texas Senate Bill 1 to submit a Drought Contingency and Water Conservation Plan to the TCEQ for approval.

[1] RiverWare critical yield estimate of the reservoir with the existing top of conservation pool elevation of 537.5 ft-msl (See Table 23 and Appendix D)

Additionally, conservation is recommended by the 2016 Brazos G Regional Water Plan for every municipal water user group with a projected shortage and a per capita water use rate greater than 140 gpcd. All new construction is required to have water efficient plumbing fixtures. Consumer education programs are in place and utilized. Review of the conservation strategies employed and recommended by Region G and the TWDB shows Aquilla Lake users are proactively employing conservation to reduce water usage and shortages over the long term. As a result, no USACE recommendations for further conservation are identified, and additional conservation strategies are not carried into the final array of alternatives.

REUSE STRATEGIES: Cleburne has a water reuse program in place, and plans have been made with permits requested for expansion of these systems. In addition to the existing reuse supplies, Cleburne has a planned reuse project that would provide an additional 2,031 AF per year (2017 TSWP). The combined conservation and reuse programs are projected to result in 3,962 AF of reduced demand (conservation) and additional supply (reuse) by 2070, but this is not sufficient to meet the projected needs. Additional reuse strategies are not currently assumed to be practicable, so additional reuse is not carried forward in the evaluation as an alternative.

DIVERT WATER FROM WHITNEY LAKE TO CLEBURNE (NEXT BEST ALTERNATIVE TO REALLOCATION): Cleburne currently has contracts with the Brazos River Authority that would allow Cleburne to access water from Whitney Lake on the mainstem of the Brazos River approximately 20 miles to the south and west of the City. This alternative has the potential to provide an estimated 4,260 AF per year of additional supply. However, the main stem of the Brazos River in the vicinity of Whitney Lake has high levels of chloride and total dissolved solids (TDS). The high salt concentration of the Whitney Lake water is expected to require advanced treatment on-site prior to transmission. The salt removal process results in a concentrated brine, which requires disposal and reduces the available yield to approximately 78 percent of the input. Brine may be disposed of by returning it to Whitney Lake; however, additional studies would be required for permitting to determine the impact on water quality and to verify that this disposal method would be acceptable. Alternative disposal methods, although costly, are available if necessary. The Whitney Lake supply alternative is carried forward into the final array of alternatives.

## *REALLOCATION ALTERNATIVES*

Initially, a range of reallocation scenarios were evaluated to identify the most efficient scale of reallocation to carry forward into detailed evaluation. These included reallocation levels of 2.5, 4.5, and 6.5 feet consistent with alternatives presented within the Brazos River Basin Systems Assessment Interim Feasibility Study completed in July 2008. Results are presented below.

### STORAGE/YIELD ANALYSIS

The summary results for critical water supply yield utilizing the USACE RiverWare system simulation are presented in Table 23. Critical period yield is the constant rate of withdrawal that can be supported through the simulated drought of record. The value represents a best estimate of the average continuous rate of withdrawal a water supply user might expect to sustain during a simulated critical drought period if the user has unlimited contract rights to the same storage space, and the user's withdrawal facilities support withdrawals at the lowest invert of the outlet works. The yields

estimated within the simulations vary due to uncertainties involved in estimating the hydrologic parameters within the critical drought period and estimating the volume of the conservation storage space. According to the WSA between the U.S. Government and BRA, dated April 5, 1976, BRA has the right to the total useable storage below elevation 537.5 ft-msl in Aquilla Lake for M&I water supply, subject to availability of water. Based on the RiverWare yield analysis, the current estimated yield of Aquilla Lake under the existing top of conservation of elevation 537.5 ft-msl is 16,445 AF per year (Appendix K, Yield Analysis). It is important to note that as the surface area of the pool increases as it would with the pool raise alternatives discussed below, so does the evaporation loss. This means that as the surface area of the pool increases with increased elevation, the efficiency of the storage decreases.

**Table 23. Critical RiverWare Yield Analysis for Aquilla Lake**

| TOC Pool Alternative | Elevation (ft) | RiverWare Yield (AF/Yr) | Increase in Yield (AF/Yr) | % Increase |
|---|---|---|---|---|
| Existing | 537.5 | 16,445 | N/A | N/A |
| 2.5-foot raise | 540 | 17,749 | 1,304 | 8% |
| 4.5-foot raise | 542 | 18,908 | 2,463 | 15% |
| 6.5-foot raise | 544 | 20,213 | 3,768 | 23% |

It is important to note that these yields were calculated using a RiverWare model that does not account for the prior appropriation doctrine in accordance with Texas water rights. This model also does not account for environmental releases that may result from the State water right permit amendment that will ultimately be required to authorize a reallocation project. As a result, they represent hydrologic yields that are not representative of the amount of water that is likely to be legally available.

The analysis provided in this report is based entirely on the Riverware computations. However, for comparison purposes, information has been included from the 2016 Brazos G Regional Water Plan, where yields for storage reallocation at Aquilla Lake were calculated using a modified version of the TCEQ Brazos Water Availability Model (WAM) that incorporates SB3 environmental flows and Texas' prior appropriation doctrine. The yield values from this modeling are less than those from the RiverWare modeling, with the rate of increase for the last increment being much less. Table 24 summarizes results of the Brazos G modeling. It is also important to note that any of the potential reallocation scenarios analyzed for this report would not meet the total need identified in this report. The sponsor would need to utilize other management strategies or to meet the remaining need.

**Table 24. 2016 Brazos G WAM Yield Analysis for Aquilla Lake**

| TOC Pool Alternative | Elevation (ft) | 2016 Brazos G Yield (AF/Yr) | Increase in Yield (AF/Yr) | % Increase |
|---|---|---|---|---|
| Existing | 537.5 | 12,556 | N/A | N/A |
| 2.5-foot raise | 540 | 13,922 | 1,366 | 11% |
| 4.5-foot raise | 542 | 15,131 | 2,575 | 21% |
| 6.5-foot raise | 544 | 15,362 | 2,806 | 22% |

REALLOCATION SCREENING

2.5-FOOT CONSERVATION POOL RAISE: This alternative would raise the conservation pool elevation 2.5 feet to elevation 540.0 ft-msl. At this elevation conservation storage capacity is increased by approximately 8,082 AF for a total of 52,659 AF. Critical period yield is approximately 17,749 AF per year. This alternative provides an eight percent increase in critical yield for an additional 1,304 AF per year and conservation storage capacity for 52,659 AF, at current sedimentation levels.

4.5-FOOT CONSERVATION POOL RAISE: This alternative would raise the conservation pool elevation 4.5 feet to elevation 542.0 ft-msl. At this elevation conservation storage capacity is increased by approximately 15,073 AF for a total conservation capacity of 59,650 AF. Critical period yield is approximately 18,908 AF per year. This alternative provides a 15 percent increase in critical yield for an additional 2,463 AF per year and conservation storage capacity for 59,650 AF at current sedimentation levels.

6.5-FOOT CONSERVATION POOL RAISE: This alternative would raise the conservation pool elevation 6.5 feet to elevation 544.0 ft-msl. At this elevation conservation storage capacity is increased by approximately 23,567 AF for a total conservation storage capacity of 68,144 AF at current sedimentation levels. Critical period yield is approximately 20,213 AF per year.

Each of the reallocation alternatives were first evaluated as part of the Brazos River Basin Systems Assessment Interim Feasibility Study, which is documented in the 2008 Information Paper. In order to further screen the alternatives, an incremental cost analysis was performed for each reallocation alternative. The necessary information for this incremental cost analysis includes the incremental increase in yield and marginal cost increase for each scale of reallocation. The yields were determined using RiverWare yield modeling which is detailed in Appendix K. The incremental cost analysis represents two components of the reallocation, cost of storage and capital costs associated with relocations and dam improvements. The storage costs were adjusted to October 2015 dollars and are consistent with storage costs for other alternatives within the formulation portion of this report. The capital costs were determined at a planning level for all three reallocation alternatives in October 2012 and were only used for planning purposes. The total cost is the combination of the storage and capital costs. The marginal cost represents the cost increase for each associated scale of reallocation as compared to the next smaller scale. Unit costs determined as $/AF were developed based on the incremental increase in yield and marginal cost. Data from the incremental cost analysis is presented in Table 25.

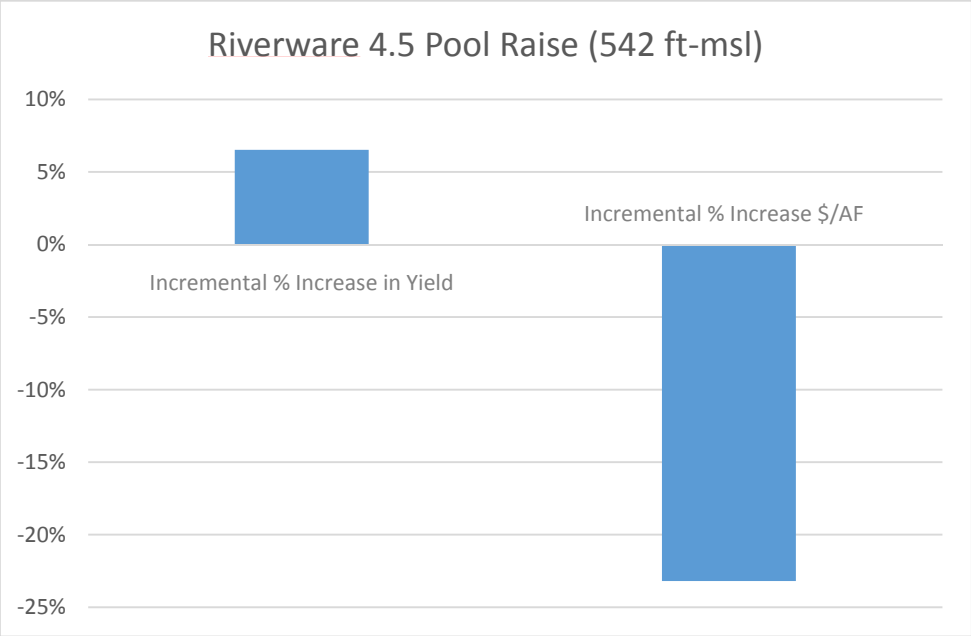
**Table 25. Reallocation Incremental Cost Analysis**

| Alternative | Elevation (ft) | RiverWare Yield (AF/Yr) | Incremental Increase in Yield (AF/Yr) | Incremental % Increase in Yield | Updated Cost of Reallocated Storage ($) | Estimated Capital Cost | Total Cost | Marginal Cost | $/AF | % Increase $/AF |
|---|---|---|---|---|---|---|---|---|---|---|
| **Existing** | 537.5 | 16,445 | -- | -- | -- | -- | -- | -- | -- | -- |
| **2.5-Foot Raise** | 540.0 | 17,749 | 1,304 | 8% | $7,632,082 | $5,178,164 | $12,810,246 | $12,810,246 | $9,824 | NA |
| **4.5-foot Raise** | 542.0 | 18,908 | 1,159 | 7% | $14,233,899 | $7,321,568 | $21,555,467 | $8,745,221 | $7,545 | -23% |
| **6.5-Foot Raise** | 544.0 | 20,213 | 1,305 | 7% | $22,255,045 | $9,437,860 | $31,692,905 | $10,137,438 | $7,768 | 3% |

Based on the incremental cost analysis the 2.5 foot pool raise has the greatest marginal cost with a $9,824/AF cost. Increasing the conservation pool an additional two feet to a 4.5-foot raise has a lower marginal cost at $7,545/AF than the first incremental pool increase. The final 6.5-foot pool raise has a greater marginal cost at $7,768/AF than the 4.5-foot pool raise. Figure 7 shows the incremental percent increase in yield and percent increase in $/AF for the 4.5-foot pool raise. Figure 8 shows the incremental percent increase in yield and percent increase in $/AF for the 6.5-foot pool raise.

A similar incremental cost analysis using the Brazos G WAM analysis was also performed using the incremental increase in yields accounting for the prior appropriation doctrine in accordance with Texas water rights. This analysis further reinforced the previous incremental cost analysis using the RiverWare yield modeling results. The final 6.5-foot pool raise has by far the greatest marginal cost at $43,885/AF than the 4.5-foot pool raise which has a marginal cost of $7,233/AF.

**Figure 7. Incremental Percent Increase in Yield and Percent Increase in Cost for 4.5-foot Pool Raise**



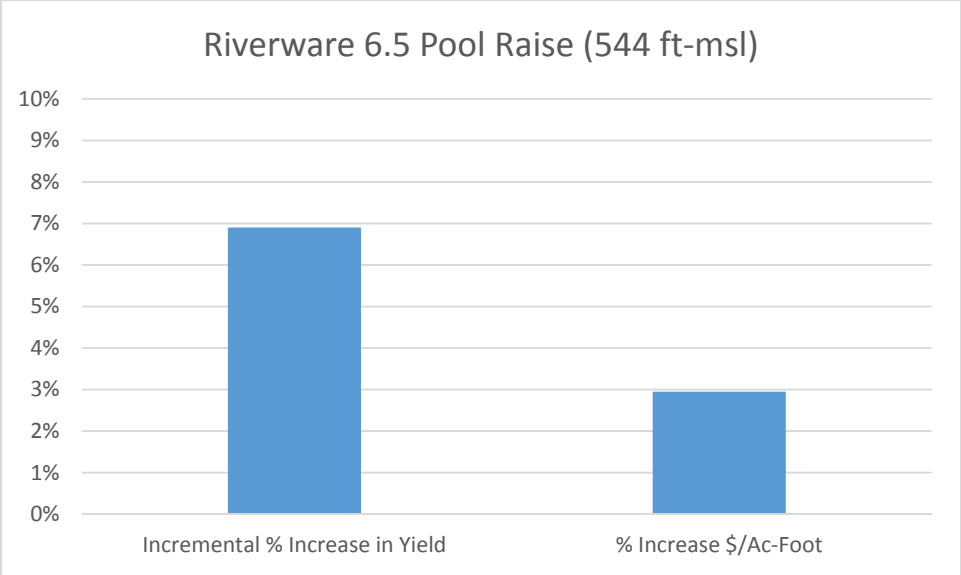



**Figure 8. Incremental Percent Increase in Yield and Percent Increase in Cost for 6.5-foot Pool Raise**

The incremental cost analysis indicates that increasing the top of conservation pool by 2.5 feet incurs a large marginal cost. This is expected given that many relocations will occur regardless of the reallocation elevation. The yield continues to increase with the 4.5-foot raise but with a lower marginal cost. This indicates that raising the pool the additional 2 feet results in a gain in yield that is not offset by a similar increase in cost. With the 6.5-foot raise the marginal cost increases again for the increased yield. This indicates that raising the top of conservation pool by the additional 2 feet has higher costs for the additional gain in yield. Based on this analysis the reallocation among the three alternatives with the lowest marginal cost is the 4.5-foot pool raise. In addition, the insight provided by the WAM model showed that from water rights standpoint, there is very little to be gained by the higher pool raise. Therefore, the 4.5-foot pool raise was selected for further evaluation while other scales were not maintained as feasible alternatives.

## *STUDY RISKS AND ASSUMPTIONS*

The 4.5-foot alternative is evaluated with respect to known Dam Safety concerns. A risk assessment was required to confirm the impacts of a conservation pool raise on the embankment. This risk assessment was conducted immediately following the Periodic Inspection that was completed in June 2016. Results of the assessment and inspection confirm that a DSAC 4 rating for Aquilla Lake Dam is appropriate. The risk assessment determined no adverse effects to the embankment and downstream consequence centers are expected if the pool is raised. The risks are not driven by pools near conservation, so it is not anticipated the pool increase would change the results. This is documented in the Cost Schedule Risk Analysis in Appendix E, Cost Estimating, and a 32 percent contingency has been applied to the cost estimate.

The following are major assumptions and risks that could affect the ability to implement a project successfully.

- There is erosion damage to the upstream embankment that must be repaired prior to implementing any change in the conservation pool. It is assumed this will be completed in advance of any construction effort that might be associated with the recommended plan.
- Obtaining a State water right permit
- Sedimentation is assumed to continue reducing the long-term yield of Aquilla Lake.
- It is assumed that all rights of way necessary for design and construction will fall within the fee simple and fee easement boundaries of the existing project.
- Up to six archeological sites may be impacted if the conservation pool is raised. Additional archeological testing during design is required to determine if these sites are eligible for listing in the National Register of Historic Places and to what extent mitigation and curation may be required. This is documented in the Cost Schedule Risk Analysis in Appendix E, Cost Estimating, and a 32 percent contingency has been applied to the cost estimate.

Prior to implementing a reallocation project, BRA will be required to obtain authorization from TCEQ through a water right permit amendment. TCEQ water right permitting requirements include protections for environmental flows for purposes of maintaining aquatic ecosystems. New TCEQ environmental flow rules for the Brazos River Basin were adopted on March 16, 2014, and are now included in the Texas Administrative Code (TAC 30 Chapter 298 Subchapter G). Initial analysis of the potential effect of the new rules on an Aquilla Lake reallocation project does not indicate significant adverse impacts to water supply benefits. However, it is possible that application of these rules during the water right permit amendment process could reduce the expected yield increase from a reallocation project to the extent that the project would no longer be practicable.

## DERIVATION OF USER COSTS

### *COST OF STORAGE ANALYSIS*

As described in the Planning and Guidance Notebook, ER 1105-2-100, the cost allocated to the non-Federal sponsor will normally be established as the highest of: (i) benefits forgone; (ii) revenues forgone; (iii) replacement cost; or (iv) the updated cost of storage.

Flooding from the tributaries downstream of the dam surpasses that of overflows from the spillway. Therefore, damages downstream of the dam are mostly attributable to flooding unrelated to overtopping of the uncontrolled spillway. As such, no flood-risk management benefits provided by the dam are foregone. Additionally, no loss of recreation benefits is expected as a result of reallocation. Since no benefits are foregone, benefits foregone is not used to calculate cost of storage.

There are no hydropower resources at Aquilla Lake. No revenues will be foregone if storage is reallocated. Therefore, revenues foregone is not used to calculate the cost of storage.

For this reallocation being proposed, there is no real estate taking. Additionally, the value of the flood storage being reduced is insignificant, and the reallocation being pursued is within the discretionary authority. Therefore, the replacement of flood control storage is not appropriate.

The methodology for updating the cost of storage is documented in Appendix F, Economics. Cost of storage was calculated consistent with ER 1105-2-100, IWR Report 96-PS-4 (Revised Dec 1998), and EM 1110-2-1304 (revised March 2016). The updated cost of storage for raising the conservation pool to 542.0 ft-msl and reallocating 15,073 AF of storage is $14,233,899 at October 2015 prices.

## *EVALUATION*

### NO ACTION

The no action or future without project alternative is documented in Chapter 2 of this report. To summarize, the no action alternative will result in the existing Aquilla Lake water users having insufficient water supply to meet their needs. The yield analysis conducted in association with this reallocation study indicates the critical period yield is approximately 16,445 AF per year.

### DIVERT WATER FROM WHITNEY LAKE TO CITY OF CLEBURNE

This alternative was originally developed as part of the Cleburne LRWSP. The pipeline alternative requires an intake and pump station at Whitney Lake, approximately nine miles of 24-inch pipe, and membrane treatment facilities for pre-treatment of saline lake water. Reject water from the membrane treatment would be returned to Whitney Lake. The estimated yield is 4,260 AF per year. Estimated first costs were presented in the City of Cleburne LRWSP and have been updated to October 2015 prices. The first cost is $47,723,238 and annual OMRR&R costs are estimated at $2,696,000.

The sizing of this alternative is based on the existing capacity of the Barkman pipeline that transfers water from Aquilla Lake to Lake Pat Cleburne within the City of Cleburne. Water would be transferred through a new pipeline from Whitney Lake to the existing Barkman pipeline (Figure 9). While this alternative results in approximately twice as much water as the 4.5-foot Aquilla Lake reallocation, it was necessary to have a larger supply to reach economies of scale for the construction of the intake, transmission and treatment facilities. Based on the needs analysis Cleburne has a need in excess of what this project can supply. This alternative is compared to the reallocation alternative on a per AF basis.

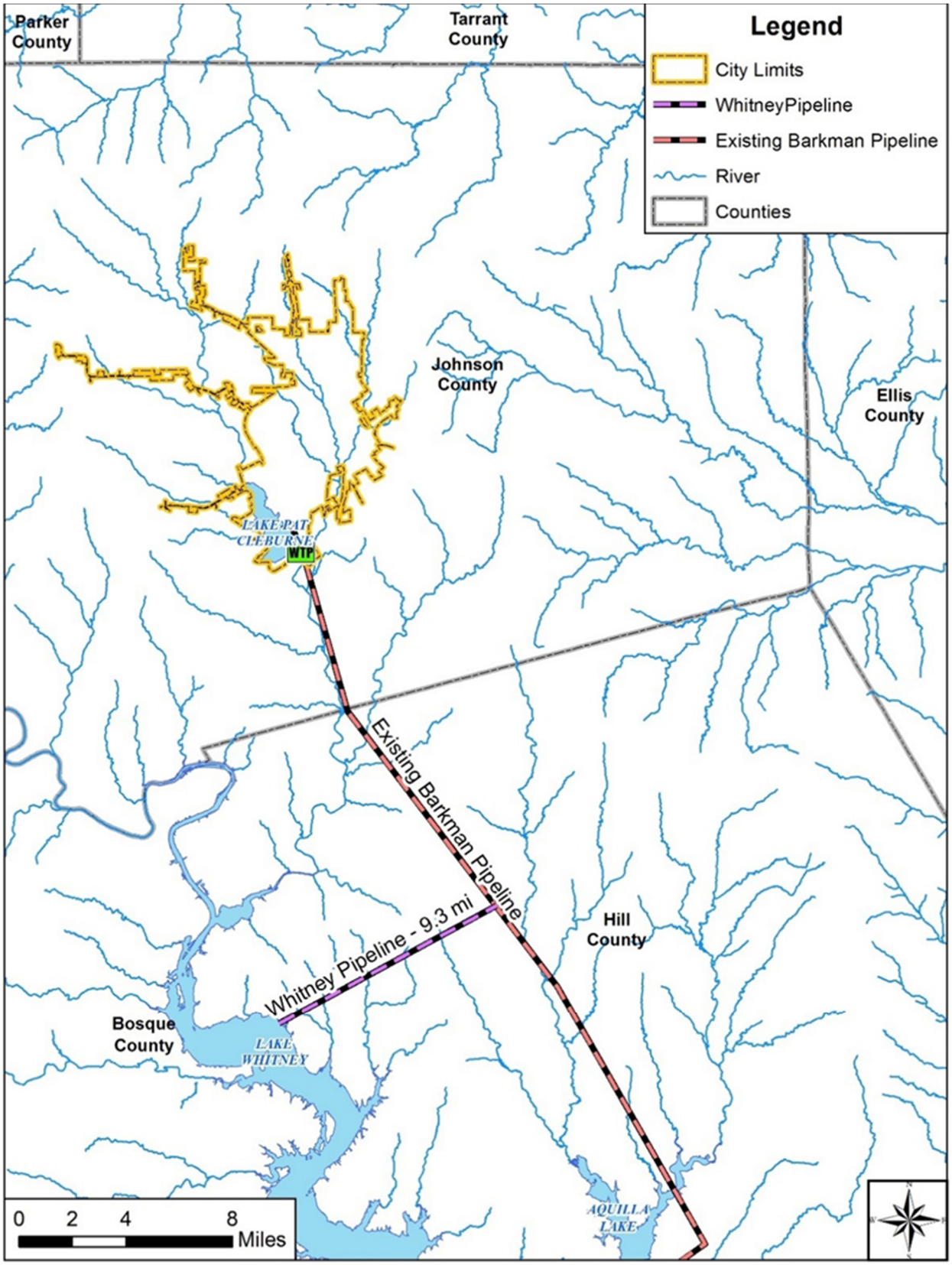



**Figure 9. Diversion Pipeline Alternative**

## *COST COMPARISON ANALYSIS*

Table 26 compares the costs of the Whitney Lake Diversion alternative and reallocation (4.5-foot pool raise) at Aquilla Lake using a 50-year period of analysis and a 3.125 percent Federal discount rate. The annual costs include annualized OMRR&R. The annual costs for the Whitney Lake diversion alternative are $4,685,468, while for the Aquilla Lake reallocation alternative, they are $1,435,450.

**Table 26. Derivation of Annual Costs (October 2015 Prices) for Financial Feasibility of Reallocation at Aquilla Lake**

| Investment | Whitney Lake Diversion | Aquilla Lake Reallocation (4.5 feet) |
|---|---|---|
| **Estimated First Cost** | $47,723,238 | $10,140,555 |
| **Updated Cost of Storage** | $0 | $14,233,899 |
| **Economic Costs** | $47,723,238 | $24,374,454 |
| **Annual Interest Rate** | 3.125% | 3.13% |
| **Period of Analysis (years)** | 50 | 50 |
| **Construction Period (months)** | 36* | 48** |
| **Compound Interest Factor** | 37.69 | 51.06 |
| **Capital Recovery Factor** | 0.039793 | 0.039793 |
| **Interest During Construction** | $2,272,189 | $1,563,587 |
| **Investment Costs** | $49,995,427 | $25,938,041 |
| **Annual Charges** | | |
| **Interest** | $1,562,357 | $810,564 |
| **Amortization** | $427,111 | $221,589 |
| **OMRR&R (Average Annual)** | $2,696,000 | $403,000 |
| **Total Annual Charges** | $4,685,468 | $1,435,152 |
| **Total Annual Cost of Non-Reallocation** | $4,685,468 | $4,685,468 |
| **Net Savings** | $0 | **$3,250,316** |
| **Benefit to Cost Ratio** | 1:1 | **3.26-to-1** |

*The 36-month construction period represents the time to construct the intake, pipeline and treatment facilities.
**The 48-month construction period represents the time for all relocations and improvements to the dam.

Table 27 shows the annual cost per acre foot of water provided by the alternatives. Diverting water from Whitney Lake to Aquilla Lake would cost $1,100 per acre foot of water per year. Reallocation at Aquilla Lake would cost $583 per acre foot of water per year.

**Table 27. Calculation of Annual Cost per AF (October 2015 Prices)**

| Element | Whitney Lake Diversion | Aquilla Lake Reallocation (4.5 feet) |
|---|---|---|
| **Yield (AF per year)** | 4,260 | 2,463 |
| **Annual Investment Cost** | $1,989,468 | $1,032,152 |
| **Annual OMRR&R** | $2,696,000 | $403,000 |
| **Total Annual Cost** | $4,685,468 | $1,435,152 |
| **Annual Cost Per (AF per** | $1,100 | $583 |

# CHAPTER 4: ENVIRONMENTAL CONSEQUENCES*

This section describes the potential impacts, both beneficial and adverse, of the no action and potential action alternatives on the human and natural environment. Impacts can be direct or indirect and short-term, long term, or permanent. They can vary from a negligible change in the environment to a total change. Impacts that would result in substantial changes to the environment should receive the greatest attention in the decision making process.

The alternatives included in this consequences discussion include one potential reallocation plan that was identified in the plan formation process, the diversion of water from Whitney Lake to the City of Cleburne via pipeline, and a "no action" alternative, which is equivalent to the future without project conditions.

## CLIMATE

Climate models predict an average increase of temperatures in Texas of 4° F by 2050. Although future predictions of the effects of climate change in annual precipitation are highly variable and uncertain, the models are consistent that future precipitation patterns will be more intense with even longer prolonged periods of drought. With a corresponding increase in evaporation and transpiration attributed to an increase in temperatures, available water within the watershed will become increasingly scarce.

None of the action alternatives will have an attributable impact on climate change; however, each of them offer a partial solution to the declining water supply expected as the result of climate change.

## LAND USE

It is assumed the NRMA budget for Aquilla Lake would continue to be limited. If the project is implemented it is assumed that habitat areas would be left to develop naturally. Management of NRMA areas around the lake would continue through the use of Agricultural Grazing Leases, however most land at Aquilla Lake would continue in its trend to have minimal land management, thus areas would develop in natural succession.

Although the pool raise alternatives would result in a larger conservation pool, the land use of the study area would not change. The deeply incise nature of the creeks that feed into Aquilla Lake at the upstream end of the reservoir allows any backwater effects resulting from an increase of the conservation pool to remain within the channel and not flood additional property beyond the USACE owned fee and flowage easement lands. Aquilla Lake would still be managed for water supply and recreational areas. None of the proposed alternatives would alter land uses within the study area.

## REGIONAL GEOLOGY, SOILS, AND TOPOGRAPHY

None of the proposed alternatives would alter the geological, soil, or topographic characteristics of the study area.

### *PRIME FARMLANDS*

As required by Section 1541(b) of the Farmland Protection Policy Act (FPPA) of 1980 and 1995, 7 U.S.C. 4202(b), federal and state agencies, as well as projects funded with federal funds, are required to (a) use the criteria to identify and take into account the adverse effects of their programs on the preservation of farmland, (b) consider alternative actions, as appropriate, that could lessen adverse effects, and (c) ensure that their programs, to the extent practicable, are compatible with state and units of local government and private programs and policies to protect farmland.

NO-ACTION ALTERNATIVE: Under the No-Action Alternative, soils would remain under the current conditions with the current conservation pool, and no prime farmland would be adversely impacted.

4.5-FOOT POOL RAISE: Approximately 142 acres of prime farmland soil area would be impacted as a result of permanent inundation at the target pool rise elevation. However, these soils are not being farmed currently and haven't been for over 30 years since they became part of the lake project lands so there would be no loss of prime or unique farmlands with implementation of this alternative.

DIVERSION PIPELINE: Approximately 92 acres of prime farmland soils would be temporarily disturbed resulting from the construction of the pipeline between Whitney Lake and the existing Barkman pipeline. However, these impacts would be temporary as existing agricultural operations would continue after the installation of the pipeline.

## AIR QUALITY

The Clean Air Act (CAA) sets national primary and secondary ambient air quality standards as a framework for air pollution control. The 1990 amendments to the CAA specifically define "conformity" for Federal projects in relation to a state's implementation plan and require that an agency's action not cause new violations, increase the severity of any existing violations, or delay attainment.

As previously mentioned in the Environmental Settings section, the project area's nearest location of a non-attainment area by the EPA is the Dallas Fort Worth area located approximately 60 miles north of the Hill County Area. Therefore the project area is not expected to exceed any Federal air quality standards designated as non-attainment areas.

NO-ACTION ALTERNATIVE: There would be no impacts to air quality without the project implementation.

POOL-RAISE ALTERNATIVE: Minimal short term adverse impacts could occur as a result of fugitive dust being released during the relocation and reconstruction of recreational use facilities including boat ramps associated with Aquilla Lake. Minor emissions of $NO_X$, CO, $SO_2$, volatile organic compounds (VOCs), hydrocarbon (HC), and PM could occur during the deconstruction/construction activities due to refueling, vehicle/engine exhaust, painting, and the application of water proofing chemicals. However, such mentioned adverse impacts would be minimal and short term. No adverse long term impacts are anticipated with project implementation of the proposed reallocation alternative.

DIVERSION PIPELINE: Minimal short term adverse impacts could occur as a result of fugitive dust being released during the construction of the pipeline and clearing for the pump and intake facilities. Minor emissions of $NO_X$, CO, $SO_2$, VOCs, HC, and PM could occur during the construction activities due to refueling and vehicle/engine exhaust. However, such mentioned adverse impacts would be minimal and short term. No adverse long term impacts are anticipated with project implementation of the pipeline alternative.

## HYDROLOGY AND HYDRAULICS

ALL ALTERNATIVES: None of the proposed alternatives would alter the floodplain characteristics of the study area. The effect of the proposed alternatives on discharge-duration is insignificant.

## HAZARDOUS, TOXIC, AND RADIOACTIVE WASTES

ALL ALTERNATIVES: No sites were identified where hazardous substances or petroleum products had been released, and no water, oil, or gas well locations were identified within the search area impacted by the proposed pool raise. Additional studies would be required to identify any impacts associated with the pipeline alternative. Due to the extreme cost differential between the pool raise and pipeline alternatives, these studies were not pursued as part of this study.

## CULTURAL RESOURCES

NO-ACTION ALTERNATIVE: Under the No-Action Alternative, there would be induced impacts to existing cultural resources at Aquilla Lake.

POOL-RAISE ALTERNATIVE: A cultural resources survey and site assessment was conducted in November 2010 in order to be able to identify the existing cultural resources at Aquilla Lake and to serve as a basis for determining what actions would be required to mitigate for any adverse impacts that might be caused by implementation of a pool raise. Thirty-nine sites were revisited and re-evaluated, and ten previously unsurveyed areas were assessed. The ten new areas were found to be highly eroded with steep gradients, or in wetland settings. Two of these areas yielded previously unknown sites containing pre-historic lithic scatter. Additionally, a site lying outside the survey areas was discovered consisting of a hand-dug, stone-lined well within a concrete box. Only one of the new sites is recommended for additional work to determine eligibility for listing in the National Register of Historic Places (NRHP). Of the 39 sites assessed in this report, five are recommended as being potentially eligible for the NRHP. Three of the five potentially eligible sites will be adversely impacted by a 4.5-ft pool raise and therefore warrant additional investigations. Prior to implementation of the pool raise alternative the additional work identified above will have to be completed in coordination with the State Historic Preservation Office. Impacts to sites determined eligible for nomination to the NRHP will be mitigated below the threshold for significance.

DIVERSION PIPELINE: Approximately 60 percent of the pipeline right-of-way utilizes cultivated croplands and pastures, which have already experienced surface disturbance as the result of farming and ranching activities. However, the proposed construction methodology for the pipeline would be

to trench and bury the line; thereby disturbing soils to a much greater depth, potentially impacting previously unknown intact cultural resources.

## WATER CONTROL PLAN

ALL ALTERNATIVES: None of the proposed alternatives would impact the Water Control Plan since the elevation of the top of the flood pool would remain at 556.0 ft-msl with the primary goal of minimizing downstream flood damages intact. Controlled releases from Aquilla Lake would continue to be made at a same rates that will not exceed the controlling channel capacities downstream.

## RECREATION

NO-ACTION ALTERNATIVE: Under the No-Action Alternative, there would be no impacts to existing recreational resources at Aquilla Lake.

POOL-RAISE ALTERNATIVE: There would be significant adverse impacts to existing recreation facilities associated with a 4.5-foot pool raise.

At the frequently visited Dairy Hill boat ramp, inundation would adversely impact 12,800 square feet of paved park road, 1,600 square feet of trailer parking, one utility pole, the concrete boat ramp, 400 linear feet of pipe rail fencing, five directional/instructional signs, four buoys, and the dock, walkway and concrete bulk head. Additionally, stabilization of the shoreline near the boat ramp, courtesy dock, and parking area would be required.

Recreation impacts at the Old School boat ramp include the vault style restroom, 3,100 square feet of paved parking, 20,300 square feet of paved road, 1,000 square feet of concrete sidewalk, three utility poles, four buoys, five directional/instructional signs, the concrete boat ramp, a boat dock, a walkway, and a concrete bulkhead. These recreation features would be relocated to higher ground. Additionally, 650 linear feet of post and cable fence would need to be relocated but would be replaced with pipe rail fencing to match the fencing in the rest of the recreation areas. Stabilization of the shoreline near the boat ramp and parking areas would also be required.

Impacts to recreation at the access area on FM 1534 include 14,800 square feet of gravel parking lot, 9,200 square feet of gravel park road, and 980 linear feet of pipe rail fence.

Impacts of the 4.5-foot conservation pool raise to the Hackberry Creek access area include 1,800 square feet of parking, 9,000 square feet of paved road, 530 linear feet of pipe rail fence, 630 square feet of sidewalk concrete, two utility poles, three buoys, one directional/instructional sign, and a vault restroom that is closed and has not been used since 2006. This access area had been leased and operated by Hill County. However, they opted not to renew the lease and thus, the park has been permanently closed. Since this area has been closed without intention of reopening, these features will be removed, but not relocated to higher ground.

The Aquilla Creek access area has been permanently closed as well. It included a vault restroom, 2,400 square feet of parking, 6,900 square feet of paved road, 6,500 square feet of gravel road, 500

linear feet of pipe rail fence, one light pole, and four directional/instructional signs. All of these recreation features would be removed and not relocated to higher ground.

DIVERSION PIPELINE: Implementation of pipeline is not expected to adversely impact any recreational facilities as any of these could easily be avoided during project design and construction.

## AQUATIC HABITAT

### *SURFACE WATER*

NO-ACTION ALTERNATIVE: Under the No-Action Alternative, the conservation pool of Aquilla Lake would remain under the current conditions, encompassing approximately 3,164 acres. No streams flowing into Aquilla Lake would be inundated by increased conservation pool levels. In addition, no streams would be impacted due to pipeline construction activities.

4.5-FOOT POOL RAISE: The 4.5-foot pool raise would increase the areal extent of the conservation pool of Aquilla Lake by an additional 661 acres encompassing 3,786 acres. The increased pool elevation will inundate approximately 5,225 linear feet (lf) of streams: 745 lf of Aquilla Creek, 1,865 lf of Rocky Branch, 325 lf of Jack's Branch, and 2,990 lf of Hackberry Creek. As the lake level fluctuates, the lake pool and stream lengths will vary inversely. Because of the deeply incised nature of these creek channels and the fact that they are intermittent streams with mostly pool habitat, backwater inundation as a result of raising the conservation pool would be expected to have positive in-stream benefits.

DIVERSION PIPELINE: The proposed pipeline alternative would not impact streams as the pipeline would be installed under the two stream crossings (Cedar and Bear Creeks) utilizing boring and directional drilling techniques. Temporary impacts would occur at Whitney Lake during the construction of the intake structure.

### *FLOODPLAINS*

ALL ALTERNATIVES: None of the proposed alternatives would alter the floodplain characteristics of the study area.

### *GROUND WATER*

Analyses of 2007 Northern Trinity/Woodbine Aquifers' groundwater model results indicate that groundwater levels in the Northern Trinity/Woodbine system are not particularly sensitive to recharge, suggesting that the system is relatively resistant to drought conditions. This is consistent with the comparatively low rate with which the groundwater flows horizontally through the aquifer and large outcrop areas associated with the modeled aquifers. Simulation of the aquifer response to future projected pumpage (based on the Region G Water Planning Group's and TWDB's pumpage estimates) shows a recovery of the artesian pressure in the Trinity/Woodbine of many hundreds of feet because of a predicted reduction in pumpage. However, projected growth throughout the IH-35

corridor will likely exert pressure to continue use of the Trinity/Woodbine aquifers at existing, or possibly greater, levels in the future.

NO ACTION ALTERNATIVE: Selection of the No Action alternative would have no direct impact on groundwater resources; however, in the absence of development of new surface water supplies, it would be expected that population growth and the associated greater water demands would increase the use of groundwater in the future. This could eventually have a negative effect on groundwater availability if aquifers are drawn down faster than they can recharge.

4.5-FOOT POOL RAISE: Implementation of this alternative would provide 2,463 AF of additional water supply; less than the 7,500 AF per year to approximately 30,000 AF per year of projected need by 2070. Therefore, implementation of the alternative should reduce the possibility of requiring additional groundwater withdrawal to make up for any anticipated shortfalls.

DIVERSION PIPELINE: The pipeline alternative would supplement the existing water supply demands on Aquilla Lake. Therefore, as with the pool raise alternatives, demands on groundwater would be alleviated.

### *WETLANDS AND WATERS OF THE U.S.*

Wetlands are classified as those areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support and, under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (USACE 1987).

Wetlands associated with the current conservation pool at Aquilla Lake would be impacted by both reallocation alternatives. Wetland areas inundated by the pool rise would experience a loss of non-woody vegetation from the addition of permanently standing water. While most of the wetlands along Aquilla Creek are located in the shallow areas along tributary creeks and streams in the upper reaches of the reservoir, many of these areas would be permanently and adversely impacted as a result of inundation. Essentially, wetlands would be transformed from their current conditions and/or reduced with changing pool elevations.

NO-ACTION ALTERNATIVE: Acreage of wetlands is not expected to change significantly over time under the no-action alternative, however habitat value of wetlands would be expected to increase over time due to the maturation of the adjacent trees and potential cover area.

4.5-FOOT POOL RAISE: Approximately 46 acres of current wetland areas would be impacted by inundation. Many of these wetland areas would be alternately inundated and exposed as the water levels fluctuate. However, as areas of inundation establish over time, other wetland areas would begin to be populated with non-woody vegetation and wetland species in areas adjacent to and upstream of the new inundation locations. In addition, isolated wetland areas on the fringe of the raised conservation pool may become hydrologically connected with the lake system. A re-distribution of wetlands would therefore be anticipated over time.

DIVERSION PIPELINE: Potential wetland areas within the proposed pipeline right-of-way are relatively small and scattered and are easily avoided. The final design of the proposed pipeline will be routed to

avoid impacts to wetland areas. Wetlands associated with Cedar and Bear Creeks would be avoided by utilizing boring or directional drilling techniques.

Waters of the U.S. that could be impacted if the proposed alternative is implemented include Aquilla Lake, tributaries present within the proposed project area, and those waters located within the Region of Influence (ROI). Navigable waters of the U.S. are not present within the study area.

Implementation of the pool-raise alternative would result in a rise in the Aquilla Lake conservation pool elevation of 4.5 feet. However, the pool raise would be achieved solely through modification of dam `operations. Activities associated with the construction of roads, revetments, groins, breakwaters, levees, dams, dikes, weirs, stabilization with riprap, or intake structures in waters of the U.S., would not occur. In addition, riprap work and work on the intake structure would occur above the existing pool elevation and would not require fill of water of the U.S. Based on the proposed design of the pool-raise alternatives, none would result in the discharge of dredged or fill material into waters of the U.S. or result in effects to navigable waters of the U.S. Therefore, authorizations under Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act would not be required.

## WATER QUALITY

The overall water quality in Aquilla Lake is good despite agricultural land use surrounding the lake and its general impacts to turbidity and suspended solids. However, even though neither the lake nor its contributing streams are listed on TCEQ's 303 (d) list as "impaired water bodies", there are identified concerns, including nickel and arsenic in the sediment and nitrates and low levels of atrazine in the water. The nitrate and atrazine concerns could potentially be improved by the increased dilution factor that would result from the potential pool raise. However, sediment concerns would probably not be affected by a pool raise.

NO-ACTION ALTERNATIVE: Without project implementation, water quality would remain under its current conditions.

POOL-RAISE ALTERNATIVE: Implementation of the pool raise would permanently inundate currently vegetated soils, adding to water turbidity and increasing levels of suspended solid for a short time. The degree of turbidity and the level of suspended solids would be expected to increase commensurately with the number of acres of land inundated. In any case, these adverse impacts to turbidity and levels of suspended solids would be temporary and would be expected to improve over time as the increase in lake volume resulting from a pool raise would dilute the amount of suspended solids currently entering the lake from upstream or as runoff from adjacent agricultural lands.

In addition, implementation of the pool raise alternative would also increase the dilution factor for nitrates and atrazine in the water column, lowering the levels of these pollutants, thus providing long term benefits to water quality. While bottom depths of the lake temperature may be slightly cooler with added depth, it is anticipated to have little impact on the quality of lake conditions and/or downstream waters. Finally, the sediments at the bottom of the lake should remain undisturbed by implementation of any of the pool raise alternatives so there should be no concern regarding a

disturbance to the sediments re-suspending nickel and arsenic into the water column. These constituents should remain trapped in the sediments.

DIVERSION PIPELINE: Water quality modeling of the pipeline alternative was conducted for four scenarios resulting in 6.36 mgd, 8.3 mgd, 10.8 mgd, and 12.7 mgd. Chloride, sulfate, and TDS concentrations in Whitney Lake are significantly higher than concentrations in Pat Cleburne Lake. Although the pipeline alternative includes water treatment to improve the water quality prior to pumping to Pat Cleburne Lake pipeline, the treated water (Whitney Feed) would still have higher concentrations of chloride, sulfate, and TDS. Once introduced into the pipeline, the water quality would decrease

## VEGETATION

Aquilla Lake has been in existence for over 30 years, and the region has experienced bouts of both drought and severe flooding conditions, thus, vegetation type and quality have developed as such under these conditions. The lake also continuously experiences variations in water levels according to both drought and flooding conditions (see Appendix D, Hydrology and Hydraulics for details of flooding occurrences and flood return periods), therefore such events have continuous impacts on habitats over time. These dynamics in fluctuating water elevations and effects on the surrounding plant communities of Aquilla Lake make it difficult to predict definite impacts. However, an attempt was made to determine the most likely occurring impacts utilizing the duration of inundation of the vegetative communities based on the release rate of flood water from the reservoir from an operations perspective.

While most of the riparian woodlands that existed along Aquilla and upland creeks were initially lost when the lake was impounded in 1983, there is still a narrow corridor of riparian woodland directly adjacent to these tributary streams.

NO-ACTION ALTERNATIVE: Under the No-Action Alternative, the acreages of existing terrestrial vegetation types are expected to alter slightly as some conversion of one habitat type to another following natural disturbances and through natural succession processes.

POOL-RAISE ALTERNATIVE: Project implementation of the pool-raise alternative would result in permanent adverse impacts to the various vegetation types surrounding the lake. While most of the terrestrial vegetation that existed along Aquilla and upland creeks was initially lost when the lake was impounded in 1983, implementation of the pool-raise alternative would adversely impact vegetation alongside the current lake shore, but not along the upstream tributary areas, as the backflow resulting from a pool raise would be contained with the deeply incised stream channels. Permanent adverse impacts caused by the loss of riparian woodlands will have to be mitigated for. Existing vegetation would be lost along the reservoir margins, potentially opening a niche for fast colonizing weeds and non-native species to become established.

Table 29 provides the loss of various habitat types and acres that would result from implementation of the potential alternatives.

DIVERSION PIPELINE ALTERNATIVE: Approximately 60 percent of the pipeline right-of-way utilizes cultivated croplands and pastures. The proposed construction of the pipeline would temporarily impact the vegetation in these areas; however, once complete, the vegetation would be restored to preconstruction conditions. The remaining areas that support woody vegetation would be permanently impacted as woody vegetation would not be allowed to return within the pipeline easement. Therefore, approximately 66 acres of woodland and shrubland vegetation would be converted to grassland.

**Table 28. Vegetation Impacts of Project Implementation at Aquilla Lake**

| Vegetation Type | No Action (acres) | 4.5-foot Pool Raise (acres) | Pipeline (acres) |
|---|---|---|---|
| **Riparian Woodland** | 0 | 66 | 11 |
| **Upland Forest** | 0 | 257 | 51 |
| **Herbaceous Wetland** | 0 | 46 | 6 |
| **Grassland** | 0 | 99 | 80 |
| **Shrubland** | 0 | 152 | 4 |
| **Savanna** | 0 | 1 | 0 |
| **Total** | | 621 | 181 |

## WILDLIFE

NO-ACTION ALTERNATIVE: The current terrestrial habitat in the project area is in general "average" habitat. Under the No-Action Alternative, habitat conditions for wildlife would remain intact. Due to the limited habitat management conducted at the lake, natural succession of habitat would be expected to occur, including the conversion of grasslands to savanna, shrubland, and riparian woodland habitats.

POOL-RAISE ALTERNATIVE: Acres of habitat and their associated ecological functions are expected along the shoreline near the new target pool elevation for the pool-raise alternative. Affected habitats include those listed in Table 28. While various acreages of total wildlife habitat (Table 29) are expected to be adversely impacted by inundation caused by the pool level rise, wildlife would itself would not be expected to be significantly impacted, as species would move into adjacent wildlife areas not impacted by the pool rise. In addition, inundation would be expected to provide an increase in snags and downed trees, which would be expected to provide valuable roosting habitat for raptors and various water birds such as herons and potential nesting sites for cavity nesting birds and other various aquatic life.

**Table 29. Summary of Impacted Acreage for 4.5-Foot Pool Raise Alternative**

| Habitat Type | Existing Acres | Acres Impacted by 4.5-foot Pool Raise | Acreage Following 4.5-foot Pool Raise |
|---|---|---|---|
| **Riparian Woodland** | 334 | 66 | 268 |
| **Upland Deciduous** | 2,802 | 257 | 2,545 |
| **Herbaceous Wetland** | 113 | 46 | 67 |
| **Grassland** | 1,199 | 99 | 1,100 |
| **Shrubland** | 2,043 | 152 | 1,890 |
| **Savanna** | 365 | 1 | 364 |
| **Disturbed Areas** | 231 | 24 | 231 |
| **Lake Surface** | 3,164* | 645 | 3,786 |
| **Total** | 10,251 | | 10,251 |

* The discrepancy in the lake's surface acreage from that found in Table 20. Aquilla Lake Pertinent Data is because of slight errors associated with GIS overlays for the various habitat types.

DIVERSION PIPELINE ALTERNATIVE: Wildlife habitat associated with woody vegetation communities would be transformed to grassland habitats within the permanent pipeline easement. Therefore, wildlife that prefer grassland and edge habitats would benefit from the modified habitat created by the pipeline easement. However, wildlife species that prefer unfragmented habitats would be impacted by the creation of the edge habitat along the pipeline easement. Impacts to wildlife habitat were minimized by routing the pipeline right-of-way along transportation corridors and across agricultural landscapes as much as feasible.

## THREATENED AND ENDANGERED SPECIES

The Endangered Species Act (ESA) requires Federal agencies to determine the effects of their actions on threatened and endangered species of fish, wildlife, and plants and their critical habitats, and to take steps to conserve and protect these species.

The Fish and Wildlife Coordination Act provides that fish and wildlife conservation receive equal consideration with other project features. It also requires that USFWS investigations be made an integral part in determining means and measures to prevent the loss of or damage to fish and wildlife resources, as well as to provide concurrently for the improvement of such resources. The USFWS Planning Aid Letter and USFWS Coordination Act Report (Appendix M) has done this through the development of mitigation and enhancement measures and recommendations.

EO 13186 directs federal agencies to evaluate the impacts of their actions on migratory birds in NEPA documents and to conserve migratory birds, giving priority to species of concern (listed by USFWS) and their important habitats.

NO-ACTION ALTERNATIVE: Under the No-Action Alternative, there would be no adverse impacts to threatened and endangered species.

POOL-RAISE ALTERNATIVE: There are no designated critical habitat areas located within the pool-raise alternative inundation area. While there are three currently listed species that occur within Hill

County, these species are not expected to occur within the project area itself, therefore no adverse impacts to any of the discussed species would be anticipated. For example, while golden-cheeked warbler and black-capped vireo have been known to occupy Hill County, but during habitat evaluations the team did not encounter any habitat that appeared suitable for the two species. While the species listed as Birds of Conservation Concern may utilize the habitat at Aquilla Lake during its migration in spring and autumn, it was determined by USFWS that it is unlikely that an increase in pool rise would have an adverse impact on these species (see Appendix M, PAL). Therefore, USACE will be coordinating a determination of "no effect" with USFWS for impacts associated with implementation of the pool raise alternative on T&E and Birds of Conservation Concern species.

DIVERSION PIPELINE ALTERNATIVE: The proposed pipeline right-of-way would bisect medium to high quality golden-cheeked warbler habitat along the edge of Whitney Lake. In addition, black-capped vireo habitat also occurs within the pipeline footprint. Consultation with the USFWS would be required to assess the potential impacts of the construction of the pipeline on these species.

## INVASIVE SPECIES

NO-ACTION ALTERNATIVE: Under the No-Action Alternative, the invasive species in the study area would remain the same and care would be taken to try to reduce the chance of any more invasive species becoming established.

POOL-RAISE ALTERNATIVE: Implementation of the pool raise would have no impacts on existing invasive species in the study area and best management practices (BMPs) would be written into any construction contract to ensure that the contractor did not introduce any new invasive species with their equipment and as a result of their activities. Therefore, no significant adverse impacts associated with invasive species are anticipated from with the pool raise alternative.

DIVERSION PIPELINE ALTERNATIVE: The alignment design and construction of the pipeline would not be handled by USACE, but we would provide oversight of any impact associated with construction on project lands; therefore we could make sure that the contractor did not introduce additional invasive species from their equipment or as a result of their construction activities on project lands. Off project lands, we have no controls over the contractor so it is we can't say that this alternative would have no significant adverse impacts of introducing or spreading of invasive species outside federal properties.

## TERRESTRIAL HABITAT EVALUATIONS

Similar to the future without project conditions, the project area consists of and would remain as 10,251 acres of land area owned by USACE. The project site would continue to be managed as a multipurpose reservoir with authorized uses of flood-risk management, water supply, and recreation. The Whitney/Aquilla Project office located at Whitney Lake would also continue as the main management authority.

The NRMA budget for the Lake would continue to be limited, consequently, after project implementation, habitat areas would be left to develop naturally. Table 30 provides a summary of

habitat acreage changes from implementation of the recommended reallocation plan over the 50-year life of the project.

**Table 30. Expected Habitat Acreage Changes Resulting from the Proposed Project at Aquilla Lake**

| Habitat | Existing Acres | Year 1 | Year 5 | Year 10 | Year 25 | Year 50 |
|---|---|---|---|---|---|---|
| **Riparian Woodlands** | 334 | 268 | 270 | 273 | 277 | 318 |
| **Upland Deciduous Forest** | 2,802 | 2,545 | 2,520 | 2,495 | 25320 | 2,458 |
| **Herbaceous Wetlands** | 113 | 67 | 103 | 127 | 127 | 127 |
| **Grasslands** | 1,199 | 1,100 | 1,084 | 1,034 | 934 | 890 |
| **Shrubland** | 2,043 | 1,890 | 1,895 | 1,906 | 1,920 | 1,930 |
| **Savanna** | 365 | 364 | 388 | 439 | 483 | 550 |
| **Disturbed Areas** | 231 | 231 | 231 | 231 | 231 | 231 |
| **Lake Surface at Conservation Pool** | 3,164* | 3,786 | 3,760 | 3,747 | 3,747 | 3,747 |
| **Total Acres** | 10,251 | 10,251 | 10,251 | 10,251 | 10,251 | 10,251 |

* The discrepancy in the lake's surface acreage from that found in Table 2. Aquilla Lake Pertinent Data is because of slight errors associated with GIS overlays for the various habitat types.

**Table 31. Summary of AAHUs for the Proposed Project at Aquilla Lake**

| Habitat | No Action AAHUs | 4.5-Foot Pool Raise AAHUs | Net Change in AAHUs |
|---|---|---|---|
| **Riparian Woodlands** | 245 | 195 | -49 |
| **Upland Deciduous Forest** | 2,065 | 1,853 | -212 |
| **Herbaceous Wetlands** | 69 | 77 | 8 |
| **Grasslands** | 446 | 415 | -31 |
| **Shrubland** | 1,358 | 1,259 | -99 |
| **Savanna** | 304 | 269 | -35 |
| **Lake Surface at Conservation Pool** | 1,424 | 1,780 | 356 |
| **Total AAHUs** | **5,911** | **5,849** | **-62** |

### *RIPARIAN WOODLANDS*

The greatest impact on the environment from the reallocation of storage in Lake Aquilla will be the loss of riparian woodland habitat due to higher lake levels. Project implementation would result in an overall net loss of riparian woodland habitat (Table 32).

**Table 32. Future with Project Riparian Woodland Habitat at Aquilla**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| Interval (years) | 0 | 1 | 4 | 5 | 15 | 25 |
| I | 0.67 | 0.67 | 0.67 | 0.68 | 0.68 | 0.70 |
| Acres | 334.00 | 268.00 | 270.00 | 273.00 | 277.00 | 318.00 |
| Target year HU | 223.78 | 179.56 | 180.90 | 185.64 | 188.36 | 222.60 |
| Interval HU | | 201.67 | 720.92 | 916.33 | 2,805.00 | 5,133.58 |
| Cumulative Hus | | | | | | 9,777.50 |
| Average Annual Hus | | | | | | 195.55 |

### *UPLAND DECIDUOUS FOREST*

The future without project conditions estimated that approximately 50 acres of this habitat type would be expected to be lost to conversion to riparian woodland habitat over the next 50 years. However, this loss would be offset by the conversion of shrubland or savanna habitat to upland forest over the next 50 years, resulting in no net loss of acreage for this habitat type

With the pool raise of 4.5 feet, approximately 257 acres would be impacted by inundation, resulting in a loss of habitat acreage at year one. However, similar to the future without project analysis, over time, 50 acres of this habitat type is expected to be lost to conversion to riparian woodland. This loss would be offset by the conversion of shrubland or savanna habitat to upland forest over the next 50 years, resulting in no net loss of acreage for this habitat type when comparing year one to year 50 (Table 33). Habitat value is expected to increase, as initial limiting factors, such as larger trees and canopy cover, increase over time.

**Table 33. Future with Project Upland Deciduous Forest Habitat at Aquilla Lake**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| Interval (years) | 0 | 1 | 4 | 5 | 15 | 25 |
| I | 0.74 | 0.74 | 0.73 | 0.73 | 0.74 | 0.74 |
| Acres | 2,802.00 | 2,545.00 | 2,520.00 | 2,495.00 | 2,532.00 | 2,458.00 |
| Target year HU | 2,073.50 | 1,883.30 | 1,839.60 | 1,821.35 | 1,873.68 | 1,818.92 |
| Interval HU | | 1,978.40 | 7,445.60 | 9,152.38 | 27,712.73 | 46,157.50 |
| Cumulative Hus | | | | | | 92,446.79 |
| Average Annual Hus | | | | | | 1,853.34 |

### *HERBACEOUS WETLAND*

Initially the amount of acres of wetlands was not expected to change significantly over the 50-year period of analysis, however habitat value was expected to increase due to the maturation of the adjacent trees and potential cover area. However, with project implementation, existing wetlands would be impacted, decreasing both H.S.I value and acreage at year one.

Approximately 46 acres would be impacted by inundation under the 4.5-foot pool raise at year one. Habitat value would decrease slightly due to inundation, but would increase again over the period of analysis.

Limiting factors for herbaceous wetlands included poor cover and the number of potential nest cavities, along with seasonable availability of water. The loss of nest cavities due to inundation would create a decrease in habitat value, however, H.S.I. would be expected to increase over time due to the maturation of the adjacent trees and potential cover area in the wetland areas that are relocated and/or re-establish following inundation. Wetlands are expected to re-establish in and along the new conservation pool according to each pool raise. Habitat value is also expected to increase as these new areas of inundation become established as wetland areas (Table 34).

**Table 34. Future with Project Herbaceous Wetland Habitat at Aquilla Lake**

| **Target Year** | **0** | **1** | **5** | **10** | **25** | **50** |
|---|---|---|---|---|---|---|
| **Interval (years)** | **0** | **1** | **4** | **5** | **15** | **25** |
| **I** | 0.54 | 0.45 | 0.607 | 0.65 | 0.65 | 0.65 |
| **Acres** | 113.00 | 67.00 | 103.00 | 127.00 | 127.00 | 127.00 |
| **Target year HU** | 61.02 | 30.15 | 61.80 | 82.55 | 82.55 | 82.55 |
| **Interval HU** | | 45.59 | 183.90 | 360.88 | 1238.25 | 2063.75 |
| **Cumulative Hus** | | | | | | 3892.36 |
| **Average Annual Hus** | | | | | | 77.52 |

### *GRASSLANDS*

Due to the limited management at Aquilla Lake, future without project predictions concluded that the overall acreage of grasslands would decrease over the next 50 years due to the conversion to shrub savanna or tree savanna habitat. Approximately 300 acres would be expected to convert over the 50 year period.

Initial inundation of resulting from a 4.5-foot pool raise would result in the loss of 99 acres of grassland habitat, and thus a slight decrease in habitat value. However, acreage of this habitat would be expected to continue to decrease over time due to both inundation impacts as well as conversion to other habitat types (Table 35).

**Table 35. Future with Project Grassland Habitat at Aquilla Lake**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| Interval (years) | 0 | 1 | 4 | 5 | 15 | 25 |
| I | 0.48 | 0.46 | 0.45 | 0.44 | 0.42 | 0.40 |
| Acres | 1,199 | 1,100 | 1,084 | 1,034 | 934 | 890 |
| Target year HU | 575.52 | 506.00 | 487.8 | 454.96 | 392.28 | 356.00 |
| Interval HU | | 540.43 | 1987.60 | 2,356.90 | 6,354.30 | 9,353.50 |
| Cumulative Hus | | | | | | 20,593.06 |
| Average Annual Hus | | | | | | 415.07 |

### *SHRUBLAND*

The trend of grassland to tree savanna and shrubland would be expected to continue even with project implementation due to the limited habitat management at the lake.

Similarly, this habitat quality is expected to increase over time along with acreage as the canopy cover of woody shrubs needed for cover develops over time.

A 4.5-foot pool raise would result in an initial loss of 152 acres due to inundation, along with a decrease in habitat quality. However, the trend of the conversion of approximately 40 acres of grassland to Savanna and shrubland habitat over the 50-year time period would still be expected. Habitat value would also be expected to increase over time as vegetation matures and develops (Table 36).

**Table 36. Future with Project Shrubland Habitat at Aquilla Lake**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| Interval (years) | 0 | 1 | 4 | 5 | 15 | 25 |
| I | 0.63 | 0.63 | 0.64 | 0.65 | 0.66 | 0.67 |
| Acres | 2,042.00 | 1,890.00 | 1,895.00 | 1,905.00 | 1,920.00 | 1,930.00 |
| Target year HU | 1,286.40 | 1,190.70 | 1,212.80 | 1,238.25 | 1,267.20 | 1,293.10 |
| Interval HU | | 1,238.58 | 4,806.97 | 6,127.54 | 1,8790.50 | 32,003.33 |
| Cumulative Hus | | | | | | 62,966.92 |
| Average Annual Hus | | | | | | 1,259.34 |

### *SAVANNA*

Minimal impacts or changes to this habitat type are expected due to project implementation.

The trend predicted in the future without project conditions would be expected to continue following project implementation, and therefore a gain of approximately 185 acres of this habitat type by the conversion of other habitat types (such as grasslands) to this habitat over the 50-year time period would be expected. Similarly, as this habitat acreage increases, habitat value would be expected to increase over the 50-year period of analysis (Table 37).

**Table 37. Future with Project Savanna Habitat at Aquilla Lake**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| Interval (years) | 0 | 1 | 4 | 5 | 15 | 25 |
| I | 0.54 | 0.54 | 0.55 | 0.56 | 0.57 | 0.58 |
| Acres | 365.00 | 364.00 | 388.00 | 439.00 | 485.00 | 550.00 |
| Target year HU | 197.10 | 196.56 | 213.40 | 245.84 | 276.45 | 319.00 |
| Interval HU | | 196.83 | 819.92 | 1,148.10 | 3,917.18 | 7,443.13 |
| Cumulative Hus | | | | | | 13,525.15 |
| Average Annual Hus | | | | | | 269.06 |

## AQUATIC HABITAT EVALUATIONS

The current surface water acreage of Aquilla Lake is 3,164 acres. Surface water acreage would be expected to increase with project implementation. In one year, a 4.5-foot pool raise would result in increasing the lake acreage from 3,164 to 3,786.

A change in the location of lake-zone function would occur as a result of the pool rise. An alteration, or transition, of areas current experiencing certain zone functions would shift, or re-locate as a result of the pool raise. The littoral zone would migrate further upstream as the water depth increased. Similarly, current in-stream habitat would be converted to more characterized littoral habitat. Essentially, water types and zone acreage would be altered as a result of the pool rise.

While upstream tributary streams would be impacted by inundation as a result of the pool rise, the aquatic life use of the creeks would not change. The creeks are located within deeply incised channels which would contain the proposed pool raise. Therefore, although the depth of the streams would increase, the existing low-velocity, pool habitats of Hackberry Creek would not change. A potential benefit of the pool raise to the creeks would be the increased thermal cover provided by the increased depth of the creeks and the extended inundation the pool raise provides to the intermittent and ephemeral streams. Because there would not be a loss of aquatic habitat, aquatic life use (habitat value) is expected to remain the same across the 50-year period of analysis (Table 38).

**Table 38. Future with Project Aquatic Habitat at Aquilla Lake**

| Target Year | 0 | 1 | 5 | 10 | 25 | 50 |
|---|---|---|---|---|---|---|
| Interval (years) | 0 | 1 | 4 | 5 | 15 | 25 |
| I | 0.45 | 0.45 | 0.47 | 0.48 | 0.48 | 0.48 |
| Acres | 3,164.00 | 3,786.00 | 3,760.00 | 3,747.00 | 3,747.00 | 3,747.00 |
| Target year HU | 1,423.80 | 1,703.70 | 1,767.20 | 1,798.56 | 1,798.56 | 1,798.56 |
| Interval HU | | 1,563.70 | 6,941.80 | 8,914.40 | 26,978.40 | 44,964.00 |
| Cumulative Hus | | | | | | 89,362.35 |
| Average Annual Hus | | | | | | 1,780.12 |

Aquatic habitat evaluations demonstrated an overall high aquatic life use value in the in-stream habitat of Aquilla Lake tributaries. Habitat evaluations and site assessments of the in-stream habitats

indicate that any in-stream habitats (low velocity pools) that would be inundated would be replaced with similar, although deeper, aquatic habitats. Therefore, no net loss of aquatic life use value within each tributary is anticipated.

NO-ACTION ALTERNATIVE: Without project implementation, aquatic habitat availability and quality would remain under their current conditions. Under its current management and operation as a Corps lake, little to no changes in aquatic habitat would be anticipated.

4.5-FOOT POOL RAISE: Approximately 683 acres of additional surface water would be added to the lake as a result of implementation of this alternative, thereby increasing aquatic habitat acreage from 3,164 to 3,786 acres. Habitat evaluations and site assessments of the in-stream habitats indicate that approximately 16,998 linear feet of in-stream habitat (low velocity pools) that would be inundated, would be replaced with similar, although deeper, aquatic habitats. Therefore, no net loss of aquatic life use value within each tributary is anticipated.

DIVERSION PIPELINE: The pipeline would not impact aquatic habitat. However, the intake structure would add artificial hard structure habitats to the lakes aquatic habitats. Screened fish excluder devices would be incorporated into the design of the intake structures to ensure that aquatic organisms would not be adversely impacted by water treatment processes or inadvertently transported via the pipeline.

## NOISE

The Noise Control Act of 1972 (Public Law 92-574) establishes a policy "to promote an environment free from noise harmful to health or welfare. Federal agencies must comply with state and local requirements for the control and abatement of environmental noise, where applicable.

Noise is defined as "unwanted sound" and in the context of protecting public health and welfare implies potential effects on people and on the environment. Ambient sound levels in a wilderness setting range from Day-Night Average Sound Level (DNL) 20 to 30 decibels (dB), while residential areas range between DNL 30 to 50 dB, and urban residential areas average from DNL 60 to 70 dB (Federal Interagency Committee on Noise (FICON) 1992). However, in outdoor areas where quiet is a basis for use, "there is no reason to suspect that the general population would be at risk for any of the identified effects of noise" (i.e., activity interference or annoyance) when sound levels are DNL 55 dB or less (EPA 1978). The American National Standard Institute (ANSI) has also suggested that land uses in "extensive natural wildlife and recreational areas" are likely to be considered compatible with DNL 60 dB or less (ANSI 1990).

NO-ACTION ALTERNATIVE: No adverse impacts to noise are anticipated under the no-action alternative.

POOL-RAISE ALTERNATIVE: Background noise in and around the Aquilla Lake area is primarily derived from recreational boats and vehicles in and around Aquilla Lake. Minimal short term adverse impacts could occur as a result of disturbance related to the demolition and construction of various recreational use facilities including boat ramps and marina equipment associated with Aquilla Lake being removed to prevent inundation impacts. Minimal long term impacts could potentially include

those noises associated with increased recreational use of the lake due to improved fish habitat which could result in increased visitors, boat use, picnicking, camping, and other activities associated with the lake. However, it would not be expected that noise levels would increase above the annoyance level for a majority of the population.

DIVERSION PIPELINE ALTERNATIVE: Minimal short term adverse impacts could occur as a result of disturbance related the construction of the pipeline and ancillary facilities. However, there would be no increase in noise levels resulting from the operation of the pipeline facility.

## LIGHT

NO-ACTION ALTERNATIVE: No adverse impacts to light are anticipated under the no-action alternative.

POOL-RAISE ALTERNATIVE: Minimal short term impacts to light could occur during the demolition and construction of various recreational use facilities including boat ramps and marina equipment as a result of inundation, if activities occur during night hours requiring lighting. Once construction was complete, no further adverse impacts to light would occur.

DIVERSION PIPELINE ALTERNATIVE: No adverse impacts to resulting from lighting are anticipated under the no-action alternative.

## SOCIOECONOMIC RESOURCES

The objective of socioeconomic analysis is to provide an open, realistic, and documented assessment of potential socioeconomic impacts from project implementation. EO 12898 (Environmental Justice) directs Federal agencies to avoid the disproportionate placement of adverse environmental, economic, social, or health impacts from Federal actions and policies on minority and low-income populations.

ALL ALTERNATIVES: Since all the project impacts would be to federally-owned lake properties under the 4.5-foot pool raise alternative no significant impacts to socioeconomic resources are anticipated from implementation of this alternative. The same is true for the pipeline diversion alternative since the alignment of the pipeline would avoid any impacts to residential and commercial facilities and any disproportionate adverse impacts to minority and low-income populations.

## CUMULATIVE IMPACTS

The Council on Environmental Quality (CEQ) regulations define a cumulative impact as an effect which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions CFR Section 1508.7. Relatively minor individual impacts may collectively result in significant cumulative impacts over a period of time.

The initial step of the cumulative impacts analysis uses information from the evaluation of direct and indirect impacts in the selection of environmental resources that should be evaluated for cumulative

impacts. A proposed action would not contribute to a cumulative impact if it would not have a direct or indirect effect on the resource. Similarly, CEQ guidance recommends narrowing the focus of cumulative impacts analysis to important issues of national, regional, or local significance. Therefore, the cumulative impact analysis for Aquilla Lake was focused on those resources that were substantially directly or indirectly impacted by the proposed action and resources that were at risk or in declining health even if the direct/indirect impacts were insignificant. The resources considered for cumulative impacts assessment include: in-stream habitat, wetlands, and terrestrial vegetation, including riparian habitat. These resources would be substantially directly impacted by implementation of any pool raise associated with reallocation of flood storage to water supply storage at Aquilla Lake, either negatively or positively.

### *PAST PROJECTS IN THE REGION*

Review of aerial photography for the period beginning with 1968 indicates the area around Aquilla Lake has remained primarily agricultural (including grasslands). Other identified actions within the area being considered for cumulative impact assessment include:

- 1985 – Expansion and improvement of the Waco Metropolitan Area Regional Sewerage System (downstream of Aquilla Lake). The new plant uses an activated sludge process and has a treatment capacity of 38.5 million gallons per day. This expansion reflects the growing needs in the Waco area, which is the first major populated area downstream of Aquilla Lake.
- 1989 – Lake Granbury (upstream of Aquilla) Surface Water and Treatment System in Hood County began operations. This expansion reflects the growing needs upstream of Aquilla Lake.

***Aquilla Lake Reallocation***: Aquilla Lake and Dam were constructed by the USACE as part of the overall Flood-Risk Management project in the Brazos River basin under the Flood Control Act of 1968, Public Law 90-483 (82 Stat. 741) 90$^{th}$ Congress, approved August 13, 1968. The dam/lake was completed in 1983. The four authorized purposes for Aquilla Lake include: flood-risk management, municipal and industrial water supply, general recreation, and fish and wildlife enhancement. While access and facilities are provided for minimum recreation, water is not controlled for that purpose. Since its impoundment in 1983, the lake has prevented an estimated $55,772,800 (September 2015 prices) in flood damages.

In order to insure that future water supply needs are met, the BRA requested a systems assessment of the USACE constructed lakes in the Brazos River Basin to determine potential water availability as a function of changes in conservation and flood control storage in each of the lakes (reallocation). Thus, alternatives have been developed to meet the water demand on Aquilla Lake as documented in the 2017 Texas State Water Plan.

### *REASONABLY FORESEEABLE FUTURE PROJECTS*

A 4.5-foot raise (the TSP) in the conservation pool will meet a portion of the forecasted demand in 2070 (26,000 to 48,000 AF per year) for BRA's current customers from Aquilla Lake. Analysis shows the 4.5-foot raise can be accomplished without requiring major modifications to the existing dam or adversely affecting the authorized purpose of flood control up through and including the 500-yr flood event.

***Belton Lake to Stillhouse Hollow Lake Pipeline***: This is designed primarily to delay the need for development of new sources by making use of surplus water at Belton.

***Whitney Lake Reallocation***: Current conservation storage elevation is 533.0 ft-msl. Rather than converting flood storage to water supply storage a potential scenario is the reallocation of hydropower storage and a portion of the inactive storage in to water supply storage and could increase the 2070 firm yield.

***Granger Lake Reallocation***: Current conservation storage elevation is 504.0 ft-msl. One potential scenario is to raise conservation elevation to 510.0 ft-msl, an increase of 6 feet, corresponding to the maximum discretionary authority of the USACE.

Cumulative impacts resulting from past, present and future activities including the establishment of the environmental mitigation plan proposed would occur to the following resources as discussed by section.

**Table 39. Summary of Potential Cumulative Impacts of the TSP and Reasonably Foreseeable Future Projects within the Region**

| Resources | Aquilla 4.5-ft pool raise | Belton to Stillhouse Pipeline | Stillhouse Hollow Intake & Pipeline | Stillhouse Hollow Reallocation | Granger Reallocation | Whitney Reallocation |
|---|---|---|---|---|---|---|
| **Climate** | - | - | - | - | - | - |
| **Land Use** | - | ↓ | ↓ | - | - | - |
| **Geology & Soils** | - | - | - | - | - | - |
| **Prime Farm Land** | - | ↓ | ↓ | - | - | - |
| **Air Quality** | - | - | - | - | - | - |
| **Aquatic Resources** | | | | | | |
| Surface Water | ↑ | - | - | ↑ | ↑ | ↑ |
| Floodplains | - | - | - | * | * | * |
| Groundwater | - | - | - | - | - | - |
| Wetlands/Waters of U.S. | - | - | - | - | - | - |
| Water Quality | - | - | - | - | - | - |
| Aquatic Habitat | - | - | - | * | * | * |
| **Biological Resources** | | | | | | |
| Vegetation | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Wildlife | - | - | - | - | - | - |
| T&E Species | - | ↓ | ↓ | ↓ | ↓ | ↓ |
| Invasive Species | - | - | - | - | - | - |
| **HTRW** | - | - | - | - | - | - |
| **Cultural Resources** | - | - | - | - | - | - |
| **Recreation Resources** | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| **Socio-economics** | - | - | - | - | - | - |
| **Noise** | - | - | - | - | - | - |
| **Light** | - | - | - | - | - | - |

### *LAND USE*

Past land use changes in the region include the conversion of farm and rangeland to open water reservoirs and their surrounding managed federal lands. USACE has a total of seven reservoirs within the Brazos River Basin.

Moderate changes to land use are expected within the region in the future as a result of population growth and urbanization. Future pipeline projects would be expected to adversely impact land use due to utility easements with significant and long-term impacts within the limited footprint of the pipeline easements as these lands are generally maintained as grasslands to reduce the chance of tree roots impacting the buried pipelines in the future. Potential reallocations actions at Stillhouse Hollow, Granger and Whitney Lakes would mainly impact federal project lands, so there would probably not be significant long-term impacts to land use associated with those actions. The 4.5-foot pool raise at Aquilla Lake will not contribute significantly to the potential adverse cumulative impacts to land use within the region.

### *PRIME FARM LANDS*

Past and future cumulative impacts to prime farm lands would be very similar to the discussion regarding land use above. In the past prime farmlands were converted to open water as reservoirs were constructed and additional prime farm lands would be lost as a result of future urbanization from land acquisition and construction associated with potential pipeline actions. Future reallocation activities however would not be expected to adversely impact prime farm lands. The 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to prime farm lands within the region.

### *AQUATIC RESOURCES*

#### *SURFACE WATER*

Future implementation of reallocation at any of the lakes identified would have similar benefits as Aquilla Lake as the result of increased acres of surface lake water over the long-term. Implementation of either/or both pipeline alternatives would be aligned and designed in such a way as to avoid adverse surface water impacts to lakes or streams. One action that might have minor, short-term adverse impacts to surface waters would be the construction of a new water intake at Stillhouse Hollow Lake. BMPs would be required to avoid or minimize those impacts to the extent possible, but the required siting of the structure within the lake means there would still be adverse impacts. The 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to surface waters within the region.

#### *FLOODPLAINS*

No floodplains would be adversely impacted by inundation as a result of the pool rise at Aquilla. Future implementation of either or both of the pipeline alternatives are not anticipated to adversely impact floodplains as pipeline alignment and design would allow siting to locate the pipeline right-of-

way in areas that would avoid floodplain impacts or the pipelines could be bored underneath and rivers or streams that need to be crossed as a way to avoid impacts.

There is not enough information about the potential reallocations at Whitney, Stillhouse Hollow and Granger Lakes at this time to determine or even to try to anticipate whether there would be adverse impacts to floodplains along the streams upstream and/or downstream of each reservoir. Certainly, compliance with NEPA, Eos, and USACE guidance and regulations prior to and during construction would avoid, minimize, or mitigate to the extent practicable any adverse impacts to floodplains associated with those federal actions. The 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to floodplains within the region.

### *WETLANDS AND OTHER WATERS OF UNITED STATES*

Implementation of the 4.5-foot pool raise at Aquilla would have temporary, adverse impacts to wetlands as a result of inundation, but this habitat would quickly return as the new inundated areas are converted from terrestrial habitats to wetlands. The pool rise would increase surface area of the lake, thus increasing limnetic zone (deep water) and littoral zone (shallow, shoreline) areas and increasing protection of waters of the United States. It is anticipated that this would be the same for any of the other potential reasonably foreseeable future reallocations. Future implementation of either or both of the pipeline alternatives are not anticipated to adversely impact wetlands as pipeline alignment and design would allow locating the pipeline right-of-way in areas that would avoid wetland impacts. The 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to wetlands within the region.

### *AQUATIC HABITAT*

The surface water acreage of any of the proposed future reallocation actions would be expected to increase with project implementation, just like that of Aquilla Lake.

While upstream tributary streams would be impacted by inundation as a result of the pool rise at Aquilla, the aquatic life use of the creeks would not change. The creeks are located within deeply incised channels which would contain the proposed pool raise. Therefore, although the depth of the streams would increase, the existing low-velocity, pool habitats of the upstream creeks would not change. A potential benefit of the pool raise to the creeks would be the increased thermal cover provided by the increased depth of the creeks and the extended inundation the pool raise provides to the intermittent and ephemeral streams. Because there would not be a loss of aquatic habitat, aquatic life use (habitat value) is expected to remain the same across the 50-year period of analysis.

Both pipeline alternatives would be aligned and designed in such a way as to avoid adverse aquatic habitat impacts. One action that might have short-term adverse impacts to aquatic habitat would be the construction of a new water intake at Stillhouse Hollow Lake. BMPs would be required to avoid or minimize those impacts to the extent possible, but the required siting of the structure within the lake means there would still be adverse impacts during construction.

There is not enough information about the potential reallocations at Whitney, Stillhouse Hollow and Granger Lakes at this time to determine or even to try to anticipate whether there would be adverse

aquatic habitat impacts to the upstream and/or downstream rivers or creeks of each reservoir. Certainly, compliance with NEPA, Eos, and USACE guidance and regulations prior to and during construction would avoid, minimize, or mitigate to the extent practicable any adverse impacts associated with those federal actions. The 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to aquatic habitat within the region.

## *BIOLOGICAL RESOURCES*

### *VEGETATION COMMUNITIES*

Just as with the Aquilla Lake reallocation, all the potential reasonably foreseeable future reallocation projects would have adverse impacts to terrestrial vegetation resulting from the conversion of vegetational types as a result of the inundation associated with a pool raise. The higher the pool raise the greater the loss of vegetative habitat acreage on federal lands. As with the Aquilla reallocation, conversion of grasslands to shrublands, from shrublands to deciduous upland forests or riparian woodlands (depending on their moisture regime) will occur over the life of the projects, but there will be an overall loss of acreage of vegetation in any case. It is anticipated that vegetation types will be changed as the result of implementation of the potential pipeline alternative also, as the right-of – ways would be cleared of woody vegetation and restored and maintained as grasslands to reduce the potential of damage to the pipeline over time from tree roots. The losses to vegetative habitat as the result of the 4.5-foot pool raise at Aquilla will be mitigated. The mitigation plan can be found in Appendix B – Environmental Resources. Therefore, the 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to terrestrial vegetation within the region.

### *THREATENED AND ENDANGERED SPECIES*

There are currently three T&E species known to occur within the counties associated with Aquilla, or have associated habitat that may be utilized – the golden-cheeked warbler, black-capped vireo, and the whooping crane. All of these same species would be on the T&E species list in the location of each of identified reasonable foreseeable future projects. The golden-cheeked warbler and black-capped vireo are either known to occur or have critical habitat within the federal lands surrounding Whitney, Stillhouse Hollow, and Granger reservoirs. Section 7 consultation with USFWS would be required for all the other potential future projects identified, which leads to the expectation that there would be some measure of adverse impacts to T&E species resulting from implementation of any of the other potential reallocation and/or pipeline projects. Coordination with USFWS as part of Coordination Act requirements for the Aquilla study, determined that there would be no adverse impacts to T&E species, as the species do not occupy the area or have any of the critical habitat associated with their life requisites.

During investigations within the Aquilla Lake study area, the team of biologists from USACE, USFWS, and TPWD did not observe any of the T&E species identified nor encounter any habitat that appeared suitable for the golden-cheeked warbler or the black-capped vireo. While the whooping crane may utilize the habitat at Aquilla Lake during its migration in spring and autumn, it was determined by USFWS that an increase in conservation pool level is unlikely to have an adverse

impact on this species. Therefore, the 4.5-foot pool raise at Aquilla Lake will not contribute significantly to potential adverse cumulative impacts to T&E species within the region.

# OTHER CONSIDERATIONS REQUIRED BY NEPA

### *UNAVOIDABLE ADVERSE IMPACTS AND CONSIDERATIONS THAT OFFSET THESE IMPACTS*

Avoidance and minimization of adverse impacts to natural, cultural, and other environmental resources were integrated into the proposed action to the greatest extent possible and practicable. However, adverse impacts may not always be completely avoided and/or minimized. A mitigation plan has been developed and is included in Appendix B – Environmental Resources. In addition, BMPs will be developed and required during construction to avoid and minimize adverse impacts to natural, cultural, and other environmental resources, as applicable. As the NEPA process progresses, additional mitigation measures and management actions may be revised based on consultation with federal and state regulatory agencies and comments received from the public. The EA will be updated to reflect these changes, including additional and revised SCMs, as applicable.

### *RELATIONSHIPS BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY*

NEPA requires an analysis of the relationship between a project's short-term impacts on the environment and the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This refers to the possibility that choosing one development option reduces future flexibility in pursuing other options, or that giving over a parcel of land or other resource to a certain use often eliminates the possibility of other uses being performed at that site. Under the Proposed Action, short-term effects would be primarily related to construction activities and the use of associated vehicles and equipment that could be used for other purposes. In the long-term, the proposed reallocation would provide help an important water supply need. With implementation of BMPs, the Proposed Action would not result in any impacts that would reduce environmental productivity or narrow the range of beneficial uses of the environment.

### *IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES*

Resources that are irreversibly or irretrievably committed to a project are those that are used on a long-term or permanent basis. This includes the use of non-renewable resources such as metal and fuel. These resources are irretrievable in that they would be used for a project when they could have been used for other purposes. Human labor is also considered an irretrievable resource. In addition, the unavoidable destruction of natural resources that could limit the range of potential uses of that particular environment is also considered an irreversible commitment of resources. Implementation of the proposed action would require the consumption of materials typically associated with construction activities for the riprap on the embankment and the relocation and replacement of recreation features (e.g., concrete). In addition, the use of vehicles and construction equipment would result in the consumption of fuel, oil, and lubricants. An undetermined amount of human energy for construction would also be expended and irreversibly lost. However, the amount of these resources

used would be relatively minor and these resources are readily available in large quantities. Therefore, implementation of the proposed action would not result in significant irreversible or irretrievable commitment of resources.

## MITIGATION ANALYSIS

The CEQ and NEPA guidelines provide that damages to fish and wildlife resources be prevented to the extent practicable through good planning and design incorporating mitigation principles. Mitigation plans are to contain the most efficient and least costly measures appropriate to reduce fish and wildlife resource losses. If project lands cannot fulfill the mitigation requirements, then separable public lands adjacent to project lands, to the extent possible, should be considered for acquisition. Subsection 906 (a) of the Water Resources Development Act (WRDA) 1986 requires that the USACE maintain the power of eminent domain, the right to take private property for public use. The intent is to maintain the integrity and viability of significant natural resources and their contributions to local or regional ecosystems by applying sound ecosystem management techniques.

The ultimate goal of the USACE Mitigation Policy is to avoid significant areas, such as wetlands and critical habitat (Resource Category 1); avoid or replace in-kind, such as Riparian Bottomland Hardwoods (Resource Category 2 Areas); minimize impacts while providing no net loss of habitat for areas such as upland hardwoods (Resource Category 3 areas); and minimize impacts and habitat loss for areas such as successional grassland/old field or active pasture lands (Resource Category 4 areas). Generally, these goals can be accomplished by avoiding negative impacts, restoring impacted areas, compensating for impacts by creating or improving habitats at a different location, or through a combination of these measures. The areas determined to have the greatest potential for mitigation yielding the greatest habitat value increase as mitigation include acres of land categorized as riparian bottomland hardwoods. As outlined in the Existing Conditions, Environmental Consequences, and Future With-Project sections above, implementation of the Proposed Action would not adversely impact aquatic habitats. In fact, increasing the pool elevation and adding pool habitat into the creeks and tributaries that feed Aquilla Lake is expected to benefit aquatic habitat over the life of the project; therefore, no aquatic mitigation is required or proposed.

### *TERRESTRIAL MITIGATION*

Mitigation is anticipated for Riparian/Floodplain Woodland habitat adversely impacted and/or permanently lost as a result of project implementation and inundation as a result of the pool rise. With each alternative, acres of riparian woodland are impacted, and habitat units are lost. The No Action Condition provides 245 AAHUs. The proposed 4.5-foot pool raise provides 195.55 AAHUs. The net loss is 49.91 AAHUs. Thus, the 4.5-foot pool raise would require 49.91 AAHUs or riparian woodland mitigation.

Certain assumptions were made during the evaluation of mitigation evaluation and preliminary plan development, including:

- Existing habitat will not degrade over time

- Lands designated as mitigation lands will be planted with native hardwood seedlings and or mature trees, with a minimum survival rate of 75 to 80 percent after two growing seasons.
- Management activities would be implemented to assist in the overall success of the mitigation areas.
- Public recreation use of the wildlife mitigation areas would be restricted to compatible, low-density activities. Mowing and intensive maintenance activities should be restricted to the late fall and winter months and will be restricted to the removal of invasive, woody species and not scheduled on a regular basis. No mowing should occur upon successful reestablishment of woody vegetation.

Preliminary mitigation areas were chosen based on GIS analysis. Suitable soil types were determined using the NRCS soil layer specific to Hill County. "Hydric" soils and "Soils Suitable for Forestland Site Preparation" were among those identified when identifying suitable areas for mitigation. Elevation contours were also used to determine areas suitable for mitigation. Similarly, the most recent (2011) aerial photography were utilized to visually identify areas for potential preliminary mitigation development (Figure 10).

There were several areas which were determined to be available for mitigation within the fee boundary according to the correct soil types (hydric), contours, and location in relation to riparian woodlands. However, upon further evaluation, it was determined that the most successful area for mitigation efforts, from a management perspective, would be the area located in the far north east area of the lake, or that area associated with Hackberry Creek (Figure 11). From a management perspective, it would be of greater benefit to keep mitigation efforts to a single area, thus eliminating having to manage areas separate from one another. Similarly, efforts concentrated to one particular area would have greater success in terms of monitoring and operations and maintenance over the 50-year project period. Thus it was determined that terrestrial mitigation efforts would be better suited, and therefore have higher potential of success were they to be conducted in the concentrated and suitable area on Hackberry Creek. The mentioned mitigation development strategy also serves to meet the requirements and guidance as described in ER 1105-2-100 (Planning Guidance Notebook, Mitigation Planning & Recommendations, and Incremental Cost Analysis (C-15). While a formal incremental cost analysis (described as the least cost mitigation plan that provides full mitigation of losses) utilizing IWR software was not developed, it was determined that the incremental cost recommendation was met, in that mitigation efforts were concentrated in a central/combined location, rather than dispersed throughout the project lands; thus less costs overall were assumed for the long term range of the project from a management perspective.

Preliminary mitigation measures and associated costs were then developed for the loss of riparian woodland. Mitigation measures were developed using the limiting factors associated with the riparian habitat evaluations, including the temporal availability of water, available winter food and lack of mast producing trees, and minimal number of potential suitable nest cavities and lack of brood and winter cover. Various measures include excavation & soil preparation, invasive species control, native tree & shrub plantings, addition of nest boxes. A minimum diameter at breast height (dbh) for the proposed tree plantings was established at 5 inches dbh due to the high wild hog activity in the proposed mitigation area. The larger diameter tree would be able to withstand destructive grubbing of the wild hogs better than seedlings or smaller diameter trees during establishment of the mitigation vegetation. The selective clearing of existing vegetation and planting density of the native trees and

shrubs would optimize the habitat quality of the mitigation area. Annualization tables such as those used for the Future-With-Project and Future-Without-Project conditions were utilized to determine how many AAHU's would result as a conversion of other habitat types to riparian woodlands (Appendix B). Detailed tables for each of the measures and associated costs and AAHU's over the 50-year period of analysis are found in Appendix B.

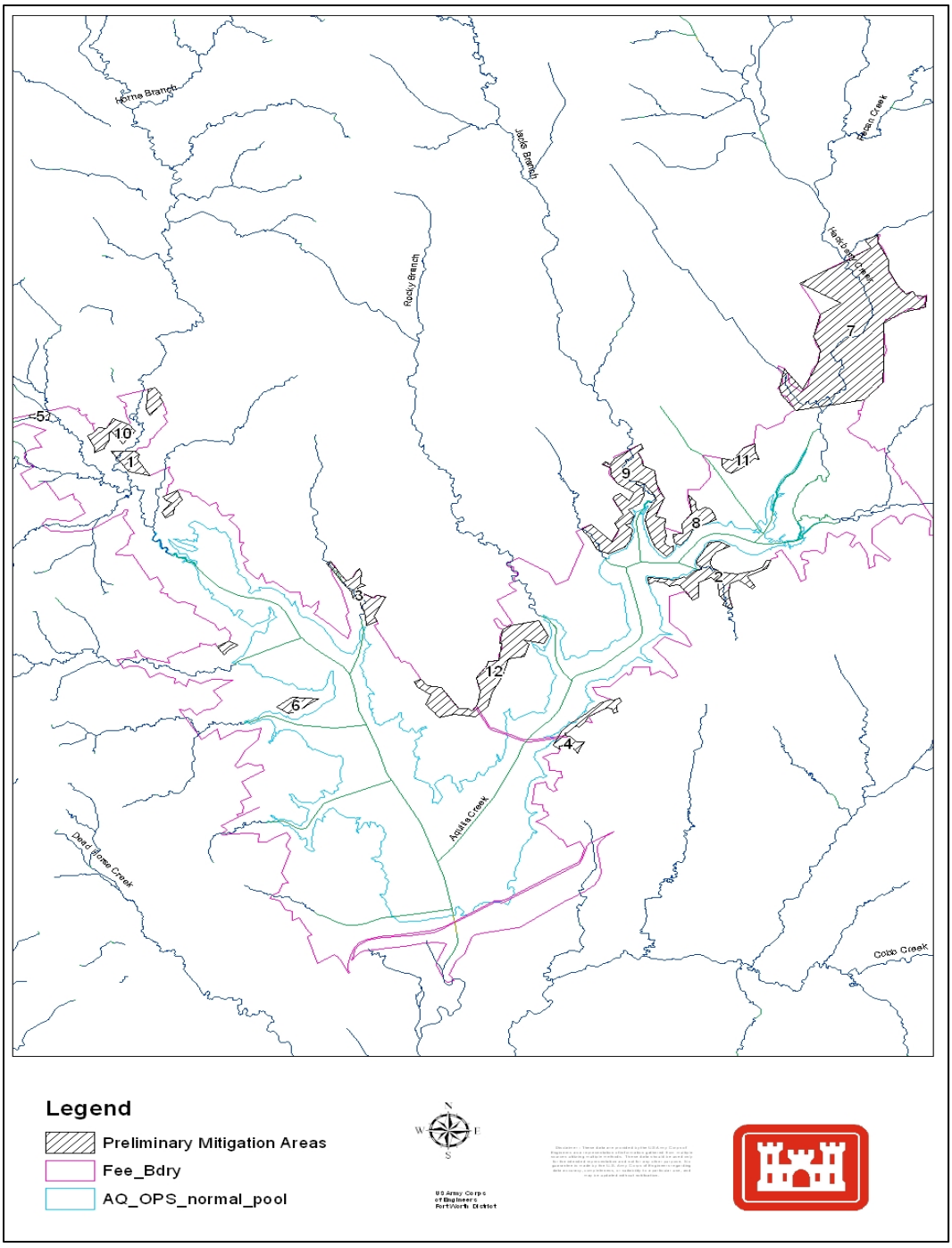


**Figure 10. Preliminary Mitigation Areas within Fee Simple Boundary at Aquilla Lake**

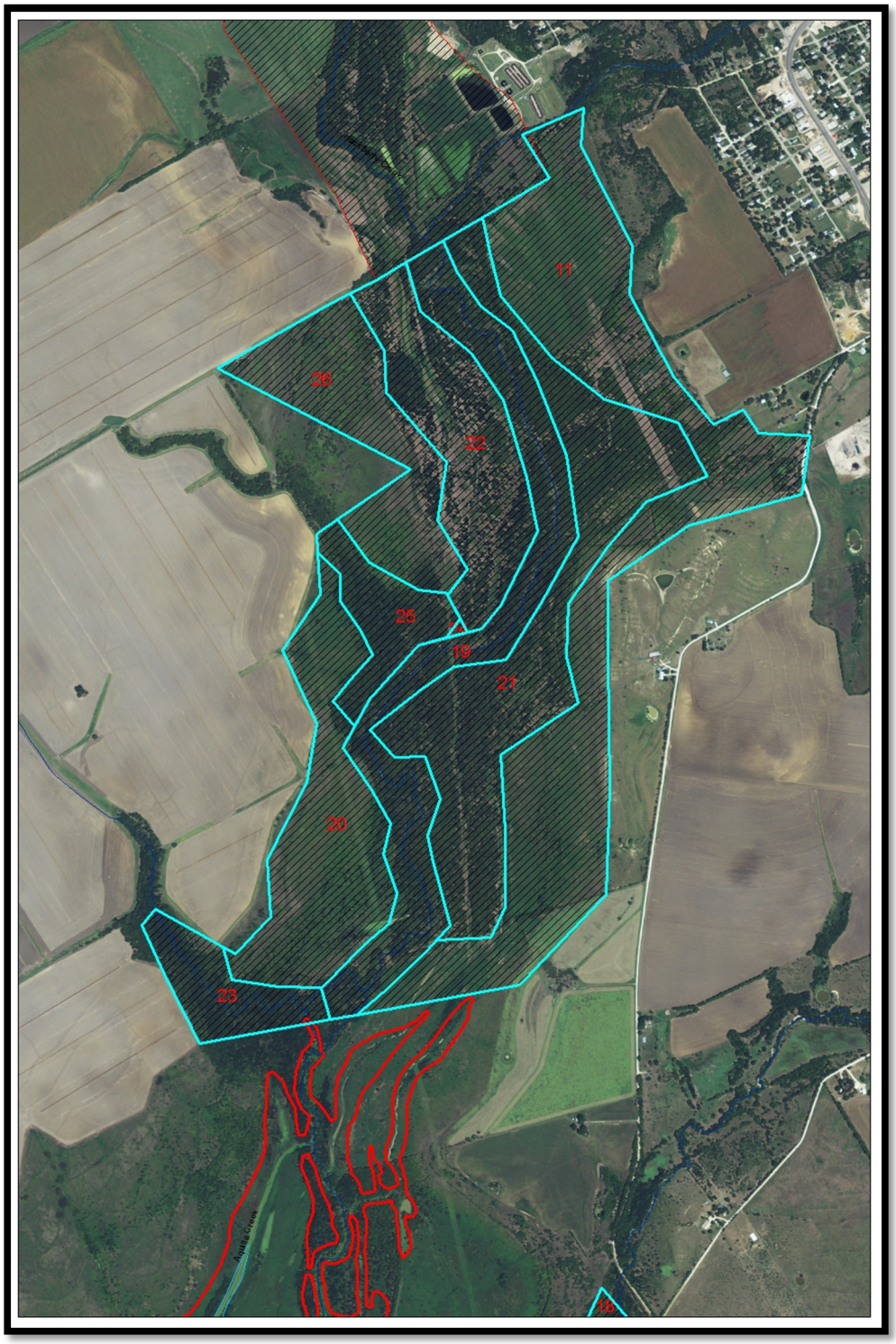



**Figure 11. Suggested Mitigation Area on Hackberry Creek**

Mitigation costs for the 4.5-foot pool raise are outlined in Table 40. Sufficient habitat units would be gained in order to meet mitigation requirements and recompense habitat loss due to impact of the pool rise. Development of the preferred plan will determine final costs associated with terrestrial mitigation efforts. Along with construction costs, O&M costs would be anticipated for the success of the mitigation efforts. Specific tasks might include nest box maintenance, continued efforts for invasive species control, and perimeter fencing addition and maintenance to protect planted mitigation areas. A preliminary cost of $10,000 per year over the 50-year project period is estimated for the 4.5-foot pool raise.

**Table 40. Preliminary Costs for Mitigation of Riparian Woodlands at Hackberry Creek**

| Habitat | Acres | Tract | AAHUs Gained | Cost per Acre | Total Cost |
|---|---|---|---|---|---|
| **Riparian/Floodplain Woodland** | 86.43 | 19 | 15.56 | $1,603.85 | $138,623.05 |
| **Riparian/Floodplain Woodland** | 24.43 | 23 | 4.40 | $1,603.85 | $39,175.88 |
| **Grassland** | 71.66 | 20 | 30.10 | $5,126.00 | $367,331.05 |
| **Total** | 182.52 | | 50.05 | | $545,129.98 |

## *MONITORING AND ADAPTIVE MANAGEMENT*

The WRDA 2007, Section 2039 states, "Monitoring includes the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain project benefits.

This section discusses the preliminary feasibility level monitoring and adaptive management strategies for the terrestrial mitigation efforts based on the tentatively selected plan. This preliminary plan briefly describes the monitoring and adaptive management activities proposed for the project and estimates their cost and duration. A Monitoring and Adaptive Management Plan will be developed to assess the development and success of the terrestrial mitigation features proposed in the mitigation plan during the pre-construction, engineering, and design (PED) phase as specific mitigation design details are made available.

The primary intent of this Monitoring and Adaptive Management Plan is to develop monitoring and adaptive management actions appropriate for the project's mitigation goals and objectives. The presently identified management actions permit estimation of the adaptive management program costs and duration for the mitigation plan. The monitoring and adaptive management plan is based on currently available data and information developed during plan formulation of the mitigation plan. Uncertainties remain regarding the exact project features, monitoring elements, and adaptive management opportunities. Components of the monitoring and adaptive management plan, including costs, were estimated using currently available information. Uncertainties will be addressed in PED, and a detailed monitoring and adaptive management plan, including cost breakdown, will be drafted by the PDT as a component of the design document.

## STATUS OF ENVIRONMENTAL COMPLIANCE

Table 41 presents the status of compliance with all environmental laws and regulations for the Recommended Plan.

**Table 41. Relationship of Plan to Environmental Protection Statutes and Other Environmental Requirements**

| Policies | Compliance of Plan |
|---|---|
| **Public Laws** | |
| Archeological and Historic Preservation Act, 1974, as amended | In Progress |
| Archeological Resources Protection Act, 1979, as amended | In Progress |
| Clean Air Act, 1977, as amended* | Compliant |
| Clean Water Act, 1972, as amended* | Compliant |
| Coastal Zone Management Act, 1972, as amended | Not Applicable |
| Endangered Species Act, 1973, as amended* | Compliant |
| Farmland Protection Policy Act | Not Applicable |
| Fish and Wildlife Coordination Act, 1958, as amended* | In Progress |
| Magnuson Fisheries Conservation and Management Act | Not Applicable |
| Migratory Bird Treaty Act, 1918, as amended* | Compliant |
| National Environmental Policy Act, 1969, as amended | In Progress |
| Rivers and Harbors Act, 1899 | Compliant |
| Wild and Scenic Rivers Act, as amended | Not Applicable |
| Native American Graves Protection and Repatriation Act, 1990 | Not Applicable |
| National Historic Preservation Act, 1966, as amended | In Progress |
| **Executive Orders** | |
| Environmental Justice (E.O. 12898)* | Compliant |
| Flood Plain Management (E.O. 11988) | Compliant |
| Protection of Wetlands (E.O. 11990) | Compliant |
| Invasive Species (E.O. 13112)* | Compliant |
| Migratory Birds (E.O. 13186)* | Compliant |

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# CHAPTER 5: RECOMMENDED PLAN

This chapter describes the recommended plan, and the process through which the proposed project would be implemented if authorized. In addition, USACE recommends TWDB, BRA, and the water user groups continue their existing conservation efforts and modify or update them if and when technology allows.

## PLAN DESCRIPTION

The proposed action would be to increase the top of conservation pool 4.5 feet into the flood storage pool, making the top of conservation pool at elevation 542 ft-msl. This will reallocate approximately 15,073 AF of storage from the flood pool to the conservation pool (Table 42). The estimated increase in yield with this reallocation is 2,463 AF per year as detailed within the storage/yield analyses section in Chapter 3. It was previously noted that any of the potential reallocation scenarios would not meet the total need of the sponsor. The increase in yield would meet approximately 67 percent of the 2020 need and diminishing to only eight percent of the need in 2070. Table 43 repeats much of the information regarding demand and supply but adds information on the estimated increase in yield from the reallocation and also displays the remaining need to be addressed by the sponsor. Additionally, there is no significant development in the floodplain so any potential loss of downstream FRM benefits would be agricultural. Furthermore, no hydropower resources exist at Aquilla Lake so no revenues from hydropower or other sources will be forgone with the flood pool reallocation.

**Table 42. Existing and With Project Elevations and Storage for Aquilla Lake Reallocation**

| | Existing Conditions | | 4.5-ft. Pool Raise | |
|---|---|---|---|---|
| Pool | Elevation | Cum Storage Acre-Ft | Elevation | Cum Storage Acre-Ft |
| Bottom of Conservation Pool | 503 | 106 | 503 | 106 |
| Top of Conservation Pool | 537.5 | 44,577.0 | 542.0 | 59,650 |
| Top of Flood Pool | 556.0 | 136,910.0 | 556.0 | 136,910 |
| Spillway Crest | 564.5 | 204,644.0 | 564.5 | 204,644.0 |
| Maximum Design Water Surface | 577.5 | 350,978.0 | 577.5 | 350,978.0 |
| Gain in Conservation Pool | | | 4.5 | 15,073 |

The proposed reallocation would require placement of two foot thick rock riprap along the upstream shoreline to protect the dam embankment from bank erosion. No changes in the dam or spillway height would be made. Recreation features including restrooms, boat ramps, parking areas, and picnic tables will need to be relocated as described in Appendix G, Recreation. Costs for these changes are included as part of the cost estimate.

USACE has four accounts that are considered as part of the planning process. The accounts are National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSEs). The recommended plan supports both NED and RED

accounts. It is the lowest cost alternative and provides positive NED benefits and supports RED as it resolves the local water supply shortage. EQ is maintained at current levels. Though not quantifiable, OSE is believed to improve as a result of increasing the storage capacity for water supply to support the surrounding population and activities.

**Table 43. Demand and Supply Summary with Recommended Reallocation**

| Description | Water Demand and Supply, Acre-Ft Per Year | | | | | |
|---|---|---|---|---|---|---|
| | **2020** | **2030** | **2040** | **2050** | **2060** | **2070** |
| Cleburne Population | 37,211 | 51,236 | 70,546 | 97,135 | 133,745 | 184,152 |
| Demand for Aquilla Lake Water Users | | | | | | |
| Cleburne (Total Demand) | 15,905 | 18,489 | 21,976 | 26,844 | 33,507 | 42,611 |
| Aquilla Water Supply District | 6,512 | 5,952 | 5,952 | 5,952 | 5,952 | 5,952 |
| Hilco United | 150 | 150 | 150 | 150 | 150 | 150 |
| Total Demand for Aquilla Lake Water Users | 22,567 | 24,591 | 28,078 | 32,946 | 39,609 | 48,713 |
| Supply | | | | | | |
| Aquilla Lake | 11,403 | 11,403 | 11,403 | 11,403 | 11,403 | 11,403 |
| Cleburne (Other than Aquilla Lake) | 7,474 | 7,405 | 7,336 | 7,267 | 7,198 | 7,129 |
| Total Supply | 18,877 | 18,808 | 18,739 | 18,670 | 18,601 | 18,532 |
| | | | | | | |
| **Surplus/Need** | **-3,690** | **-5,783** | **-9,339** | **-14,276** | **-21,008** | **-30,181** |
| Yield from Reallocation | 2,463 | 2,463 | 2,463 | 2,463 | 2,463 | 2,463 |
| Remaining Need | | -3,320 | -6,876 | -11,813 | -18,545 | -27,718 |

## CONSIDERATION OF THE PLANNING GUIDELINES CRITERIA

The planning guidelines criteria are identified in Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (March 1983) as completeness, effectiveness, efficiency, and acceptability. The recommended plan is complete in that it accounts for all necessary investments to ensure the realization of the planned effects. The recommended plan is effective in that it provides a long-term solution for the identified problem and is consistent with protecting the Nation's environment. The recommended plan is efficient in that it is the most cost effective means of alleviating the identified problem consistent with protecting the Nation's environment. The recommended plan is also acceptable in that it is a viable plan meeting the needs of the State, local entities, and general public while being compatible with existing laws, regulations and policies. The recommended plan satisfies the planning guidelines and criteria.

## CONSIDERATION OF THE ENVIRONMENTAL OPERATING PRINCIPLES

The environmental operating principles were established in 2006 and updated in 2012. These principles were considered during the formulation process. The recommended plan supports the environmental operating principles in the following ways:

1. Foster sustainability as a way of life throughout the organization – BRA and the communities they serve have in place a wide array of conservation measures, and continue to educate the public and expand the use of these conservation measures. Additionally, water re-use facilities are already in place, and permits have been requested to expand the use of these facilities.
2. Proactively consider environmental consequences of all Corps activities and act accordingly – There are no adverse impacts to aquatic environment as a result of the recommended plan. Impacts to riparian woodlands are mitigated within the existing fee simple boundary. Mitigation requires monitoring and adaptive management to ensure long term success of the replenished habitat and allows USACE to ensure that native species are provided an opportunity to thrive.
3. Create mutually supporting economic and environmentally sustainable solutions – The recommended plan provides storage for water needed to support a growing population without endangering aquatic ecosystems. Furthermore, the plan provides for supporting recreation and terrestrial features near the shoreline such that the interaction between humans and environment continues to be compatible to ensure a sustainable solution.
4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps which may impact human and natural environments – The recommended plan complies with all Federal, State and local laws and policies, and is supported by USFWS and TPWD.
5. Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs – The evaluation was initiated with an analysis of the entire Brazos River system. Aquilla Lake was determined to be a location where reallocation is possible while maintaining the existing level of flood-risk management for lands outside the existing fee simple and fee easement boundaries from a previously authorized project.
6. Leverage scientific, economic, and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner – USACE was able to scale the level of modeling analysis to the level of risk as appropriate and included components of a dam safety study into the reallocation study to ensure the safety of human lives. Modeling was conducted at only the level of detail necessary to ensure the risk to human life is minimal. USACE also collaborated with natural resource agencies to ensure the risk to the environment is minimal and there is interagency consensus on the recommended plan.
7. Employ an open transparent process that respects views of individuals and groups interested in Corps activities – The recommended plan supports growing populations at the edge of urbanized areas while continuing to serve the flood-risk management function for populations downstream and preserve environment. Public meetings are conducted for NEPA scoping. Copies of the Draft Aquilla Reallocation Report and EA are available in hard copy and online at http://www.swf.usace.army.mil/ and at http://www.brazos.org/. Comments are accepted and documented throughout the planning and review process.

# CONSIDERATION OF DAM SAFETY AND RISK MANAGEMENT

Aquilla Lake Dam was screened by a national risk cadre as part of the Fiscal Year 2005 SPRA and categorized as a DSAC 3 (Moderate Urgency). Corps criteria does not allow for the reallocation of flood storage on projects with a DSAC of 3 or less, without exception from the DSO for the Corps. The Fort Worth District implemented IRRMs to improve project conditions and further evaluate the known Dam Safety concerns. These IRRMs included stockpiling flood-fighting materials, updating the Emergency Action Plan, and conducting emergency preparedness exercises with downstream emergency management agencies. In September 2012, a re-evaluation was completed which recommended that DSAC be changed from 3 to 4 based on IRRM implementation and construction completed since the original DSAC assignment, as concurred by the DSO or Chief of Engineers for Civil Works (CECW-CE) in Memo dated August 27, 2013. As such, reallocation of flood storage is allowed, as authorized by the District/Division DSO, such that the risks associated with the project remain below the Corps Tolerable Risk Guidelines for the final changes to reservoir operations and/or flood storage.

In November 2014, the Fort Worth District conducted a PFMA of the existing conditions for the Aquilla Lake Dam to better define the risks associated with operation of the Federal Project. This was a crucial step to confirming that the 4.5-foot change to the conservation pool will not substantially increase the risks for the project. Preliminary PFMA results confirmed the need to further evaluate site conditions and downstream consequences with a SQRA to confirm the DSAC and allow for safe pool reallocation. This was conducted in June 2016 with the first Periodic Assessment of the project, in conjunction with Periodic Inspection #11. The Periodic Assessment approved May 2017 confirms that a DSAC 4 (low incremental risks) rating for Aquilla Lake Dam is appropriate, and confirms risks associated with Aquilla Dam are not driven by pools near the top of conservation pool elevation.

# PROJECT IMPLEMENTATION PLAN

## WATER SUPPLY AGREEMENT

Implementation of a Reallocation is fully funded by the non-federal sponsor. Upon final approval and signature of this Reallocation Report and Environment Assessment, a new Water Supply Agreement shall be developed and negotiated, based on the Water Supply Act of 1958. The Agreement will be the legal instrument for which funding will be provided to the Corps for Design and Construction, as well as for the cost of the updated storage. In addition, it will contain details regarding the payment of the proportionate share of the Operation and Maintenance Cost, as well as future Major Replacement cost, repayment terms, and all other required legal language.

All funding for design and construction must be provided by the non-Federal sponsor in advance of the actual implementation. Generally, an escrow account is utilized, from which the Government can make withdrawals as necessary to cover the costs as they occur.

## *PROJECT CONSTRUCTION*

### REAL ESTATE ACQUISITION

No acquisition is necessary for the proposed project. The mitigation, recreation, storage of water, and other amenities associated with the proposed project fall within the existing fee simple boundary of the previously authorized and constructed project.

### MONITORING AND ADAPTIVE MANAGEMENT

ER 1105-2-100 allows for monitoring and adaptive management of environmental components during and after construction. The cost of adaptive management is limited to three percent of the total project cost excluding monitoring costs. Monitoring and adaptive management measures are proposed for the environmental mitigation associated with the proposed project.

Pre-construction, during construction, and post construction monitoring shall be conducted by utilizing a Monitoring and Adaptive Management Team (MAMT) consisting of representatives of the USACE, BRA, and contracted personnel.

Monitoring will focus on evaluating mitigation success and guiding adaptive management actions by determining if the project has met Performance Standards. Validation monitoring will involve various degrees of quantitative monitoring aimed at verifying that restoration objectives associated with the mitigation plan have been achieved for both biological and physical resources. Effectiveness monitoring will be implemented to confirm that project construction elements perform as designed. Monitoring will be carried out until the project has been determined to be successful (performance standards have been met), as required by Section 2039 of WRDA 2007. Monitoring objectives have are summarized in Table 44.

**Table 44. Monitoring Criteria, Performance Standards, and Adaptive Management Strategies for Mitigation Area of Proposed Aquilla Lake Project**

| Measurement | Performance Standard | Adaptive Management |
|---|---|---|
| **Woody Stem Density** | Achievement of a specified density of assigned habitat category | Replacement of dead woody vegetation; modification of woody species composition or location within the assigned habitat category area; allowance of natural succession of native woody species within the assigned habitat category area |
| **Herbaceous Percent Canopy** | > 80% canopy cover | Remedial planting/seeding; modification of plant species composition; amending soil; increased irrigation |

| | | |
|---|---|---|
| **Non-Native Vegetation** | < 10% canopy cover; no areas > 0.25 acres in size with > 10% non-native species | Remedial planting/seeding; modification of plant species composition; amending soil; increased irrigation; herbicide application; biological control; mechanical removal |
| **Non-Native and Noxious Weeds** | No areas > 0.25 acres in size with > 10% non-native or noxious weed species | Chemical and mechanical removal |

A baseline vegetation inventory of the mitigation site will be conducted prior to construction of the mitigation alternatives. Vegetation metrics to be collected include woody stem density; percent canopy cover of the overstory, shrub, and herbaceous layers; percent cover for each species; and percent of native/non-native species.

Woody stem density goals are dependent on the woody vegetation measure assigned to the particular area of the mitigation area. (Statement of woody vegetation density measures). The woody stems per acre measurement should be able to meet these performance standards. Any planted woody vegetation that has died within the warranty period shall be replaced. Post warranty period, adaptive management could include replacement of woody vegetation, modifying the woody species composition or location within the assigned habitat category area and allowance of natural succession of native woody species within the assigned stem density area.

Restoration of the herbaceous vegetation would be considered successful when the herbaceous canopy percent cover of the mitigation site is at least 80 percent. Adaptive management could include remedial planting/seeding, modifying the species composition, amending the soil, and/or increased irrigation to ensure establishment of herbaceous canopy.

The percent canopy cover of non-native vegetation in a 0.25-acre area within the mitigation site should be less than 10 percent. On an annual basis, or more frequently if needed, areas greater than or equal to 0.25 acres in size that have more the 10 percent areal cover of non-native vegetation shall be treated per mitigation plan. This typically includes the use of chemical and mechanical methods for management of non-native weeds. Noxious weeds shall also be monitored with a performance standard of less than or equal to 10 percent.

Evaluation of the success of the mitigation plan will be assessed annually until all performance standards are met. Site assessments will be conducted annually by the MAMT and an annual report will be submitted to the USFWS, TPWD, and other interested parties by January 30 following each monitoring year.

Permanent locations for photographic documentation will be established to provide a visual record of habitat development over time. The locations of photo points will be identified in the pre-construction monitoring report. Photographs taken at each photo point will be included in monitoring reports.

Costs to be incurred during PED and construction phases include drafting of the detailed monitoring and adaptive management plan. Cost calculations for post-construction monitoring are displayed as a ten-year (maximum) total. If ecological success is determined earlier (prior to ten years post-construction), the monitoring program will cease and costs will decrease accordingly.

It is intended that monitoring conducted for the terrestrial and aquatic mitigation will utilize centralized data management, data analysis, and reporting functions associated at the Fort Worth District. All data collection activities will follow consistent and standardized processes established in the detailed monitoring and adaptive management plan. Cost estimates include monitoring equipment, photo point establishment, data collection, quality assurance/quality control, data analysis, assessment, and reporting for the proposed monitoring elements.

TOTAL PROJECT COST

Project first costs amount to $10,147,570 including Design, and construction management. Fish and Wildlife Mitigation costs include plantings, monitoring, and adaptive management activities. Design costs include surveys, archeological studies, geotechnical studies, and project design. Storage allocation costs are $14,233,899, making total project costs $24,381,469 (Table 45).

**Table 45. Total Project Costs for Aquilla Lake Reallocation**

| Cost Item | Cost | Contingency | Total |
|---|---|---|---|
| **Real Estate** | $0 | $0 | $0 |
| **Relocations** | $618,832 | $186,330 | $805,162 |
| | | | |
| **Fish and Wildlife Mitigation** | $1,017,211 | $306,282 | $1,323,493 |
| **Levees and Floodwalls (Rock Rip Rap)** | $3,520,102 | $1,059,903 | $4,580,005 |
| **Recreation Facilities** | $953,171 | $287,000 | $1,240,171 |
| **Design** | $951,398 | $286,466 | $1,237,864 |
| **Construction Management** | $733,118 | $220,742 | $953,860 |
| | | | |
| **Project Costs** | $7,793,832 | $2,346,723 | $10,140,555 |
| **Storage Allocation** | $14,233,899 | $0 | $14,233,899 |
| **Total Costs** | $22,027,731 | $2,346,723 | $24,374,454 |

## *OPERATION, MAINTENANCE, REPAIR, REHABILITATION, AND REPLACEMENT*

The 1976 BRA – USACE water supply storage contract authorizes BRA to use 100 percent of the total storage space in Aquilla Lake below elevation 537.5 ft-msl, whatever that may be at any point in time. The original volume of storage below elevation 537.5 ft-msl was estimated at 52,400 AF. The water supply storage contract estimates a storage volume of 33,600 AF for this space after 100 years of sedimentation. Storage is classified as present or future use in the contract based on the future estimated total volume of 33,600 AF. Initially upon contract execution, 3,360 AF of storage (10 percent of the total estimate) was activated for present use with 30,240 AF remaining for future use. As storage is activated to present use through time, BRA's costs increase. The yield estimate for the

initial 3,360 AF of activated storage was 1,086 AF/year. When BRA's use of water reached that amount, additional storage was activated using the same storage – yield relationship. Currently 75.87 percent, or 25,493 AF, is activated with the remainder reserved for future use. Five (5) additional segments of varying percentages have been activated since the initial 10 percent. Each subsequent segment was activated based on BRA's exceedance of the corresponding yield of the activated storage that was in place at the time. See Table 46 for activated segment amounts and year activated.

**Table 46. Active Storage at Aquilla Lake**

| Year | Segment # | Storage Acre-Feet | Yield Acre-Feet | Percent of Total Storage % | O&M Portion % |
|---|---|---|---|---|---|
| **Initial Activation** | 1 | 3,360 | 1,086 | 10.00 | 5.34 |
| **1995** | 2 | 3,444 | 1,113 | 10.25 | 5.48 |
| **1999** | 3 | 1,856 | 600 | 5.52 | 2.95 |
| **2007** | 4 | 7,116 | 2,300 | 21.18 | 11.32 |
| **2009** | 5 | 6,074 | 1,963 | 18.08 | 9.66 |
| **2012** | 6 | 3,643 | 1,177 | 10.84 | 5.79 |
| **Current Totals** | | 25,493 | 8,240 | 75.87 | 40.54 |
| **Fully Activated Totals** | | 33,600 | 10,860 | 100.00 | 53.43 |

In the event of reallocation of flood control storage for water supply use, it is recommended that BRA activate the remaining future use storage of the original 33,600 AF allocated to them below the current conservation elevation of 537.5 ft-msl as specified in the original water supply contract, number DACW63-76-C-0090. It is also recommended that any new contracted water supply storage occurring through reallocation be fully activated when that storage is first made available for use.

Low frequency events (0.33% ACE or less frequent) may result in an event based increase in repair costs to repair erosion associated with overtopping the uncontrolled spillway. However, due to the low frequency and the absence of any historical data associated with events less frequent than the 2 percent ACE, it is expected that the change in average annual cost would be quite small.

## *IMPLEMENTATION SCHEDULE*

The implementation schedule and costs are identified in Table 47. No real estate needs to be acquired. However, some utility and road relocations or improvements are needed to implement the proposed project. Some existing recreation facilities will need to be demolished and replaced to support the proposed project. The existing embankment will be reinforced with rip rap to support the proposed reallocation. Terrestrial environmental habitat adversely impacted by the proposed project will be mitigated, and monitoring and adaptive management will take place to ensure success of the new habitat areas. Once construction is complete and impoundment begins, BRA will initiate payment for storage allocation costs. These costs may be paid in one lump sum when impoundment begins or BRA may elect to make payments over a 30-year period based on their water supply agreement with the U.S. Army Corps of Engineers.

Preconstruction engineering and design would be completed in 2019 and construction would be spread over 2020-2022. Some funds have been distributed in the construction interval to provide engineering support during construction and review as-built drawings submitted by the construction contractor.

Utility relocations, construction of new recreation facilities, and the additional of erosion protection to the upstream embankment of the dam would occur under one contract awarded in 2020. Work associated with the utility relocations includes two ONCOR towers in the lake. Work associated with recreation includes relocating/constructing restrooms, fencing, signs, light posts, utility poles, parking areas, boat ramps, docks, buoys, and roads. We will stabilize the shorelines at the new access areas. Existing facilities not relocatable will then be demolished and environmental cleanup completed in the vicinity of the existing vault style restrooms. Because facilities at Aquilla Creek and Hackberry Creek access areas are closed, these facilities would not be replaced, but would be demolished and environmental cleanup in the vicinity of the existing vault restrooms completed prior to impoundment.

**Table 47. Implementation Schedule and Cost Including Contingencies from Cost/Schedule Risk Assessment**

| Project Feature | In Cost Estimate | Feature Cost | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Real Estate | $0 | $0 | $0 | $0 | $0 | $0 |
| Relocations (Utilities) | $805,162 | $805,163 | $0 | $805,163 | $0 | $0 |
| Embankment (Levees & Floodwalls) | $4,580,005 | $4,580,005 | $0 | $4,580,005 | $0 | $0 |
| Recreation Facilities | $1,240,171 | $1,240,171 | $0 | $1,240,171 | $0 | $0 |
| Environmental Mitigation (including M&AM) | $1,323,493 | $1,323,493 | $0 | | $1,058,794 | $264,699 |
| Construction Totals | | $7,948,832 | $0 | $6,625,339 | $1,058,794 | $264,699 |
| PED | $1,237,864 | $1,237,864 | $1,114,078 | $61,893 | $49,515 | $12,379 |
| Construction Management | $953,860 | $953,860 | $47,693 | $715,395 | $143,079 | $47,693 |
| | | $10,140,556 | $1,161,771 | $7,402,627 | $1,251,388 | $324,770 |
| Storage Allocation | $14,233,899 | $0 | $0 | $0 | $0 | $0 |
| **Total Project Costs** | **$24,374,454** | **$10,140,556** | **$1,161,771** | **$7,402,627** | **$1,251,388** | **$324,770** |

The contract for environmental mitigation would be awarded in 2021 and span two years. The first year includes invasive vegetative species control, excavation of top soil, preparation of soils, grading, tree planting, shrub/grass planting, and adaptive management to ensure success of the new plantings. The second year would include placing nest/bird boxes and continuing adaptive management.

## *COST SHARING*

The sponsor will provide 100 percent of the funding for the proposed reallocation project in accordance with Section 103 Water Resource Development Act of 1986.

## *FINANCIAL PLAN AND CAPABILITY ASSESSMENT*

BRA will provide a self-certification letter following the conclusion draft report reviews and incorporation of comment responses, and completion of cost certification by the USACE Cost Directory of Expertise.

## *VIEWS OF THE LOCAL SPONSORS*

BRA supports the 4.5 foot pool raise alternative identified as the Recommended Plan within the Middle Brazos Systems Assessment, Phase II: Aquilla Water Supply Reallocation Report and Environmental Assessment. TCEQ water availability modeling, which includes the modeling of water rights and Senate Bill 3 environmental flows, indicated an estimated incremental yield increase of only 231 acre-feet/year between the 4.5 foot pool raise scenario and the 6.5 foot pool raise scenario. Due to the increased costs and the nominal yield increase, the 6.5 foot pool raise scenario was not considered to be an optimal solution or the best use of available storage.

BRA recognizes that the water supply increase generated by the 4.5 foot pool raise meets only a portion of the future water needs at Aquilla Lake and that reallocation is one of several projects currently under evaluation to increase the water supply of the Aquilla Lake area. With an estimated cost of approximately $25 million, the decision of if and when to implement the 4.5 foot pool raise at Aquilla Lake will be considered by BRA and will require authorization by the BRA Board of Directors after the USACE approval process. Pending the outcome of the USACE report approval process and the TCEQ permit request and approval process, BRA feels the schedule and costs presented in this report are reasonable at this time.

## *VIEWS OF THE RESOURCE AND OTHER FEDERAL AGENCIES*

Consultation with Federal and state agencies has been ongoing since the inception of this project. This would include contacts that are made during the development of the proposed action and writing of the report. Formal and informal coordination have been or will be conducted with the following agencies:

- U.S. Fish and Wildlife Service (USFWS)
- U.S. Environmental Protection Agency (USEPA)
- Texas State Historic Preservation Office (SHPO)

- Texas Parks and Wildlife Department (TPWD)
- Texas Commission on Environmental Quality (TCEQ)

The proposed project has been reviewed in accordance with Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. In addition, Executive Order 11990, Protection of Wetlands and Executive Order 11988, Floodplain Management was considered during development of the proposed project. The proposed project would not involve activities subject to the requirements of Section 10 or Section 404, and no further coordination for Section 401 water quality certification is required.

There has been on-going coordination with Texas Parks and Wildlife, and the SHPO. A major part of NEPA compliance is to ensure that an adequate number of alternatives are considered during plan formulation, which is also the intent of this report. It is anticipated that there would be no adverse or controversial comments that would necessitate conducting an environmental impact statement. At the close of the comment period, the Fort Worth District Engineer would sign a Finding of No Significant Impact, if appropriate.

# CHAPTER 6: PUBLIC INVOLVEMENT*

A NEPA scoping meeting was conducted in 2008. The draft report with integrated environmental assessment is available for public review for a period of 30 days beginning 6 July, 2017. The draft mitigated FONSI and report were sent to the USFWS, TPWD, Texas Historical Commission, TCEQ, EPA Apache Tribe of Oklahoma, Caddo of Oklahoma, Tonkawa Tribe of Oklahoma, Comanche Nation of Oklahoma, and Delaware Nation; posted at the Hillsboro Public Library, Cleburne Public Library, West Public Library, Fort Worth District web site and Brazos River Authority Web site; and posted in a local news release for public review and comment. The Notice of Availability was sent to addressees on the regulatory county mailing lists. The Press Release is included in Appendix L of this document. Comment letters received concerning the draft will be incorporated into the final report and a copy of the letters included in Appendix N.

# CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

The authorized purposes of Aquilla Dam and Lake include flood risk management, municipal and industrial water supply, environmental stewardship and recreation. The storage is allocated between flood risk management (flood pool) and municipal and industrial water supply (conservation pool).

The proposed reallocation of 15,073 acre feet of storage from the flood pool to the conservation pool would maintain a top of flood pool elevation of 556 msl and result in no adverse impacts to the flood risk management mission or dam safety. There would be no major structural or operational changes as a result of reallocation. The only alteration to the existing structure would be the addition of rip rap to the upstream face of the dam to ensure erosion protection. This is less than 5 percent of the total cost of the proposed reallocation. Controlled releases through the outlet works would continue in accordance with the existing Water Control Plan consistent with downstream channel capacity. Flood elevations are dominated by discharges from a downstream watershed (Cobb Creek) the proposed reallocation, and modeling completed as part of the reallocation study and the 2016 Periodic Assessment of dam safety risks at Aquilla Dam indicate there would be no increase in flood damages or life safety risks as a result of the proposed reallocation.

The USACE, USFWS, and TPWD completed a habitat assessment of the study area. There are no Threatened and Endangered Species and no species of interest located in the study area and none are expected in the foreseeable future. Environmental impacts to riparian woodlands can be mitigated successfully within existing project lands.

The entirety of the proposed action occurs completely within the existing project area boundary owned and maintained by the Federal Government. No real estate actions would be required as part of the proposed action.

The proposed project is supported by BRA who is the non-federal sponsor and has contracted with USACE for the total storage currently allocated to water supply. BRA recognizes the proposed reallocation will reduce the immediate water supply shortage forecasted for existing users, but not completely eliminate the shortage. BRA has worked with USACE to ensure this is the most cost effective way to reduce the shortage in the immediate future. The estimated increase in yield is approximately 2,463 acre feet per year. This additional yield would reduce the projected water supply shortage from 5,783 acre feet to 3,320 acre feet in 2030. In accordance with Section 103 of the Water Resources Development Act, BRA would fund 100 percent of the design and construction of the project.

It is recommended that the proposed reallocation of 15,073 acre feet of storage (approximately 11 percent of total storage) from flood storage to conservation storage be approved to reduce the forecasted water supply shortage faced by existing users in the immediate future. It would be required that Safety Assurance Reviews be conducted through the design and construction phases to ensure there are no adverse impacts to the flood risk management mission or the dam. In coordination with the Texas State Historical Preservation Office, further evaluation and classification of three archeological sites potentially eligible for National Registrar of Historic Places will be required if the proposed project is approved. Recreation facilities impacted by the pool raise would be relocated with the exception of the two recreation areas that have been permanently closed

(Aquilla Creek Access Area and Hackberry Creek Access Area). The facilities at the two closed recreation areas would be demolished and the vicinity of the vault restrooms remediated prior to impoundment. Environmental mitigation for a net loss of 50 Average Annual Habitat Units of riparian woodlands with monitoring and adaptive management is included in the proposed action. As proposed, the mitigation is located in a contiguous 183 acre area located on the western bank of Hackberry Creek. As proposed, the project meets the National Economic Development objective for providing the most cost effective water supply and is consistent with the criteria in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources* (1983).

# LIST OF PREPARERS*

| **USACE Preparers** | |
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| Stacy Gray – Project Manager | Jodie Foster – Lead Planner |
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| Aaron Abel (BRA) | Jeremy Rice (Freese and Nichols, Inc.) |
| | |

# LIST OF ACRONYMS/TERMS

**Table 48. ACRONYMS AND TERMS**

| | |
|---|---|
| °F – degrees Fahrenheit | mg/L – milligrams per liter |
| AAHUs – Annual Average Habitat Units | NAAQS – National Ambient Air Quality Standards |
| ACE – Annual Chance Exceedance | NCTCOG – North Central Texas Council of Governments |
| AF – Acre-Feet or Acre-Foot | NED – National Economic Development |
| ANSI – American National Standard Institute | NEPA – National Environmental Policy Act |
| AWSD – Aquilla Water Supply District | NGVD – National Geodetic Vertical Datum |
| BRA – Brazos River Authority | $NO_X$ – Oxides of Nitrogen |
| CAA – Clean Air Act | NRMA's – Natural Resources Management Area |
| CECW– CE – Chief of Engineers for Civil Works | NRCS – Natural Resources Conservation Service |
| cfs – cubic feet per second | $O_3$ – Ozone |
| CTP – Chisholm Trail Parkway | OMRR&R – Operation and Maintenance, Repair, Replacement, and Rehabilitation |
| CO – Carbon Monoxide | OSEs – Other Social Effects |
| CEQ – Council on Environmental Quality | P&S – Plans and Specifications |
| dB – decibels | PAL – Programmatic Agreements Library |
| dbh – Diameter Breast Height | Pb – Lead |
| DDR – Detailed Design Report | PDT – Project Delivery Team |
| DNL – Day-Night Average Sound Level | PED – Pre-construction, Engineering, and Design |
| DSAC – Dam Safety Action Classification | PFMA – Potential Failure Mode Analysis |
| DSO – Dam Safety Officer | PM – Particulate Matter |
| EA – Environmental Assessment | PM10 – Particulate less than 10 microns in diameter |
| ECO-PCX – Ecosystem Restoration Planning Center of Expertise | RED – Regional Economic Development |
| EOP – Environmental Operating Principles | ROI – Region of Influence |
| EQ – Environmental Quality | $SO_2$ – Sulfur Dioxide |
| ETJ – Extra-Territorial Jurisdiction | SPRA – Screening Portfolio Risk Assessment |
| ESA – Endangered Species Act | SQRA – Semi-Quantitative Risk Assessment |
| FICON – Federal Interagency Committee on Noise | SWCB – Soil and Water Conservation Board |
| FONSI - Finding of No Significant Impact | T&E – Threatened and Endangered |
| FPPA – Farmland Protection Policy Act | TCEQ –Texas Commission of Environmental Quality |
| FRM – Flood-Risk Management | TDS – Total Dissolved Solids |
| ft-msl – feet above mean sea level | TOC – Top of Conservation |
| gpcd – gallons per capita per day | TPWD – Texas Parks and Wildlife Department |
| GIS – Geographical Information Systems | TSWP – Texas State Water Plan |
| HC – Hydrocarbons | TWDB – Texas Water Development Board |
| HEP – Habitat Evaluation Procedures | USACE – U.S. Army Corps of Engineers |
| HSI – Habitat Suitability Index | USFWS – United States Fish and Wildlife Service |
| HU – Habitat Units | VOCs – Volatile Organic Compounds |
| IRRMs – Interim Risk Reduction Measures | WAM – Water Availability Models |
| lf – Linear Feet | WRDA – Water Resource Development Act |
| LRWSP – Long Range Water Supply Plan | WSA – Water Supply Agreement |
| M&I – Municipal and Industrial | |
| MAMT – Monitoring & Adaptive Management Team | |

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