REGION C STUDY COMMISSION
Final Report – Phase I and Phase II

Prepared for:

Study Commission on Region C Water Supply

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GLOSSARY

Acre-foot	Volume of water needed to cover 1 acre to a depth of 1 foot. It equals 325,851 gallons.
Availability	Maximum amount of water available during the drought of record, regardless of whether the supply is physically or legally available.
Basin of Origin	The local river basin where a water supply alternative is located. For example, if water were provided from the Toledo Bend Reservoir to the Dallas – Ft. Worth area, the river basin in which Toledo Bend Reservoir is located would be considered the Basin of Origin.
Bottomland Hardwood	Bottomland hardwood occur mostly in floodplain and/or flats along river channels. Periodic inundation prevents the establishment of species that cannot tolerate anaerobic conditions. Examples of trees found in the bottomland hardwood forests in Texas include bald cypress, pecan, oaks, elm, cottonwood and hackberry. These types of hardwoods, especially the older growth of 50 to 100 years-in-age, contribute to the biodiversity of the wetland system.
Compensatory Mitigation	Steps taken to avoid or minimize negative environmental impacts. Mitigation can include: avoiding the impact by not taking a certain action; minimizing impacts by limiting the degree or magnitude of the action; rectifying the impact by repairing or restoring the affected environment; reducing the impact by protective steps required with the action; and compensating for the impact by replacing or providing substitute resources.
Conservation Pool	The volume of lakes dedicated to water storage for municipal, domestic, industrial, agricultural and recreational purposes between two specific elevations.
Conservation Storage	The space available to store water above the lowest outlet and below the top of conservation pool, or normal maximum operating level. Conservation storage refers to the volume of water held within the conservation storage space. Not included is any water in flood control storage (above the top of conservation pool or normal maximum operating level), or any water in the dead storage. Conservation storage percentage is based on the conservation storage capacity of the reservoir and the conservation storage in the reservoir on date shown. Percent change is given by 100 (current conservation storage - past conservation storage)/conservation storage capacity.
Dead Pool	The total storage below the invert level of the lowest discharge outlet from the reservoir. It may be available to contain sedimentation or to preserve fish and wildlife habitat.
Direct Effects	A change in an industry that has a direct economic effect. For example, if a factory closes down, the economic loss of what that factory produces would be considered a direct economic effect.

Drainage Area	The upstream area draining into a stream at a given point.
Drought	Term is generally applied to periods of less than average precipitation over a certain period of time. Associated definitions include *meteorological drought* (abnormally dry weather), *agricultural drought* (adverse impact on crop or range production), and *hydrologic drought* (below average water content in aquifers and/or reservoirs).
Drought of Record	Period of time during recorded history when natural hydrological conditions provided the least amount of water supply. For Texas as a whole, the drought of record is generally considered to be from about 1950 to 1957.
Eutrophic	Usually refers to a nutrient-enriched body of water which produces high algal growth.
Existing Water Supply	Maximum amount of water available from existing sources for use during drought of record conditions that is physically and legally available for use.
Firm Yield	The maximum annual supply of a given reservoir that is expected to be available on demand. The reservoir elevation will be reduced as the supply is taken from the reservoir. If no additional flow comes into the reservoir, the reservoir will be empty at the end of the drought conditions if the maximum firm yield is diverted annually.
Flood Control Storage	Storage in a lake or reservoir, between two designated water surface elevations that is dedicated to storing floodwater so that flood damages downstream are eliminated or reduced.
Hydroelectric Power	Electricity generated using streamflow or reservoir releases to turn turbines and generators.
Impoundment	A body of water confined by a dam, dyke, floodgate or other barrier. It is used to collect and store water for future use or treatment.
Inactive Pool	Water storage situated between the bottom conservation pool and/or power pool elevation and the invert level of the lowest discharge outlet from the reservoir; typically, the reservoir may not be drawn into the inactive pool.
Indirect Effects	A change to a secondary industry due to the direct effect on the primary industry. For example, if a factory closed down (direct effect) and stopped purchasing raw material, the reduction in purchases of raw material would be considered an indirect economic effect.
Indirect Reuse	The subsequent beneficial use of water after it has been discharged from the wastewater treatment plant into a natural surface water or groundwater body, from which further water is taken.

Induced Effect	An economic change in household spending due to a direct or indirect effect. For example, if a factory closes down and a worker is laid-off, the reduced purchases of the unemployed workers would be considered an induced economic effect.
Infrastructure	Physical means for meeting water and wastewater needs, such as dams, wells, conveyance systems, and water or wastewater treatment plants.
Instream Flow	Water flow and water quality regime adequate to maintain an ecologically sound environment in streams and rivers.
Interbasin Transfer	Physical conveyance of surface water from one river basin to another.
Invert	The lowest gated outlet of a reservoir that can readily draw water. The lowest invert outlet is typically located between the inactive pool and the dead storage zone of a reservoir.
Lake Surface Area	The area of the surface of the lake measured at a specified elevation.
Mitigation	Mitigation means the restoration (re-establishment or rehabilitation), establishment (creation), enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved. [33 CFR Part 332.2]
Mitigation Area	The portion of a site, right-of-way, or piece of property upon which mitigation is proposed or performed.
Needs	Projected water demands in excess of existing water supplies for a water user group or a wholesale water provider.
Reallocation of Flood Storage	Reallocation of existing flood control storage to water supply uses. The reallocation may occur in USACE reservoirs if certain conditions are met, including adequate flood protection is maintained. Reallocation could also include converting hydroelectric power supply to water supply.
Recommended Water Management Strategy	Specific project or action to increase water supply or maximize existing supply to meet a specific need that are recommended by regional water planning groups in their adopted regional water plans.
Reservoir Capacity	Volume of water stored in a reservoir from the bottom of the flood pool to the top of the flood storage pool. Not to be confused with firm yield of a reservoir.
Reuse	Use of surface water that has already been beneficially used once under a water right or the use of groundwater which has already been used.

Sediment Pool	The reservoir space allotted to the accumulation of deposited sediments during the life of the structure.
Sedimentation	Action or process of depositing sediment in a reservoir, usually silts, sands, or gravel.
Socioeconomic Impact	Studies/indicators looking at both social and economic conditions relevant to well-being and the effects upon individuals resulting from a specific event.
Storage	Natural or artificial impoundment and accumulation of water usually for later withdrawal or release.
Uncontrolled Spillway	A spillway structure on a reservoir that has no gates or facilities to stop or slow water from being released from an exiting the reservoir at a specific water level.
Upland Hardwoods	Hardwood trees that are primarily found at higher elevations than the bottomland hardwoods. Species that occur in Texas include: white oak, red oak, blackjack oak, post oak, shumard oak, black oak, and Texas hickory.
Water Availability Model	Numerical surface water flow model utilized to determine the availability of surface water during a drought of record for water right permitting in the state.
Water Conservation	Refers to reducing the use of water and reducing the waste of water. The wise use of water with methods ranging from more efficient practices in farm, home and industry to capturing water for use through water storage or conservation projects. Conservation could include practices that encourage consumers to reduce the use of water.
Water Conservation Plan	A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for preventing or reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. The Texas Water Code, Chapter 11, requires adoption of water conservation plans for certain utilities and water right holders. A water conservation plan may be a separate planning document or may be contained within another water management document(s). Regional water planning groups must consider these in developing their own regional water plans.
Water Demand	Quantity of water projected to meet the overall necessities of a water user group in a specific future year. Water demands for regional water planning purposes are adopted by the TWDB.
Water Right	TCEQ granted right to utilize surface water from the State of Texas. The water right will have an annual amount and priority date specified in addition to other requirements.

Water Contract	A contract between two parties for the supply of raw or potable water. The contract will have specific terms in relation to payment and expiration dates.
Water Supply	A supply of water; specifically, water collected, as in reservoirs, and conveyed, as by pipes, for use in a city, mill, or the like.
White Oak Creek Wildlife Management Area	The White Oak Creek Wildlife Management Area (WOCWMA) was created as mitigation area for the construction of Lake Jim Chapman. The WOCWMA is located in Bowie, Cass, Morris and Titus counties, in northeast Texas, near the Arkansas, Oklahoma and Texas border. The WOCWMA covers approximately 25,777 acres of mostly bottomland hardwood forest at the confluence of the Sulphur River and White Oak Creek. The WOCWMA is managed under a license agreement with the USACE. Outdoor recreation includes hunting, fishing, hiking, horseback riding and wildlife viewing. Public hunting is permitted for white-tailed deer, feral hog, spring eastern turkey, quail, mourning dove, waterfowl, early teal, duck, woodcock, rail, gallinule, snipe, squirrel, rabbits, hares and furbearers.

ACRONYMS

- Acre-foot or acre-feet (ac-ft);
- Acre-feet per year (afpy);
- Basin and Bay Expert Science Team (BBEST)
- Cubic Feet per Second (cfs);
- Dallas Water Utilities (DWU);
- Dissolved Oxygen (DO);
- Environmental Impact Statement (EIS);
- Federal Energy Regulatory Commission (FERC);
- General Land Office (GLO);
- Greater Texoma Utility Authority (GTUA);
- Initially Prepared Plan (IPP);
- International Paper (IP);
- Lake Wright Patman (WP);
- Lake O' the Pines (LOP);
- Mean Sea Level (msl);
- North Texas Municipal Water District (NTMWD);
- North East Texas Municipal Water District (NETMWD);
- Oklahoma Water Resources Board (OWRB);
- Oklahoma Department of Environmental Quality (ODEQ);
- Oklahoma Department of Wildlife Conservation (ODWC);
- Oklahoma Water Resources Research Institute (OWRRI);
- Red River Authority of Texas (RRAT);
- Riverbend Water Resources (RWR);
- Sabine River Authority of Texas (SRA);
- Sabine River Authority of Louisiana (SRA-LA);
- Sulphur River Basin Authority (SRBA);
- Tarrant Regional Water District (TRWD);
- Texas Commission on Environmental Quality (TCEQ);
- Texas Department of Agriculture (TDA);
- Texas Historical Commission (THC);
- Texas Parks and Wildlife Department (TPWD);
- Texas State Soil and Water Conservation Board (TSSWCB);
- Texas Water Development Board (TWDB);
- Toledo Bend Interbasin Transfer Project (TBIBT);
- Total Dissolved Solids (TDS)
- Total Maximum Daily Load (TMDL);
- Trinity River Authority (TRA);
- U.S. Army Corp of Engineers (USACE);
- U.S. Fish and Wildlife Service (USFWS);
- U.S. Geological Survey (USGS);
- Upper Trinity Regional Water District (UTRWD);
- Water Treatment Plant (WTP); and
- White Oak Wildlife Management Area (WOCWMA).

EXECUTIVE SUMMARY PHASE I

The Study Commission on Region C Water Supply (Study Commission) was established by Senate Bill 3, Section 4.04, of the 80th Texas Legislative Session. Section 4.04 (e) charged the Study Commission with eight tasks regarding water supply alternatives available to the Region C Regional Water Planning Area. Senate Bill 3 requires the Study Commission to perform these eight tasks. The objective of the Study Commission is to evaluate water supply alternatives to determine if a reasonably equivalent alternative to the Marvin Nichols project is available.

This study was commissioned by the TWDB in the later part of 2008. Based on available funding from the TWDB, the Study Commission divided the scope of work defined in Senate Bill 3 into two Phases. This report is a summary of activities performed in Phase I of that division of work.

Phase I of the proposed scope was further divided into two tasks. The scope of Task 1 was defined to include a collection of existing data (from 1985 to present, with some historical data collected from prior years), a literature review of that data, and a data gap analysis for five water management alternatives selected based on size and location of the projects. The five alternatives were the proposed Marvin Nichols Reservoir Site IA and existing Lake Wright Patman, Toledo Bend Reservoir, Lake Texoma, and Lake O' the Pines. The data gap analysis was performed to identify areas in each of the five water supply alternatives that would need to have additional clarification, analysis or evaluation.

Task 2 was defined to include a review of existing socioeconomic studies of the five alternatives to identify discrepancies and/or data gaps. The development of the methodology for the socioeconomic impact evaluation (if different than the existing work) was also to be created. The methodology was then to be utilized to perform a socioeconomic evaluation of one of the five alternatives. Toledo Bend Reservoir was selected as the water supply alternative for the example of the socioeconomic impacts to the area where the water supply is located. Toledo Bend was selected for the example of the socioeconomic impacts to the area where the water supply is located due to the extensive information readily available to perform the analysis.

Task 1 Literature Review and Data Gap Summary

Based on the scope of work, documents from 1985 through present were collected from multiple sources. An estimated 212 documents were collected and reviewed. Data was collected and entered into a website database for use by all Project Team members (http://portal.espeyconsultants.com/RCCS/). A listing of these documents is provided in Appendix A.

As expected all five options could provide additional water for use in Region C. Summary of the additional water available and related data gaps for each of the five alternatives is contained in Table ES1. The amounts of available water in Table ES1 are above existing demands of the water supply alternatives.

Table ES1. Available Water Supply

Reservoir	Ac-ft	Comment
Lake Wright Patman[65]	57,500	Texarkana has additional 180,000 afpy of water rights, of that 57,500 available
	180,000	Flood storage reallocation to 228.64 ft
	108,000	System operations with Chapman
	unspecified	Flood storage reallocation above 228.64 ft
Lake O' the Pines[246]	88,000	NETMWD has 241,800 afpy of water rights, of that 88,000 available
Lake Texoma[37]	None Available	Texas allocation of water supply
	150,000	Currently considered hydropower reallocation
	unspecified	Flood storage reallocation
Toledo Bend Reservoir[37]	500,000 - 700,000	Existing water rights (SRA), amount depends on study reviewed
Marvin Nichols Reservoir[37]	489,400 - 602,000	Yield range dependent on amount dedicated to local use

It is important to point out that it is unlikely that additional hydropower storage could be converted to water supply. If this alternative, however, is to be evaluated congressional authorization would need to be obtained.

Based on the literature review, a data gap analysis was performed to identify other potential water supply as addressed as part of the Region C Water Plan. As such, a data gap analysis was completed for each of the reservoirs addressed above identifying further study or evaluations needed to address the potential additional water supply alternative.

Lake Wright Patman

Planning Data Gaps:

- What volume of water is available from Lake Wright Patman after giving consideration to existing water rights holders, anticipated local needs over the term of a contract period, unexpected local need and retained local excess surplus supply for drought protection?
- How much water is available from existing water rights holders for sale or contract? Which parties would be selling or contracting water?
- What operating level of Lake Wright Patman is reasonable due to the WOCWMA facility and how will operations be modified?
- What is the expected yield of Lake Wright Patman under the most reasonably achievable operating scenarios?

Permitting/Design Data Gaps:

- In order to increase the water supply yield of Lake Wright Patman, what action is needed from the following organizations or agencies?
  - US Congress (Congressional authorization for reallocation of flood storage to water supply over 50,000 ac-ft) or 15% of total storage.
  - USACE (operating changes, WOCWMA structures, additional flood impact analysis, impact on downstream navigation from loss of flood storage, potential replacement of flood protection and mitigation for Jim Chapman Lake).

   - Region C Regional Water Planning Group – incorporation as a recommended water management strategy for specific water user groups.
   - Project Sponsor(s) – Apply for permits and implement strategy.
   - TWDB. (approval of applicable regional water plan and adoption of State Water Plan Amendment)
- Environmental permitting (EIS, 404 issues, water quality issues, habitat and ecological analysis, pipeline mitigation, etc).
- Cost estimating (pipeline, mitigation, permitting, etc.).
- What is the mitigation impacts for each change in reservoir operation considered?
- What is the current procedure and process for evaluating mitigation and developing a Mitigation Plan?
- What role could recent rules for mitigation banking play in each scenario?

Lake O' the Pines (LOP)

<u>Planning Data Gaps:</u>
- What volume of water is available from LOP including permitted water that has not been contracted below elevation 228.5 feet msl? Are there any other consideration for existing water rights holders (including contracts that may not be fully utilized), anticipated local needs over the term of a contract period, unexpected local need and retained local excess surplus supply for drought protection?
- Has sedimentation impacted the total volume of LOP (this would reduce the amount of water available for sale)? A hydrographic study could be performed to evaluate the impact of sedimentation in the reservoir and improve the answer to how much water is available for sale to Region C; the TWDB is currently under contract to conduct a hydrographic study.

<u>Permitting/Design Data Gaps:</u>
- TCEQ interbasin transfer permitting.
- What is the current procedure and process utilized to determine the amount of mitigation required and development of a Mitigation Plan for pipeline construction?
- Environmental permitting for pipeline and pump station construction (EIS, 404 issues, Giant Salvinia, water quality issues, wetlands, pipeline mitigation, etc).
- Cost estimating (pipeline, intake structure and pump station, mitigation, permitting, etc.).
- Is there additional flood storage over the elevation of 228.5 feet that could be reallocated to water supply? Is so, would congressional authorization be needed (over 50,000 ac-ft) or 15% of total storage.

Lake Texoma

<u>Planning Data Gaps:</u>
- No large data gaps in the planning phase.

<u>Permitting/Design Data Gaps:</u>
- Long term Oklahoma law will need to be assessed to determine if Oklahoma will be able to sell water to Texas.
- If additional water from Oklahoma portion of Lake Texoma is sold to Texas environmental permitting will have to be completed (EIS, impact of the invasive Zebra Mussel, etc.).
- If additional water from Oklahoma portion of Lake Texoma is sold to Texas water quality will need be further evaluated (blending, desalination, brine disposal, etc.).
- If additional water from Oklahoma portion of Lake Texoma is sold to Texas the TCEQ interbasin transfer permitting issues will need to be addressed.

- It is unlikely that additional hydropower storage could be converted to water supply. However, if this alternative is to be evaluated congressional authorization would need to be obtained.

Toledo Bend Reservoir

Planning Data Gaps:

- How often will the transfer and sale of water from Toledo Bend impact the ability of the reservoir to provide hydropower?

Permitting/Design Data Gaps:

- Cost estimates are outdated and need to be updated. If supply is not economical now these revised cost estimates will also be out of date in the short term future. Cost analysis of Toledo Bend Reservoir should be done later in the process.
- FERC licensing issues.
- Texas water rights and contract from SRA.
- Interbasin transfer permitting issues.
- Mitigation for pipeline, storage and/or pump stations.
- Louisiana issues?

Marvin Nichols

Planning Data Gaps:

- What role could recent rules for mitigation banking play in the mitigation of Marvin Nichols?

Permitting/Design Data Gaps:

- TCEQ (interbasin transfer permitting issues, additional water rights permitting, water right ownership, etc.).
- What is the current procedure and process utilized to determine the amount of mitigation required and development of a Mitigation Plan?
- Amount of water needed for local area.
- Environmental permitting (EIS, 404 issues, water quality issues, habitat and ecological analysis, instream flow issues, etc).
- Updated cost estimates (construction of dam, pipeline, mitigation, permitting, etc.).

Task 2 Socioeconomic Data Gap Summary

In conducting the literature review, the Project Team identified two types of data gaps which exist related to socioeconomic analysis of the water supply alternatives to be considered by the Region C & D Study Commission. These include:

1. Limited or no economic data compiled and/or analysis developed for a specific water supply alternative; or
2. Inconsistencies in the methodologies, assumptions, and/or focus of studies conducted.

The first of the identified data gaps were applicable to Lake Wright Patman, Lake O' The Pines, and Lake Texoma. To the knowledge of the Project Team, no formal socioeconomic impact analysis has been conducted related to these water supply alternatives.
In regards to the second type of data gap identified, this gap was most applicable to the Marvin Nichols Reservoir and the Toledo Bend Reservoir

Based on the above identified gaps, the Commission may wish to develop a specific methodology and/or recommended techniques or guidelines for conducting future socioeconomic analysis. Appendix F of this document presents the Project Team's recommendations regarding this potential methodology. Pursuant to the Phase I Scope of Services, applies the Project Team's methodology recommendations to an analysis of the Toledo Bend Reservoir.

Phase I Recommendations

Phase I literature review and data collection has been completed. As stated above, there are many planning and permitting/design data gaps identified.

The above data gaps were ranked to determine if some of the gaps can be filled with current resources available from the TWDB. The data gaps were ranked based on identifying the most efficient use of those funds.

Since the permitting/design gaps data only become an issue when the water supply alternatives are decided, the permitting/design gaps are ranked the lowest. These gaps will need to be addressed at some point during the water management strategy development and should be noted. However, they are not as critical to the planning aspect of the strategies.

The data gaps listed as planning gaps need to be addressed initially. The ranking of these planning data gaps was performed by determining which water management alternative was the closest to a reasonable alternative for the amount and cost of Marvin Nichols Site IA.

Therefore, based on amount of water available and the cost of the alternative, it is recommended that the planning data gaps for Lake Wright Patman be considered the highest priority. The second alternative is to address the planning data gaps is identified as Lake O' The Pines. If sufficient funds are available both Lake Wright Patman and Lake O' The Pines planning data gaps should be evaluated.

In regards to overcoming the data gaps related to the socioeconomic analysis of the identified water supply alternatives, the Project Team would recommend that as part of Phase II, initial socioeconomic impact analysis be conducted for Lake Wright Patman and Lake O' The Pines. However, it will be important that these options be thoroughly defined and evaluated before the socioeconomic impact analyses can be completely. With regards to potential water supplies from Lake Texoma, the Project Team is of the opinion that socioeconomic impact analysis is not necessary as this water supply alternative has no direct socioeconomic effect on Region D.

EXECUTIVE SUMMARY PHASE II

The Study Commission on Region C Water Supply (Study Commission) was established by Senate Bill 3, Section 4.04, of the 80th Texas Legislative Session. Section 4.04 (e) charged the Study Commission with eight tasks regarding water supply alternatives available to the Region C Regional Water Planning Area. Senate Bill 3 requires the Study Commission to perform these eight tasks. The objective of the Study Commission is to evaluate water supply alternatives to determine if a reasonably equivalent alternative to the Marvin Nichols project is available. This study was commissioned by the TWDB in the later part of 2008. Based on available funding from the TWDB, the Study Commission divided the scope of work defined in Senate Bill 3 into two Phases. This report is a summary of activities performed in Phase II of that division of work.

Phase II of the Study Commission task took the recommendations from Phase I and focused on further data collection and analysis on Lake Wright Patman and Lake O' the Pines as equivalent alternatives to the Marvin Nichols project. Phase II is divided into eleven tasks (1.1 – 1.11) and these tasks are summarized below. Phase II also will summarize the steps needed to quantify the socioeconomic effect to the area from using this water in Region C.

TASK 1.1 Potentially Available Water From Lake Wright Patman

Certificate of Adjudication No. 03-4836 (Appendix I) lists the City of Texarkana (Texarkana) as the water right holder of 180,000 acre feet per year (afpy) of water from Lake Wright Patman. Based on the permitted water rights available to Texarkana (180,000 afpy), the total amount of unused permitted water from Lake Wright Patman can be determined by subtracting contracted water rights from the total permitted water rights. Through discussions with Texarkana and Riverbend Water Resources, as well as review of the TCEQ Water Rights database, it was determined that Texarkana has contracts for approximately 122,500 afpy of the 180,000 afpy permitted water. The remaining 57,500 afpy of un-contracted water rights could be available for contract through Texarkana (Table ES 1). The use of this 57,500 afpy would also require future contracts between Texarkana and the entities that would utilize the water. In order to obtain the total 180,000 afpy, Texarkana would need to get USACE to change their lake operating procedure.

Table ES 1. Lake Wright Patman Estimated Available Water

City of Texarkana Water Rights	Industrial	Municipal	Total
Permitted Water Rights (afpy)	135,000	45,000	180,000
Contracted Water Rights (afpy)	(120,000)	(2,500)	(122,500)
Un-contracted Water Rights (afpy)	15,000	42,500	**57,500**

TASK 1.2 Water Available From Existing Owners of Lake Wright Patman Water Rights

Espey Consultants, Inc. (EC) conducted discussions with the Texarkana, Riverbend Water Resources and International Paper Corporation (IP) to determine quantities of "unused" contracted water rights. Review of data provided by IP show the average diversion of raw water, over a 14 year period (1994–2007), to be approximately 36,828 afpy. Preliminary communications with Texarkana and IP indicate a willingness to discuss the redistribution of portions of this "unused" contracted water. It is estimated that about 60,000 afpy of water could be available from IP to redistribute to new water users (Table ES 2). Information found in Table ES 2 is defined in more detail later in this report. Again, the redistribution of the "unused" contracted water would require new contracts for the new water users.

Table ES 2. Potentially Available Unused Water from International Paper Corporation

International Paper Water Rights	afpy
Contracted Water Rights	120,000
Average Annual Diversion (1994-2007)	(36,000)
Estimated Retained Water for Unexpected Needs	(24,000)
Potentially Available Unused Water	**60,000**

TASK 1.3 Lake Wright Patman Operating Levels With Consideration for White Oak Creek Wildlife Management Area

To assist in determining a reasonable operating level, EC held meetings and discussions with Texarkana, the Texas Parks and Wildlife Department (TPWD) and the United States Army Corp of Engineers (USACE). As a result of these meetings, the EC team identified several operation levels of interest. These levels consisted of conservation pool elevations of 228.6, 230.0, 235.0, and 240.0 feet msl. To determine the amount of land inundated and impact to sensitive ecosystems, EC analyzed the latest Texas Ecological Systems Database dated November 30, 2009 as well as data provided directly by TPWD. Table ES 3 provides an estimate of Lake Wright Patman firm yield as well as acreage of land area and ecosystem type inundated if the lake were operated at elevations 230 and 240 feet msl. Contour information was not available for elevations of 228.6 or 235.0 msl.

The challenges with each of these operating levels are discussed in detail in this report. For the purposes of this summary a ranking of the difficulty of these operating levels is included in Tables ES 3 and ES 4. The difficulty of operating Lake Wright Patman at these levels is subjective and is based on current knowledge derived from information obtained as part of this report as well as discussions with the TPWD, USACE and Texarkana. The difficulty levels are based on factors such as inundation area, reallocation procedures, mitigation decisions, environmental permitting, impact to the WOCWMA, etc.

Table ES 3. Estimated Firm Yield, Land Area and Ecosystem Area Inundated

	Lake Wright Patman Operating Scenarios	
Upper Conservation Pool Operating Elevation	**230 foot (msl)**	**240 foot (msl)**
Estimated Total Firm Yield*	514,505	790,800
WOCWMA Land Inundated	521	3,596
Area - Wide Land Inundated	11,961	32,666
WOCWMA Hardwood Type Ecosystem Inundated	349	2,712
Area - Wide Hardwood Type Ecosystem Inundated	8,101	24,123
WOCWMA Wetland Type Ecosystem Inundated	0	224
Area - Wide Wetland Type Ecosystem Inundated	221	557
Implementation Difficulty	difficult	very difficult

* Estimated Yield based on flat operating curve and 215.25 lower conservation pool elevation

TASK 1.4 Expected Yield of Lake Wright Patman

Yield analysis of Lake Wright Patman was performed using the latest available TCEQ WAM input files for the Sulphur River Basin dated August 6, 2008. Table ES 4 provides firm yield estimates for lake operating scenarios up to 240 feet msl.

Table ES 4. Lake Wright Patman Firm Yield Estimates at Various Operating Elevations

Reservoir Reallocation Scenario	Upper Conservation Pool Elevation (msl)	Lower Conservation Pool Elevation (msl)	Estimated Total Firm Yield (afpy)	Implementation Difficulty
Ultimate Curve (1)	224.89 - 228.64 feet	220 feet	184,591	likely
Ultimate Flat Curve (1)	228.64 feet	215.25 feet	363,717	likely
Scenario 1 (2)	230 feet	215.25 feet	514,505	difficult
Scenerio 2 (2)	235 feet	215.25 feet	669,790	medium difficulty
Scenario 3 (2)	240 feet	215.25 feet	790,800	very difficult

(1) Freese and Nichols, System Operation Assessment of Lakes Wright Patman and Jim Chapman, 2003
(2) 2010 Espey Consultants, Inc. firm yield estimate

TASK 1.5 Additional Information Needed to Allow Consideration of Each Operating Scenario

For each of the three operating scenarios proposed (230.0, 235.0, and 240.0 msl) additional information will need to be collected and analyzed to allow consideration of these strategies as equivalent alternatives to the proposed Marvin Nichols Reservoir.

Scenario No. 1 – 230 foot Constant Operational Level of Lake Wright Patman

Communications with the USACE indicate that operating Lake Wright Patman at or above a flat conservation pool elevation of 228.64 feet would constitute a reallocation of flood storage to conservation storage exceeding 50,000 acre-feet and would require Congressional authorization[5].

Additional Information Needed:

- Information to support a reallocation plan that meets state and federal requirements;
- Sources of funding would need to be identified;
- Determine impact to WOCWMA ecosystems caused by higher operating levels and the backwater effect;
- Evaluate integrity of levee system at higher lake operating levels;
- Identify ecological benefits of higher water elevations;
- Evaluate changes to floodplain resulting from higher releases and increase in lake elevation;
- Estimate impact of shoreline erosion caused by higher lake operating level;
- Update Sulphur Basin WAM input files to include drought of 2002 – 2004;
- Predict any loss or change in sedimentation storage over the life of the needed water demand;
- Determine the impact of a lower bottom of conservation pool elevation of 215.25 feet;
- Design a flexible wetland management plan

Scenario No. 2 – 235 foot Constant Operational Level of Lake Wright Patman

In addition to the information needed for Scenario 1 to be considered an equivalent alternative to Marvin Nichols Reservoir, Scenario 2 would need the following additional information gathered:

Additional Information Needed:

- Due to the complexity and number of possible impacts caused by this scenario, a Basin Wide Study is recommended
- There is inconsistent data regarding the elevation of the lowest control structure in the WOCWMA – Verify this elevation
- Determine the feasibility of raising the elevation of the lower water control structures in the WOCWMA to minimize the impact of a 235 foot operating level

- Determine the feasibility of adding pumps to assist in the management of the WOCWMA wetlands and bottomland hardwood forest ecosystems
- Determine impact of shoreline erosion caused by a higher lake operating level
- Determine inundation of property at the modified surface water elevation;
- Collect LiDAR data of Lake Wright Patman, WOCWMA and surrounding areas to support GIS habitat/ecosystem mapping using one foot contour lines
- Determine potential for additional flood damage downstream of Lake Wright Patman

Scenario No. 3 – 240 foot Constant Operational Level of Lake Wright Patman
For Scenario 3 to be considered a reasonable alternative to Marvin Nichols Reservoir much of the same information for Scenario 1 and 2 would need to be gathered. Due to the increased operational level of Lake Wright Patman to 240 feet, Freese and Nichols (2003) estimated that approximately 3,800 acres of WOCWMA land would be inundated (approximately 15 percent of the total 25,500 WOCWMA). At this operational level approximately 33,000 acres of Lake Wright Patman area-wide habitat would be inundated. Additional detailed study would need to be conducted to determine the effect of this operational level on the groundwater table and soil saturation zone in the affected areas. An elevated groundwater table may negatively impact more acreage of hardwood forest than is represented by the contour line at a 240 foot elevation. The higher costs for environmental and cultural resource investigation would need to be determined as well as the need to determine mitigation for losses at Atlanta State Park.

Additional Alternatives
In 2003, Freese and Nichols estimated that an additional 108,000 afpy could be made available to Lake Wright Patman by system operation of Lakes Wright Patman and Jim Chapman. Further study would need to be conducted to determine the impact of raising the upper conservation pool elevation of Lake Wright Patman above 228.64 feet and its affect on system operations of these two reservoirs.

Other issues that could also effect the selection of operation scenarios include possible restrictions of moving water from one reservoir to another. These restrictions could be based on invasive vegetation or animals that are found in the source reservoir and should not be transferred into the receiving reservoir. Storage volumes in Lake Wright Patman are owned by a water provider. Any increased yield could potentially only benefit those owners.

TASK 1.6 Cost Estimate for Wright Patman Conveyance

The costs to increase storage in Lake Wright Patman and construct a conveyance system to water suppliers in Region C were estimated using cost estimation procedures documented in the 2011 Initially Prepared Water Plan for Region C and Table Q-29 of the 2011 IPP as a template for unit cost calculations. Cost elements associated with increasing storage and reallocation of flood storage were based on limited information available from USACE. More definitive cost data for these elements will be available after completion of the Sulphur River Basin Feasibility Study proposed by USACE.

Cost estimates in 2008 dollars for Phase 1 and 2 pipelines from Lake Wright Patman to the Region C area are summarized in Table ES 5. A comparison of project costs for Lake Wright Patman and Marvin Nichols Reservoir are presented in Table ES 6. Costs for Marvin Nichols were obtained from the 2011 IPP for Region C. The cost analysis for Lake Wright Patman contained more detail in route location, pumping elevation, pump design and cost, pipeline routing in the Region C area (reservoir to reservoir), etc. Additional cost detail should be added to the Marvin Nichols estimate to ensure the comparability of the cost estimates. At the time of this report the additional details for the cost estimates of Marvin Nichols were not available.

Table ES 5. Cost Estimate to Convey Water From Lake Wright Patman to Region C

Operating Elevation Scenario	**230 feet**	**235 feet**	**240 feet**
Water Volume (afpy)	**500,005**	**655,290**	**776,300**
Phase 1 Costs			
Raw Water Improvements	$159,778,000	$305,777,000	$460,275,000
Phase 1 Pipeline	$1,504,135,000	$1,637,049,000	$1,878,374,000
Phase 1 Pump Station	$284,225,000	$314,886,000	$347,775,000
Sub Total Phase 1 Construction Costs	**$1,948,138,000**	**$2,257,712,000**	**$2,686,424,000**
Phase 2 Costs			
Phase 2 Pipeline	$1,381,912,000	$1,621,453,000	$1,861,866,000
Phase 2 Pump Station	$210,245,000	$307,076,000	$339,965,000
Sub Total Phase 2 Construction Costs	**$1,592,157,000**	**$1,928,529,000**	**$2,201,831,000**
Total Construction Costs	**$3,540,295,000**	**$4,186,241,000**	**$4,888,255,000**
Phase 1 Permitting and Mitigation	**$35,403,000**	**$41,862,000**	**$48,883,000**
Phase 1 Interest	$237,030,000	$274,696,000	$326,857,000
Phase 2 Interest	$193,718,000	$234,644,000	$267,897,000
Total Interest	**$430,592,000**	**$509,340,000**	**$594,754,000**
Phase 1 Costs	$2,220,571,000	$2,574,270,000	$3,062,164,000
Phase 2 Costs	$1,785,875,000	$2,163,173,000	$2,469,728,000
Total Project Costs	**$4,006,446,000**	**$4,737,443,000**	**$5,531,892,000**
Phase 1 Annual Costs			
Operation & Maintenance	$22,147,000	$24,243,000	$27,478,000
Electricity ($0.09/kWh)	$56,358,000	$67,667,000	$76,811,000
Debt Service 6% for 30 years	$161,322,000	$190,306,000	$222,463,000
Raw Water Purchase (100,000 afpy Texarkana)	$10,101,000	$10,101,000	$10,101,000
Total Annual Cost Phase 1	**$249,928,000**	**$292,317,000**	**$336,853,000**
Phase 2 Annual Costs			
Operation & Maintenance	$19,075,000	$23,891,000	$27,118,000
Electricity ($0.09/kWh)	$43,631,000	$67,667,000	$75,990,000
Debt Service 6% for 30 years	$129,742,000	$157,152,000	$179,423,000
Total Annual Cost Phase 2	**$192,448,000**	**$248,710,000**	**$282,531,000**
Unit Costs (until amortized)			
per Acre-foot Phase 1	$1,000	$882	$868
per Acre-foot Phase 2	$770	$759	$728
per Acre-foot Total	$885	$821	$798
Unit Costs (after amortization)			
per Acre-foot Phase 1	$354	$311	$295
per Acre-foot Phase 2	$251	$279	$266
per Acre-foot Total	$303	$295	$280

These estimates are based on the scenario to develop 390,000 afpy from Lake Wright Patman presented as Table Q-29 in the 2011 Initially Prepared Water Plan for Region C and revised with information provided by the Fort Worth District of USACE. Additional details are provided in Section 1.6 of this report.

Table ES 6. Comparison of Cost Estimates to Convey Water From Lake Wright Patman and Marvin Nichols Reservoir to Region C

Water Supply Project	Lake Wright Patman			Marvin Nichols I[1]
Operating Elevation Scenario	230 feet	235 feet	240 feet	Reservoir and Transmission System
Water Volume (afpy)	**500,005**	**655,290**	**776,300**	**495,300**
Total Project Costs	$4,006,446,000	$4,737,443,000	$5,531,892,000	$3,300,565,000
Cost per Acre-foot (until amortized)	$885	$821	$798	$677
Cost per Acre-foot (after amortization)	$303	$295	$280	$187
[1]From Table Q-20, 2011 Initially Prepared Water Plan for Region C.				

TASK 1.7 Volume of Available Water from Lake O' the Pines

Permitted Versus Contracted Water Rights

The 2011 Region D Initially Prepared Water Plan (IPP) [1] for TWDB lists water supply from LOP to be 182,000 afpy through 2060. The IPP lists the projected water demand through existing contracts of NETMWD to be 148,000 afpy. The difference between this available supply and the contracted demand is estimated at 34,000 afpy (Table ES 7). The use of this 34,000 afpy would also require future contracts between NETMWD and the entities that would utilize the water.

Table ES 7. Lake O' the Pines Water Supply, Contracted Demand and Un-contracted Water

Supply and Demand	Water (afpy)	Estimated Water Available (afpy)
Available Water Supply *	182,000	
NETMWD Contracted Water Demand *	(148,000)	
Estimated Un-Contracted Permitted Water		**34,000**

* Region D Initially Prepared Water Plan. March 2010

Redistribution of Existing Water Rights

In addition to un-contracted water rights, it may be possible to purchase a portion of unused water from the current users and owners of these water rights. EC had discussions with NETMWD and determined an estimate for the unused portion of the existing contracts. The amounts of unused water that could be redistributed to other entities are summarized in Table ES 3. The NETMWD estimates the volume of available water in Lake O' the Pines to be approximately 100,000 afpy (See Table ES 8).

Table ES 8. Lake O' The Pines Estimated Available Water

Owner / Water Contract Holder	Estimated Available Water* (afpy)
NETMWD Uncontracted Water	34,000
US Steel Corporation	31,000
NETMWD Member Cities	36,000
Total Estimated Available Water	**101,000**

* Estimated water availability data provided by the NETMWD

TASK 1.8 Lake O' the Pines Water Right Holder Considerations, Needs, Surplus and Drought Protection

Water demand data listed in the Region D 2011 IPP[1], as well as discussions with the NETMWD regarding unused water from US Steel Corporation and the Member Cities, indicate that NETMWD's estimate of available water (100,000 afpy) takes into consideration anticipated and unanticipated local needs, existing water right holders, releases for Caddo Lake, and retained local surplus for drought protection.

TASK 1.9 Lake O' the Pines Cost Estimate

Cost estimate data for Lake O' the Pines conveyance to Region C area is summarized in Table ES 9.

Table ES 9. Cost Estimate to Convey Water from Lake O' the Pines to Region C

Water Destination	DWU East Side WTP[1]	NTMWD Leonard New WTP[2]	TRWD Rolling Hills WTP[3]
Water Volume (afpy)	**101,000**	**101,000**	**101,000**
CONSTRUCTION COSTS			
Pipeline	$458,818,000	$382,577,000	$604,893,000
Pump Station	$81,556,000	$71,844,000	$119,834,000
Sub Total Construction Costs	**$540,374,000**	**$454,421,000**	**$724,727,000**
Sub Total Permitting and Mitigation	**$5,404,000**	**$4,544,000**	**$7,247,000**
Interest during construction (24 months)	**$44,132,000**	**$37,113,000**	**$88,178,000**
Total Project Costs	**$589,910,000**	**$496,078,000**	**$820,152,000**
ANNUAL COSTS			
Operation & Maintenance	$6,627,000	$5,622,000	$9,045,000
Electricity ($0.09/kWh)	$13,623,000	$10,788,000	$20,588,000
Debt Service 6% for 30 years	$42,856,000	$36,040,000	$59,583,000
Raw Water Purchase	$9,873,000	$9,873,000	$9,873,000
Total Annual Cost	**$72,979,000**	**$62,323,000**	**$99,089,000**
Unit Costs (until amortized)			
per Acre-foot	$723	$617	$981
Unit Costs (after amortization)			
per Acre-foot	$298	$260	$391

[1]Based on the scenario to develop 89,600 afpy from Lake O' the Pines presented as Table Q-30 in the 2011 Initially Prepared Water Plan for Region C.

[2]Based on the scenario to develop 87,900 afpy from Lake O' the Pines presented as Table Q-31 in the 2011 Initially Prepared Water Plan for Region C.

[3]Based on the scenario to develop 87,900 afpy from Lake O' the Pines presented as Table Q-32 in the 2011 Initially Prepared Water Plan for Region C.

TASK 1.10 Reallocation of Flood Storage Over the Elevation of 228.5 msl

Firm Yield of Lake O' the Pines was modeled using the TCEQ Run 3 (Full Authorization) input files dated January 13, 2010. Firm yield modeling results and conservation storage data for several conservation pool elevations are provided in Table ES 10. Additional firm yield may be available to users based on new water rights and contracts.

Table ES 10. Lake O' the Pines Firm Yield Estimates at Various Operating Levels

Upper Conservation Pool Elevation (msl)	Estimated Total Firm Yield (afpy)	Conservation Storage (afpy)
228.5	153,500	251,000
231	167,000	301,000
235	187,600	392,000

* Conservation storage based on 1958 survey, USACE New Orleans District

TASK 1.11 Lake O' the Pines Reservoir Reallocation Process and Congressional Approval

Congressional Approval

Per the Water Supply Act of 1958, changes in existing allocated storage capacities greater than approximately 50,000 ac-ft or 15 percent of the total storage capacity allocated to all authorized project purposes would result in the need for Congressional approval. Based on data obtained from the original 1958 area/capacity survey of Lake O' the Pines, it is concluded that an increase in the upper conservation pool elevation above approximately 230.5 feet msl would result in a change in storage capacity greater than 50,000 ac-ft which would trigger the Congressional approval requirement.

USACE Reservoir Reallocation Process

When reallocation of a USACE reservoir is desired, numerous federal and state requirements must be met. USACE Official Headquarters guidance on reallocations can be found in engineering regulation ER 1105-2-100 (Planning Guidance Notebook). Periodic Engineering Circulars and Policy Guidance Memorandums can also be issued on this procedure.

There are significant amounts of information still needed for the reallocation process for Lake Wright Patman and Lake O' the Pines. Some of these include mitigation impacts, mitigation ratios, detailed supply analysis, additional cost analysis, economic impacts, conservation pool elevation, cultural resource evaluation, etc. The Sulphur Basin study proposed by the USACE should be performed to assist in developing these and other analyze.

Socioeconomic Impact

Given the variations in water supply alternatives and the varying degrees of economic impact that can be experienced, it is important that when quantifying the anticipated economic impact, each alternative must be studied carefully to determine the total net impact on landowners, agricultural and natural resources, businesses and industries, and taxing entities. It is also important to recognize that some impacts cannot be as easily quantified. The inability to quantify an impact does not decrease its importance – these impacts must also be identified and qualitatively evaluated in order to understand the total impact of a water supply alternative. The steps needed to quantify these impacts are defined in this report.

Conclusion

Additional water is available from Lake Wright Patman and Lake O' the Pines. The amount of water available varies depending on the strategy implemented. There is water available from both reservoirs from existing un-contracted water rights, "unused" contracted water rights, and firm yield created from reallocation of USACE storage. The implication of each of these scenarios is defined in this report. There are still many issues that will need to be addressed if these alternatives are to be developed. Most of these issues can be addressed if the basin-wide study of the Sulphur River Basin is performed. Therefore, it is recommended that the basin-wide study be initiated to obtain the data needed to allow these projects to be evaluated fully.

1.0 PHASE I - INTRODUCTION

The Study Commission on Region C Water Supply (Study Commission) was established by Senate Bill 3, Section 4.04, of the 80th Texas Legislative Session. Section 4.04 (e) charged the Study Commission with eight tasks regarding water supply alternatives available to the Region C Regional Water Planning Area. In summary, these tasks included:

1. Review the water supply alternatives available to the Region C Regional Water Planning Area;
2. Analyze the socioeconomic effect on the area where the water supply is located that would result from the use of the water to meet the water needs of the Region C Regional Water Planning Area;
3. Determine whether water demand in the Region C Regional Water Planning Area may be reduced through additional conservation and reuse measures;
4. Evaluate measures that would need to be taken to comply with the mitigation requirements of the USACE in connection with any proposed new reservoirs;
5. Consider whether the mitigation burden may be shared by the Regions C and D Regional Water Planning Areas in proportion to the allocation to each region of water in any proposed reservoir;
6. Review innovative methods of compensation to affected property owners;
7. Evaluate the minimum number of surface acres required for the construction of proposed reservoirs; and
8. Identify the locations of proposed reservoir sites and proposed mitigation sites, as applicable, as selected in accordance with existing state and federal law, in the Regions C and D Regional Water Planning Areas.

Senate Bill 3 requires the Study Commission to perform these eight tasks. The objective of the Study Commission is to evaluate water supply alternatives to determine if a reasonably equivalent alternative to the Marvin Nichols project is available. This study was commissioned by the Study Commission in the later part of 2008. Based on available funding from the TWDB, the Study Commission divided the scope of work defined in Senate Bill 3 into two Phases.

Phase I of the proposed scope was further divided into two tasks. The scope of Task 1 was defined to include a collection of existing data (from 1985 to present, with some historical data collected from prior years), a literature review of that data, and a data gap analysis for five water management alternatives selected based on size and location of the projects. The five alternatives were the proposed Marvin Nichols Reservoir Site IA and existing Lake Wright Patman, Toledo Bend Reservoir, Lake Texoma, and Lake O' the Pines. The data gap analysis was performed to identify areas in each of the five water supply alternatives that would need to have additional clarification, analysis or evaluation.

Task 2 of Phase I was defined to include a review of existing socioeconomic studies of the five alternatives to identify discrepancies and/or data gaps. The development of the methodology for the socioeconomic impact evaluation (if different than the existing work) was also to be created. The methodology was then to be utilized to perform a socioeconomic evaluation of one of the five alternatives. Toledo Bend Reservoir was selected as the water supply alternative for the example of the socioeconomic impacts to the area where the water supply is located.

This report is a summary of activities performed in Phase I of that division of work. Phase II of the scope of work will be completed pending additional funding approval from the TWDB, and is not included in this report.

1.1 TASK 1 LITERATURE REVIEW AND DATA GAP ANALYSIS

Over 200 reports were collected and reviewed as part of the literature review. Each document collected was incorporated into a comprehensive list detailing each study, including a synopsis of each study, title, date of study, sponsor, author, type (technical vs. planning), subject (specific facility vs. water user water plan), and relevant information to the focus of this project. A summary was created in the form of a spreadsheet matrix (Appendix A) and a literature review summary page was established (Appendix B) for each reference. The list of documents in Appendix A are inclusive of all the documents collected as part of the literature review. Data collection and storage for this project is described in Appendix H. Finally, contacts the Project Team had with any of the agencies or individuals are provided in Appendix C.

Once the documents were reviewed a data gap analysis was performed to determine if pertinent information for each of the five selected water management alternatives was missing. The data gap analysis was divided into two categories: planning and permitting/design. The planning data gaps are those gaps that were identified that needed to be addressed in the planning context of the water alternatives (mitigation issues, conservation, etc.). The permitting/design data gaps were those gaps that were identified that needed to be performed at some point in the project but not necessarily immediately. Examples of permitting/design data gaps would be if an EIS needs to be performed prior to building a pipeline or congressional approval needs to be obtained to reallocate flood storage.

Section 2 of this report gives a brief summary of the literature review performed for each of the five reservoirs identified by the Study Commission in Phase I of the scope of work.

1.2 TASK 2 SOCIOECONOMIC EVALUATION

The project team collected relevant reports related to the socioeconomic evaluation of the five selected alternatives. Once the literature was reviewed, a data gap analysis was to be performed. The goal of the data gap analysis was to provide guidance to the Study Commission on the perceived strengths and/or weaknesses of the methodologies and/or results of the previously conducted socioeconomic studies. A further goal of the data gap analysis was to identify areas that might require additional clarification, analysis, or evaluation so as to produce a useful measure of the socioeconomic impact on the basin of origin of each identified water supply alternative. Upon review of the data gap analysis by the Study Commission, it is the Project Team's intent to seek guidance from the Study Commission on the methodologies and/or techniques to be employed in socioeconomic impact analysis at the appropriate time in the future.

2.0 LITERATURE REVIEW SUMMARY

2.1 MARVIN NICHOLS RESERVOIR

A literature review was performed for the proposed Marvin Nichols Reservoir as part of Task 1 of this study. The literature review covers documents, studies, and reports related to Marvin Nichols Reservoir since 1985. A total of 23 relevant references were collected, reviewed, and summarized.

References include reviewed documents, along with contacts with a number of municipal, state and federal agencies, authorities, utilities, universities and interest groups. In addition to the document review, five agencies or utilities were contacted or visited to request additional information on Marvin Nichols Reservoir. Additional information from a Region D public meeting was obtained and reviewed, as well. The majority of the studies and reports that were available for Marvin Nichols Reservoir focus primarily on water demands and firm yield from the reservoir, ecological and environmental impacts.

2.1.1 Overview – Marvin Nichols Reservoir Site IA

The proposed Marvin Nichols Reservoir Site IA is located in northeast Texas on the Sulphur River in Red River and Titus counties, Texas. In the 2006 Region C Water Plan and the 2007 State Water Plan the Marvin Nichols Reservoir Site IA is recommended as a water management strategy for the North Texas Municipal Water District, Tarrant Regional Water District, and the Upper Trinity Regional Water District. The 2001 and the 2006 Region C Water Plans both recommend Marvin Nichols Reservoir Site IA as a unique reservoir site.[253]

The proposed Marvin Nichols Reservoir Site IA has a conservation pool elevation of 328 feet and a conservation capacity of 1,562,669 acre-feet. A summary table for reservoir area and related capacity for the proposed Marvin Nichols Reservoir Site IA is provided in Table 2.1.[253] The Marvin Nichols Reservoir Site IA reservoir has a total drainage area of 1,889 square miles. At conservation pool elevation, the reservoir will inundate an approximate total of 67,392 acres.[253]

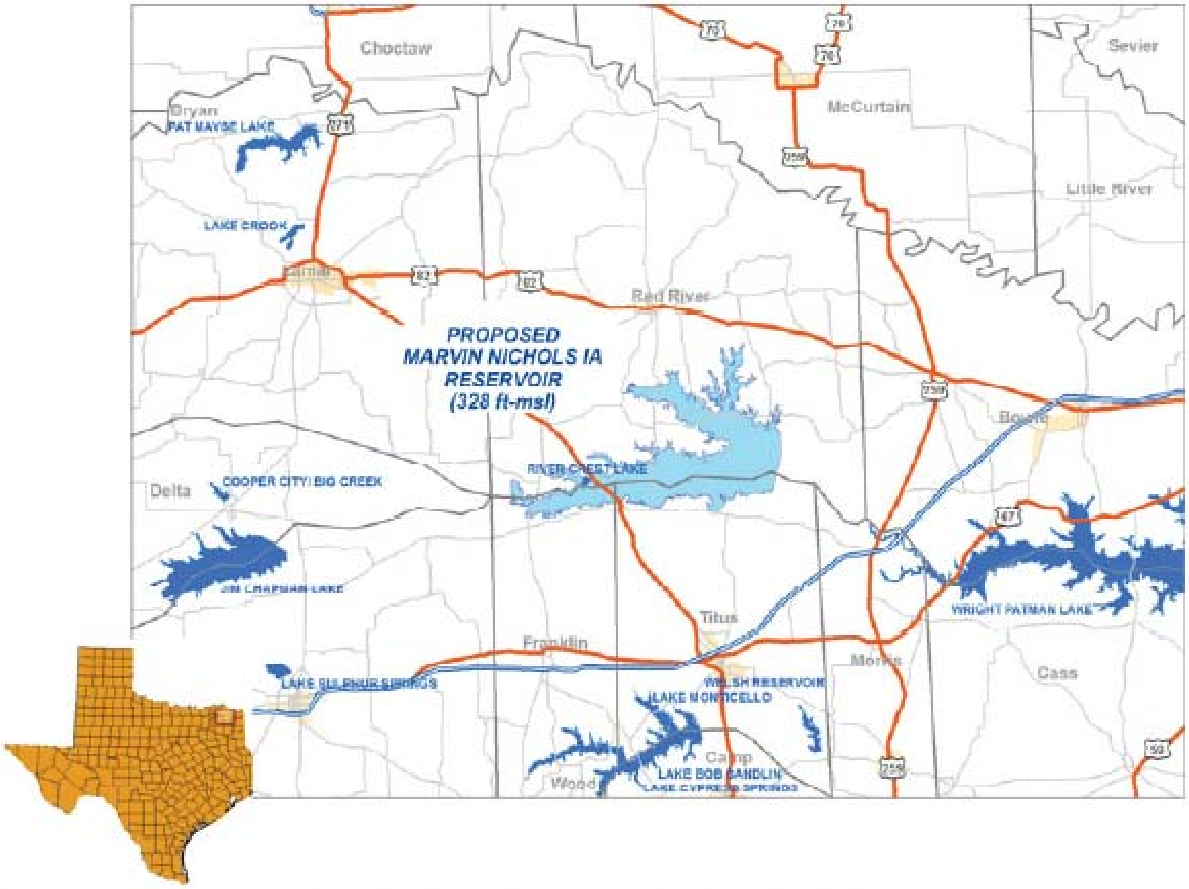

Figure 2.1 Marvin Nichols Reservoir Location Map

Table 2.1 Area Capacity Data for Marvin Nichols 1A Reservoir Site.

Elevation (ft-msl)	Area (acres)	Capacity (ac-ft)
260	0	0
265	96	235
270	192	954
275	3,435	9,944
280	6,678	35,207
285	10,690	78,612
290	14,703	142,084
295	20,072	229,008
300	25,441	342,780
305	30,778	483,319
310	36,114	650,543
315	43,726	850,130
320	41,337	1,087,776
325	61,372	1,369,531
328	67,392	1,562,669
330	71,406	1,701,463

2.1.2 Available Water Supply

Estimates for the firm yield of the Marvin Nichols Reservoir Site IA range from 602,000 to 624,000 afpy.[34, 37, 249, 116, 253] The firm yield numbers, however, will be lower if other proposed reservoirs (Parkhouse I, Parkhouse II, and / or Ralph Hall) recommended for protection in the 2007 State Water Plan are constructed within the Sulphur River Basin. Marvin Nichols Reservoir Site IA is reported to provide firm raw water for approximately a cost of $510 million. The cost translates to $61 per acre-foot ($0.19 per 1,000 gallons) during the debt service period to water providers in the Dallas-Fort Worth area in the Region C water planning area (2005 cost figures).[253] One of the benefits to Marvin Nichols Reservoir Site IA is that the water supply is a permanent source with a water right from the TCEQ and not a contract or lease for the water supply.

The 2006 Region C Water Plan[37] has listed Marvin Nichols reservoir as a recommended water management strategy for Region C wholesale providers - TRWD, NTMWD, and UTRWD. Marvin Nichols is listed as an alternative supply for DWU and the City of Irving.

Water allocation to the Region C wholesale providers from Marvin Nichols Reservoir is as follows:

Wholesale Provider	Water Allocation (afpy)[37]
TRWD	280,000
NTMWD	174,840
UTRWD	35,000
Total	**489,840**

Discussions between the reservoir sponsors have proposed that approximately 80% of the total yield, or 489,840 afpy, could be allocated to Region C and the remaining 20% of Marvin Nichols water could be reserved for local demands.

2.1.3 Ecological and Environmental Impacts

With the construction of Marvin Nichols Reservoir Site IA, the inundated area,[37] wildlife disturbed, and bottomland and upland hardwood forests affected[227, 229] have been studied and documented. Projected mitigation areas for Marvin Nichols have varied widely based on alternate project locations and study. The specific projected mitigation area required due to construction of Marvin Nichols Reservoir Site IA will need to be determined. The USACE will have the final determination of the mitigation area needed for the construction of Marvin Nichols Reservoir Site IA.

A brief description of the mitigation process is provided in this section and is applicable in all areas of this report that discuss mitigation. The intent of mitigation (Federal Clean Water Act) is to achieve the federal goal of "no net loss of wetlands." The determination of what exactly must be mitigated and how it must be mitigated is established during the permitting stage of a project. For planning purposes, it is possible to anticipate some of the mitigation requirements by reviewing the current laws involving mitigation and making reasonable inferences about the application of these laws to possible projects. It should be noted that current mitigation laws demonstrate a preference for mitigation banking, and it is possible for the mitigation areas to be outside of the basin where the impacts are located. It is also possible for the mitigation areas to be out of kind in relation to the impact that is being mitigated. Since the application of the mitigation laws have been adjusted in the last five years and the application of the mitigation laws using the current guidance is relatively new, it is not possible to determine with certainty the exact location or type of mitigation for any project until the decisions are made for that particular project. It should be noted that general assumptions about mitigation requirements have changed in the last five years and caution should be exercised when attempting to use assumptions that now may not be appropriate with the current guidance on the application of the mitigation laws. The most appropriate sources for guidance on application of the mitigation laws are the federal sources.

Additional environmental impacts include forestland in the inundation area. The USFWS has classified the majority of the reservoir inundation area as Priority 1 bottomland hardwoods. The USFWS considers Priority 1 bottomlands to be "…excellent quality bottomlands of high value to key waterfowl species" (USFWS, 1985 taken from TWDB, 2008:100). The Marvin Nichols Reservoir Site IA will affect these bottomlands areas through inundation. The TPWD has summarized the existing land cover for the acreage that will be inundated by the proposed reservoir.[253] A large continuous bottomland hardwood forest (39 percent) covers the majority of the proposed Marvin Nichols Reservoir Site IA area. Upland forest and grasslands cover approximately 20 percent each of the reservoir area, while marsh swamp, and open water total approximately 13 percent coverage and scrubland and agricultural land are approximately eight percent.[253]

According to the Texas Parks and Wildlife (1999) the Marvin Nichols Reservoir Site IA not located on an ecologically significant stream segment; however, the reservoir is located approximately 29 miles upstream of a section of the Sulphur River, Morris County, Texas, that is considered an ecologically significant stream. Ecological significance for the stream segment is "…based on biological function associated with bottomland hardwood forests and the presence of paddlefish, which is a state-listed threatened species."[253] Geological evidence of lignite deposits (brown coal) have been identified within the vicinity of the proposed reservoir site, however, there are presently no lignite mining areas within the proposed reservoir area.[253] Additionally, gas wells and other oil and gas operations, archeological areas, and cemeteries located within the Marvin Nichols Reservoir Site IA and will have to be evaluated and addressed. Water quality data for the Sulphur River Basin has been documented in the Region C 2001 Water Plan[39] which was collected in October 1979 through July 1987.

2.1.4 Socioeconomic Evaluations

For the Marvin Nichols Reservoir, two studies have been conducted specific to the reservoir and its potential impact, while a third study provides comment on these two studies. The first study, conducted by Weihaun Xu[226] of the Texas Forest Service focuses on the impact the reservoir will have on the local timber industry. The second study, conducted by Dr. Bernard Weinstein and Dr. Terry Clower[234] of the University of North Texas takes a broader look at the total economic impact of the water supply alternative. The third study, conducted by Dr. Ray Perryman, reviews and provides comment on the work of Xu and Weinstein and Clower.

It should be noted that the above studies, conducted in 2002 and 2003, were performed prior to a final decision on the location of the Marvin Nichols dam site. As such, the studies may not contain the most up-to-date assumptions and analysis regarding the impact of the reservoir (Appendix E). Further analysis of these studies in contained in Appendix E, while further discussion of the socioeconomic data gaps related to the Marvin Nichols reservoir are discussed in Section 4.3.1 of this report.

2.1.5 Summary

- Marvin Nichols Reservoir Site IA is a recommended water management strategy in the 2006 Region C Water Plan.
- Firm yield estimates for Marvin Nichols Reservoir Site IA range from 602,000 to 624,000 afpy.

- Construction and inundation of the Marvin Nichols Reservoir Site IA will potentially impact local communities, wildlife, forestland, oil and gas operations, access to lignite deposits, archeological sites, cemeteries, and potentially local groundwater aquifers.
- Two socioeconomic studies have been performed associated with Marvin Nichols Reservoir locations.

2.2 LAKE WRIGHT PATMAN

A total of 29 relevant references were collected, reviewed, and summarized related to Lake Wright Patman. The most significant documents that provided the basis for information about Lake Wright Patman were: (1) 2006 Region C Water Plan,[37] prepared for the Region C Water Planning Group, and (2) "System Operation Assessment of Lake Wright Patman and Lake Jim Chapman,"[65] prepared for the USACE.

In addition to the document review, agencies and/or utilities were contacted to request additional information on Lake Wright Patman.

2.2.1 Overview – Lake Wright Patman[233]

The original project was authorized as Texarkana Dam and Reservoir under the comprehensive project, "Red River, Texas Oklahoma, Arkansas, and Louisiana, below Denison Dam, Texas and Oklahoma" by the Flood Contract Act of 1946 (Public Law 526, 79th Congress, 2nd Session). It was later known as Lake Texarkana and on December 15, 1973, President Nixon signed H.R. 945, officially designating the project, "Wright Patman Dam and Lake," in honor of Congressman Patman of the First Congressional District of Texas.

Flood control is part of the Lake Wright Patman comprehensive plan on the Red River below Denison, Texas. The drainage area of 3,400 square miles above the dam site is approximately 91 percent of the drainage area of the Sulphur River above the Red River and approximately 12 percent of the drainage area below Denison Dam, excluding the Ouchita-Black River Basin.

Construction commenced on August 20, 1948, with clearing of the dam site and impoundment began in 1953. The reservoir was operated as a temporary detention basin until June 27, 1956, at which time the gates were closed and intentional impoundment was started. Lake Wright Patman operations were transferred from the New Orleans District to the Fort Worth District on September 1, 1979.

The Lake Wright Patman Dam is located at river mile 44.5 on the Sulphur River approximately nine miles southwest of Texarkana, Texas. The Dam is located in Bowie and Cass Counties and the lake extends throughout portions of Bowie, Cass, Morris, Titus, and Red River Counties. The location map for Lake Wright Patman is shown in Figure 2.2.

Lake Wright Patman is a multi-purpose lake utilized for flood control, water supply and recreation. Table 2.2 provides the area/capacity calculations for Lake Wright Patman and its stage elevations are demonstrated in Figure 2.3. The table relates lake elevation to amount of acres and capacity of the reservoir at each of those elevations.

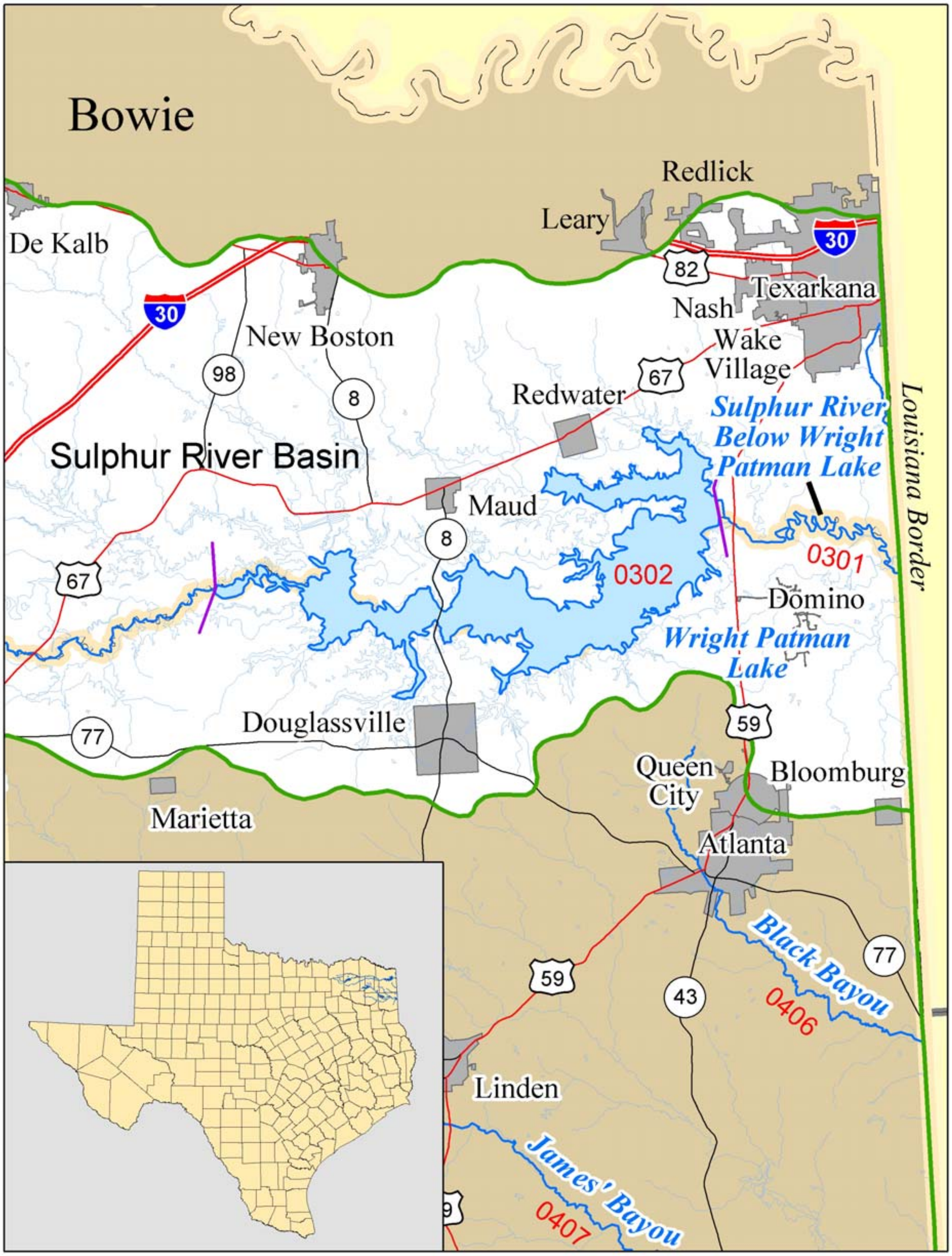

Figure 2.2 Lake Wright Patman (228.64' msl) Location Map

Table 2.2 Area Capacity Data for Lake Wright Patman.[65]

Elevation (Ft-MSL)	Capacity (Ac-Ft)	Area (Acres)
195	1	1
200	47	27
205	550	243
210	7,204	3,157
215	38,095	9,834
220	110,900	18,994
225	231,540	28,297
230	395,420	38,600
235	614,120	49,200
240	887,570	60,500
245	1,222,320	73,600
250	1,626,170	88,100
255	2,107,070	104,500
260	2,671,970	121,300
265	3,325,620	140,600
270	4,080,270	161,300
275	4,940,770	182,900
280	5,912,020	205,800
285	6,999,420	229,600
290	8,204,420	252,400

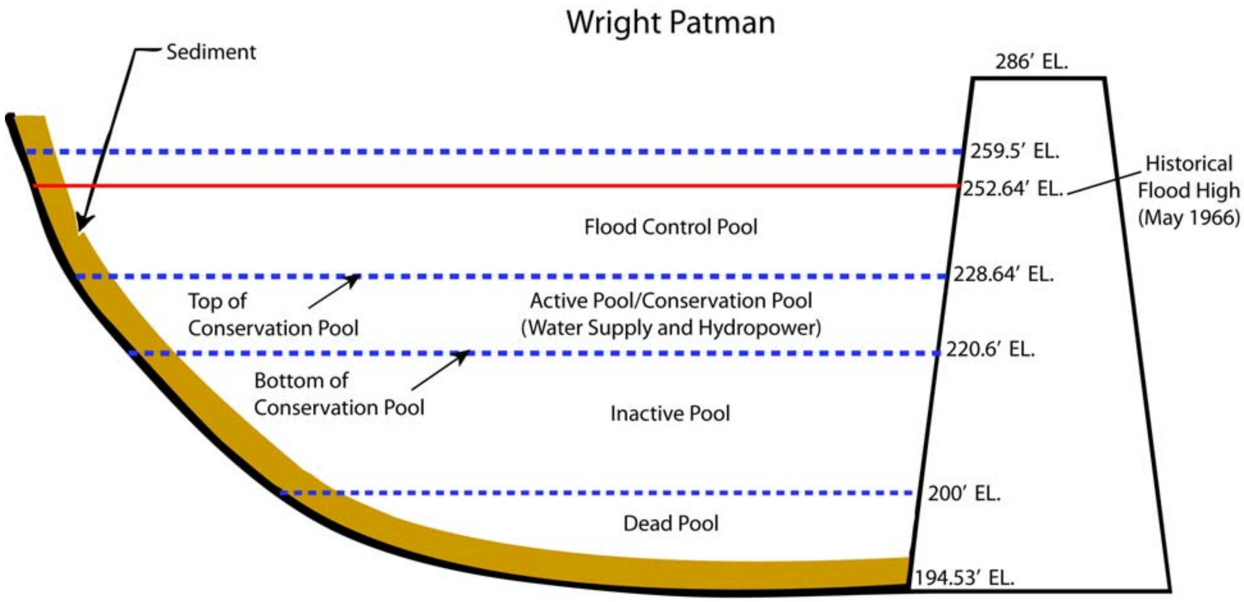

Figure 2.3 Lake Wright Patman Elevations

2.2.2 Available Water Supply

Lake Wright Patman is operated by the USACE. The current existing yield of Lake Wright Patman is approximately 8,974 afpy as it is currently operated[65]. The current operation of the reservoir is dictated by the interim operating rule curve. Additional yield is available from Lake Wright Patman when operations are changed to the ultimate curve. A discussion of these operating rule curves is provided in Appendix H.

The 2006 Region C Water Plan identifies three strategies for Lake Wright Patman as alternatives to make water available to Region C.[37] The strategies include:

1. Voluntary Redistribution of Water Resources from Lake Wright Patman – Purchase water from City of Texarkana (Texarkana) under its existing water right.

Table 2.3 City of Texarkana Water Rights[65]

	Industrial	Municipal	Total
Total Water Right (afpy)	135,000	45,000	180,000
Contracted (afpy)	120,000	2,500	122,500
Remaining for Contract (afpy)	15,000	42,500	57,500

Texarkana currently has a contract with IP for 120,000 afpy of the industrial water and other contracts with local communities for 2,500 afpy of the municipal water rights.[110] The remaining amount of water that the City has to contract is 57,500 afpy. The full use of the water right would require the activation of the contract between Texarkana and the USACE for additional conservation storage in Lake Wright Patman.[65] The activation of the contract would also trigger the additional payment of the debt service from Texarkana to USACE.

2. Reallocation of Reservoir Storage – Convert flood storage to water supply and make the increased yield available to Region C. Additional firm yield modeling scenarios were performed as part of a study for the USACE, "System Operation Assessment of Lake Wright Patman and Lake Jim Chapman."[65] The study provided estimates of the additional yield available through reallocation. In the study, the additional firm yield was estimated to be 180,000 afpy at the elevation of 228.64 msl. A detailed description of the yield estimates from the study is found in Appendix H.

3. Reservoir System Operation – Operate Lake Wright Patman as a system with Jim Chapman Lake to further increase yield and make it available to Region C. The "System Operation Assessment of Lake Wright Patman and Lake Jim Chapman"[65] report also estimated additional yield from operating Lake Wright Patman and Jim Chapman as a system. Water storage holders for Lake Jim Chapman include City of Irving, NTMWD, Sulphur River Municipal Water District, and the TWDB. Water right holders for Lake Jim Chapman are the Sulphur River Municipal Water District, North Texas Municipal Water District, and the City of Irving.[65] The additional yield was estimated to be 108,000 afpy (Appendix H).

2.2.3 Ecological and Environmental Impacts

Since this water management alternative is an existing reservoir the impacts will be based on raising the conservation pool elevation and inundating that area. The White Oak Creek Wildlife Management Area (WOCWMA) was created on White Oak Creek in the flood pool of Lake Wright Patman as mitigation for

Jim Chapman reservoir. The TPWD acknowledges that the WOCWMA will be impacted as the conservation pool on Lake Wright Patman is increased. An increase in conservation pool elevation over 230 ft would begin to inhibit the ability to properly drain and manage the wetlands.[269] If lake elevations go above 230 ft, environmental and ecological impacts will have to be evaluated for the WOCWMA.

Additional ecological and environmental impacts would be associated with pipeline construction.

2.2.4 Socioeconomic Evaluations

During the course of the literature review, the Project Team was unable to locate any socioeconomic impact studies conducted related to water supply alternatives from Lake Wright Patman.

2.2.5 Summary

- Based on the current operation of Lake Wright Patman, the yield is approximately 410 afpy.
- Full use of existing Texarkana's water rights would require activation of the storage contract with the USACE and trigger debt service payment.
- The White Oak Creek Wildlife Management Area (WOCWMA) can tolerate a constant pool up to 230 feet; above that level will require additional study, evaluation and negotiation.
- Additional supply could be provided by Texarkana under existing water rights.
- Reallocation of flood storage to water supply could increase the yield of Lake Wright Patman by 180,000afpy. This would require Congressional authorization.
- System operations with Jim Chapman could yield an additional 108,000 afpy. However, consideration will need to be given to impacts on existing water rights holders in Him Chapman Reservoir. The use of Jim Chapman in a system operations context would also require additional environmental studies.

2.3 LAKE TEXOMA

A literature review was performed for documents, studies, and reports related to Lake Texoma dating back to the year 1985. In total, 37 relevant documents were collected, reviewed, and summarized. In addition to the document review, 11 agencies or utilities were contacted or visited requesting additional information on Lake Texoma. The three most important documents on available Lake Texoma water supply include the 2006 Region C Water Plan,[37] the United States Army Corps of Engineers (USACE) Final Environmental Assessment of Lake Texoma and Storage Reallocation Study from May 2006,[186] and the USACE Volumetric Survey of Lake Texoma from April 2003.[176] Appendix C contains a correspondence log for agency and utility contact.

2.3.1 Overview – Lake Texoma

Construction of Denison Dam and Lake Texoma was completed in 1944. Lake Texoma is located on the Red River five miles north of Denison, Texas as shown in Figure 2.4. Lake Texoma is located in Texas and Oklahoma and inundates parts of Grayson and Cooke Counties in Texas and parts of Marshall, Love, and Bryan Counties in Oklahoma. Lake Texoma provides for flood control, water supply, hydroelectric power, and recreation purposes. Denison Dam and appurtenant structures are owned by the U.S. Government and operated by the USACE.[41]

Lake Texoma is the 12th largest lake by volume in the United States, with a current flood storage capacity of 2,544,830 acre-feet, and current conservation storage capacity of 1,467,283 acre-feet. The current conservation storage includes 1,017,283 ac-ft for hydropower and 450,000 ac-ft for water supply. The current water supply storage includes 150,000 ac-ft for Oklahoma and 300,000 acre-feet for Texas. The benefit to Lake Texoma water supply is that the supply is a permanent water right and not a contract or lease.

Dissolved solids in the Red River and Lake Texoma are generally high. The lower water quality in Lake Texoma requires additional treatment and/or blending before it can be used for municipal and industrial water supply. Desalination is currently used by the City of Sherman, the Red River Authority, and Preston Shores. NTMWD and the City of Denison currently perform blending of Lake Texoma water with other higher quality water.[75]

The conservation storage in Lake Texoma includes allocations for hydropower and water supply. Water supply storage in Lake Texoma is contracted with the USACE. Water diversion permits from Lake Texoma are issued by the OWRB and the TCEQ. Oklahoma currently does not have any publicly documented plans for its share of Lake Texoma water supply; whereas, the Region C Water Plan includes water strategies up to the year 2060 for the majority of the water allocated to Texas. It may be possible to reallocate additional water supply storage from the existing hydropower storage. However, storage reallocation would require authorization by the United States Congress. Details of the water storage, diversion, and possible storage reallocation are explored in the following sections.

Figure 2.4 Lake Texoma (617' msl) Location Map

2.3.2 Available Water Supply

Lake Texoma has a current flood storage capacity of 2,544,830 ac-ft and current conservation storage capacity of 1,467,283 ac-ft.[186] The current conservation storage includes 1,017,283 ac-ft for hydropower and 450,000 ac-ft for water supply. The 2006 Region C Water Plan provides water use plans for nearly all of Texas' current share by the year 2060. The area/capacity relationship for Lake Texoma is shown in Table 2.4 The area capacities between elevations 520 and 620 are from the 2003 volumetric survey from the TWDB and the flood storage capacity is estimated from the 1985 survey.

Table 2.4 Area Capacity Data for Lake Texoma

Area Capacity Data for Lake Texoma Reservoir		
Elevation (Ft-MsL)	**Capacity (Ac-Ft)**	**Area (Acres)**
520	0	0
525	77	57
530	1,062	400
535	5,629	1,679
540	17,149	3,033
545	37,585	5,273
550	72,616	8,900
555	129,669	13,636
560	206,401	16,926
565	298,808	20,020
570	407,404	23,517
575	535,073	27,698
580	684,293	31,896
585	855,578	36,727
590	1,048,949	40,434
595	1,261,262	44,702
600	1,496,276	49,380
605	1,757,009	54,986
610	2,045,901	61,022
615	2,371,383	69,854
620	2,779,641	84,911
625	3,550,000	106,000
630	4,150,000	116,568
635	4,850,000	132,000
640	5,500,000	141,418
645	6,200,000	NA
650	6,900,000	NA
670	**Top of Dam**	

The USACE Tulsa District considers the conservation storage to be between elevations 617 feet and 590 feet. The "inactive pool" is between elevations 590 feet and 523 feet. Any capacity below the elevation

523 feet (elevation of the lowest invert) is considered "dead pool." Figure 2.5 provides a graphical representation of the various storage allocations for Lake Texoma.

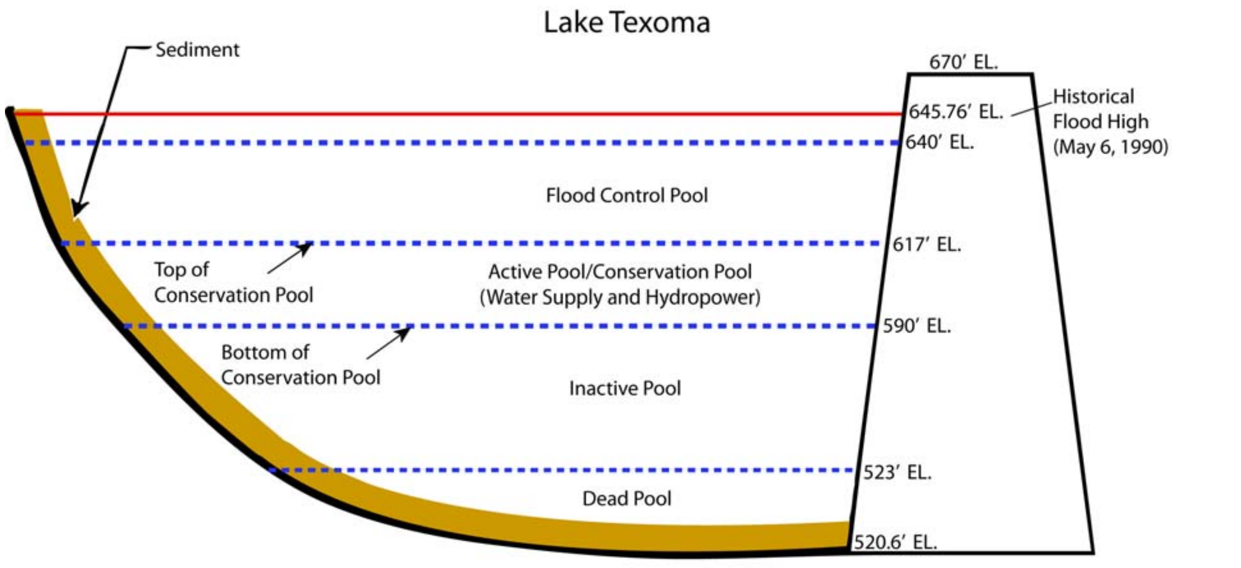

Figure 2.5 Storage Profile for Lake Texoma

Lake Texoma inflows carry a large amount of sediment that mostly comes from the Red River. During periods of high flow, bank caving and erosion occur at many locations upstream of Lake Texoma increasing the sediment load in the lake and decreasing water storage capacity. [186]

Currently, all water allocated to Texas from Lake Texoma is owned as water rights (from TCEQ) or has been applied for through TCEQ. Additional water from the Oklahoma portion of the Lake Texoma allocation could potentially be available; however, Oklahoma currently has a moratorium related to selling water to Texas. It is also theoretically possible to reallocate additional water supply storage from the existing hydropower storage. In 1986, the Water Resources Development Act (WRDA) authorized the reallocation of 150,000 afpy hydropower storage for Texas. In 2001, the USACE initiated a study to evaluate this reallocation of hydropower storage and begin an environmental assessment, which was completed in 2006. Additional environmental studies were complete in 2008. The reality of hydropower storage reallocation at this time is not feasible. Each of these alternatives will have water quality related issues that will also have to be addressed.

2.3.3 Ecological and Environmental Impacts

Water currently utilized by NTMWD from Lake Texoma is transferred via a pipeline to the headwaters of Sister Grove Creek (an unclassified stream in the Trinity River Basin) and conveys the water downstream to Lake Lavon.[272] This transfer of Lake Texoma water to Lake Lavon has several environmental impacts and concerns. If additional water is utilized from Lake Texoma these issues will need to be addressed.

Water issues related to the use of Lake Texoma Water [273]:

- Texoma water presents treatability challenges because of the high salinity of the water.
- Disposal of the brine created from the desalination process.
- High desalination process electric costs.

Environmental Issues Related to the interbasin water transfer:

- Zebra mussels have been found in Lake Texoma as well as the receiving stream (West Fork Sister Grove Creek) downstream of the outfall pipe, upstream of Lake Lavon.[274]
- The potential now exists for Zebra Mussels to spread to Lake Ray Hubbard and surrounding lakes via boats or downstream migration.[275]
- Preliminary investigation of the effect of increased flow rates in Sister Grove Creek document changes in fish composition at some of the sample stations.[276]
- The NTMWD has petitioned the TCEQ to increase the water quality standards for salts in Lake Lavon, based on the interbasin transfer of water from Lake Texoma to Lake Lavon.[278]

2.3.4 Socioeconomic Evaluations

In reviewing available literature for Lake Texoma and the economic impact of this reservoir as a water supply alternative for Region C, the Project Team found significant data via news articles and presentations regarding the economic contributions of Lake Texoma; however, to-date, no comprehensive economic analysis appears to have been conducted concerning Lake Texoma as a water supply alternative.

2.3.5 Summary

- Lake Texoma is a multipurpose reservoir on the Red River and is shared by Oklahoma and Texas and is utilized for flood control, water supply, hydroelectric power, and recreation.
- Oklahoma law currently prohibits the sale of water to Texas.
- Most if not all of the available water for Texas use has been permitted or is in the process of being permitted.
- Reallocation of hydropower storage to water supply was initiated in the 1980s and is currently going through the approval process.
- Interbasin transfers incur additional environmental impacts.
- The water quality does not allow immediate use as a potable water supply without the ability to blend with higher quality water or desalination.

2.4 LAKE O' THE PINES

A literature review was performed for documents, studies, and reports related to Lake O' the Pines (LOP) dating back to the year 1964. In total, 22 relevant documents were collected, reviewed, and summarized. The most relevant documents were Lake O' the Pines/Cypress Basin Water Supply Study (2003), Regional Water Supply Plan, Vols. 1-2 (1993), and Targeted Monitoring in the Cypress Basin, Nutrient Study in Lake O' Pines, Final Report (2000).

2.4.1 Overview – Lake O' the Pines

The USACE owns and operates LOP. LOP was authorized by the Flood Control Act in 1946. The reservoir is located in the Cypress Creek Basin, nine miles west of the City of Jefferson in Marion, Morris and Upshur Counties.[70] See Figure 2.6 for a location map. LOP is located within stream segment 0403 as defined by the TCEQ and deliberate impoundment began in 1958.

In 1998 TWDB indicated that the surface area of the lake at the conservation storage elevation of 228.5 feet was approximately 16,919 acres and the storage volume was 241,081 ac-ft. The area capacity relationship is shown in Table 2.5. The area capacity data was taken from the TWDB Volumetric Survey performed in 1998.[254] The additional flood storage relationship was obtained from the original area capacity curves developed prior to the construction of the reservoir.[252] See Figure 2.7 for a storage profile for LOP. LOP is a multipurpose reservoir providing flood control for the Big Cypress River watershed, water supply for the Northeast Texas Municipal Water District (NETMWD), and recreational uses.[179] The drainage area for LOP is 887 square miles.[94]

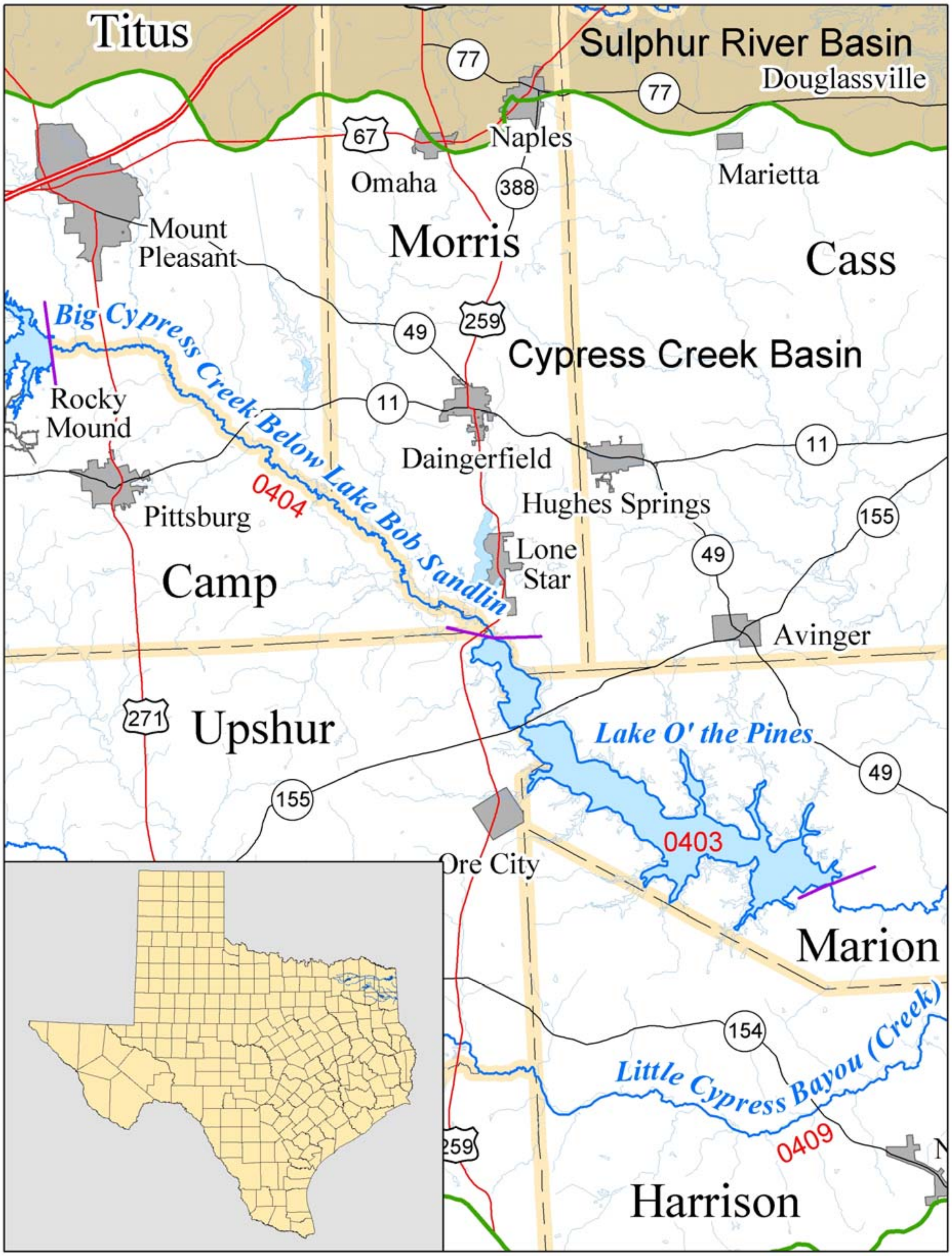

Figure 2.6 Lake O' Pines (228.5' msl) Location Map

Table 2.5 Area Capacity Data for Lake O' the Pines[254]

Elevation (Ft-MSL)	Capacity (Ac-Ft)	Area (Acres)
176.9	0	0
180	0	0
185	3	2
190	39	16
195	281	116
200	2,148	831
205	10,766	2,875
210	32,324	5,761
215	68,263	8,581
220	119,091	11,798
225	185,989	14,909
228.5	241,081	16,919
230	290,000	20,000
235	400,000	24,000
240	530,000	28,700
245	690,000	34,000
250	870,000	39,000
255	1,080,000	44,500
260	1,320,000	50,500
277	**Top of Dam**	

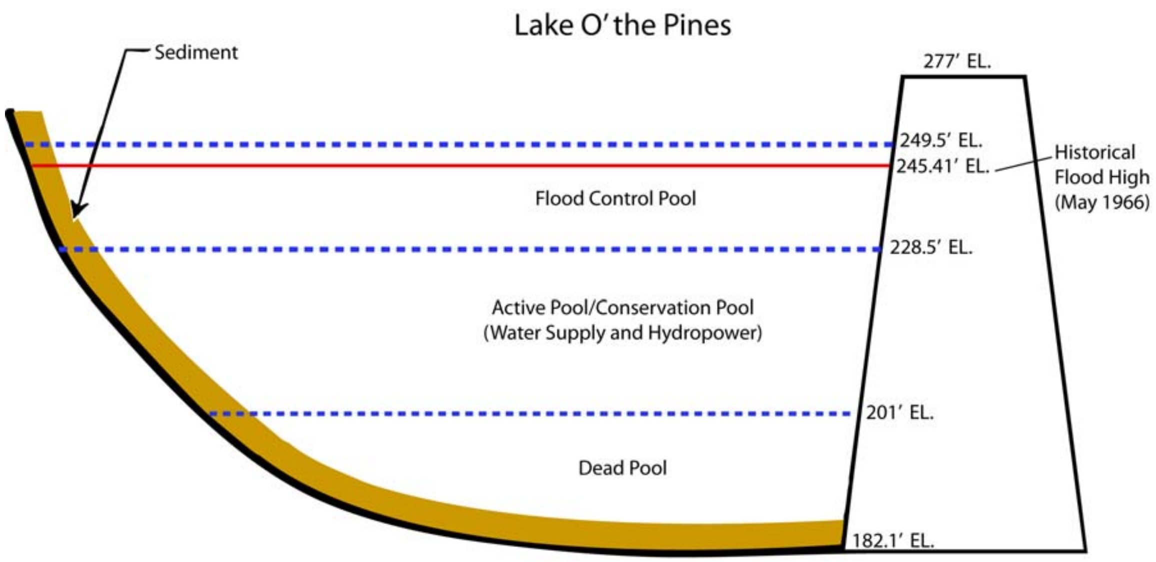

Figure 2.7 Storage Profile for Lake O' the Pines

2.4.2 Available Water Supply

NETMWD originally applied for and was granted 203,800 afpy of water from LOP. The original water right was divided into 42,000 afpy for municipal use and 161,800 for industrial use.[242] The water right has been modified twice; the first amendment added 18,000 afpy for industrial use and the second added 20,000 afpy for industrial and municipal use. The result of the two amendments is that NETMWD now owns a water right for water in LOP for 241,800 afpy.

Additional water from LOP was discussed in the 2006 Region C Water Plan. The amount of water listed as available was 89,600 afpy.[37] Although this amount of water was discussed in the 2006 Region C Water Plan, the importation of Cypress River Basin water was not a recommended water management strategy in the 2006 Plan. The additional water is listed as an alternative strategy for Dallas Water Utilities and NTMWD.[37] NETMWD indicated a slightly lower amount of available water that could be as high as 88,000 afpy.[246] This water supply alternative would be a contract or lease of water from LOP with the NETMWD and therefore listed as a long-term temporary water supply.

2.4.3 Ecological and Environmental Impacts

LOP contains elevated nutrients and is considered eutrophic. Based on a screening completed in 1996 by the Texas Clean Rivers Program, LOP demonstrated low dissolved oxygen (DO), and DO was listed as a possible concern.[150] Segment 0403 that encompasses LOP was listed in 2000 as impaired due to low DO values. As such the segment has an implementation plan for a TMDL for DO. The TMDL describes photosynthesis and respiration as the source for low DO with phosphorous being the limiting nutrient in the reservoir. The TMDL indicates a 56% reduction in phosphorous loadings are needed to restore water quality.[140]

One industrial and eight municipal wastewater treatment plants discharge into LOP. In addition, the adjacent area is largely agricultural which has lead to increased nutrients. There is a concern that the elevated nutrients will lead to taste and odor problems.[119]

Additional environmental impacts associated with the sale of 88,000 afpy from LOP are:

- Potential changes in flow to the Big Cypress River.
- Potential changes in instream flow for Big Cypress River segments.
- Impact on spills at LOP.
- Differing lake levels and habitat associated with those levels.
- Potential changes in water quality.

2.4.4 Socioeconomic Evaluations

During the course of the literature review, the Project Team was unable to locate any socioeconomic impact studies conducted related to water supply alternatives from LOP.

2.4.5 Summary

- LOP is a multipurpose reservoir providing flood control for the Big Cypress River watershed, water supply for the NETMWD, and recreational uses.[179]
- 88,000 afpy[37] is potentially available as a water supply alternative via contract or lease of water with the NETMWD as a long-term temporary water supply
- Segment 0403 that encompasses LOP was listed in 2000 as impaired due to low DO values.

2.5 TOLEDO BEND RESERVOIR

A literature review was performed for a total of 30 documents related to Toledo Bend dating back to 1985. In addition to reviewing documents, six agencies were contacted for report access and to request additional information. Interaction with SRA and SRA-LA presented new information and presented the most recent reports on Toledo Bend.

The majority of the reports included in the literature review were on the subject of water supply and water demand, many covered subjects such as cost and feasibility, environmental impacts, inter-basin transfers and water conservation, and a few entailed instream flows, socioeconomic impacts, water quality, water transmission and water availability modeling. The most recent and/or relevant studies reviewed were: East Texas Region Special Study No. 1: Inter-Regional Coordination on the Toledo Bend Project;[134] Region C Water Plan;[37] Impact of Potential Toledo Bend Operational Changes Memo Report;[58] and Yield Study Toledo Bend Reservoir.[5]

In addition to the existing reports, it is important to note that studies are presently being conducted to determine instream, bay and estuary flow needs for the Sabine River Basin. The report should include analysis of various conditions at selected control points and the utilization of the WRAP computer program to analyze water availability at selected control points along the Sabine and Neches Rivers. This may be useful when determining available water for water supply planning further upstream.

2.5.1 Overview – Toledo Bend Reservoir

Toledo Bend Reservoir is a large existing reservoir located in Region I on the Texas and Louisiana border in the Sabine River Basin. Many of the Toledo Bend alternatives that have historically been considered involve some supply and conveyance through Region D; therefore, the literature research and review included sources and information from the three regions, Region C, D and I. Since the reservoir is on the state line with Louisiana, the water is shared between the two states. Additional information was collected through discussions with the SRA and the SRA-LA. Several of the most recent key documents were provided by these two Authorities.

Since Toledo Bend is an existing reservoir with existing water rights that are not committed, much of the literature review involved consideration of pipeline routes and the overall cost of conveyance. Key considerations included which entities might participate in the project, how much water would be needed from the project, and when it might be needed. The proposed Toledo Bend pipeline project consists of the transfer of 500,000 afpy of water from the Toledo Bend Reservoir, with the potential to increase the transferred water amount to 700,000 acre-feet per year.[37, 134] The project delivery of water in the amount of 500,000 afpy includes the following entities [37]:

- 100,000 acre-feet per year for the Sabine River Authority in the upper Sabine Basin (North
- East Texas Region)
- 200,000 acre-feet per year for Tarrant Regional Water District
- 200,000 acre-feet per year for North Texas Municipal Water District.

The Toledo Bend project deliver of water in the amount of 700,000 afpy includes these entities [134]:

- North Texas Municipal Water District 200,000 acre-feet per year
- Tarrant Regional Water District 200,000 acre-feet per year
- Dallas Water Utilities 200,000 acre-feet per year
- Sabine River Authority 100,000 acre-feet per year

A location map for Toledo Bend is provided in Figure 2.8. The Toledo Bend reservoir occupies parts of Sabine and De Soto Parishes, Louisiana and Newton, Panola, Sabine, and Shelby counties, Texas. The reservoir is situated approximately 80 miles northeast of Beaumont, Texas. The reservoir is primarily a storage water facility having 185,000 surface acres (area capacity of 4,477,000 ac-ft) at the top of the conservation pool zone of 172 ft-msl.[127] The reservoir is oriented in a northwest to southeast direction along the borders of Texas and Louisiana. There are approximately 1,200 miles of shoreline and the reservoir is seven miles wide at its widest point. The Toledo Bend reservoir drains approximately 7,178 square miles, and according to a 2004 SRA study it has an estimated runoff of 3.6 million-acre-feet.[258]

The reservoir was constructed jointly by the SRA (formed 1949) and the SRA-LA (formed 1950), with the dam being completed in 1969. The rolled earth –filled dam has a maximum height of 112-feet and a length of 11,250-feet, with an elevation of 185 ft-msl. The Toledo Bend reservoir is the fifth largest in the United States, and the largest in the South. The reservoir provides multiple uses for hydroelectric power, water supply, and recreation usage. The reservoir has a yield of 1,868,000 gallons per day to be shared equally between SRA-Texas and SRA-Louisiana.[127] Toledo Bend has a hydroelectric output within Texas of 58,500 horsepower (43.875-MW).[127] Under the conditions of a current Project license, the hydroelectric use within the reservoir operates between 172 ft to 168 ft msl. The historical high water mark of 173.93 ft was reached during flooding of May, 1989.[258] Table 2.6 presents the Toledo Bend area/capacity data, and Figure 2.9 illustrates the reservoir's storage profile.

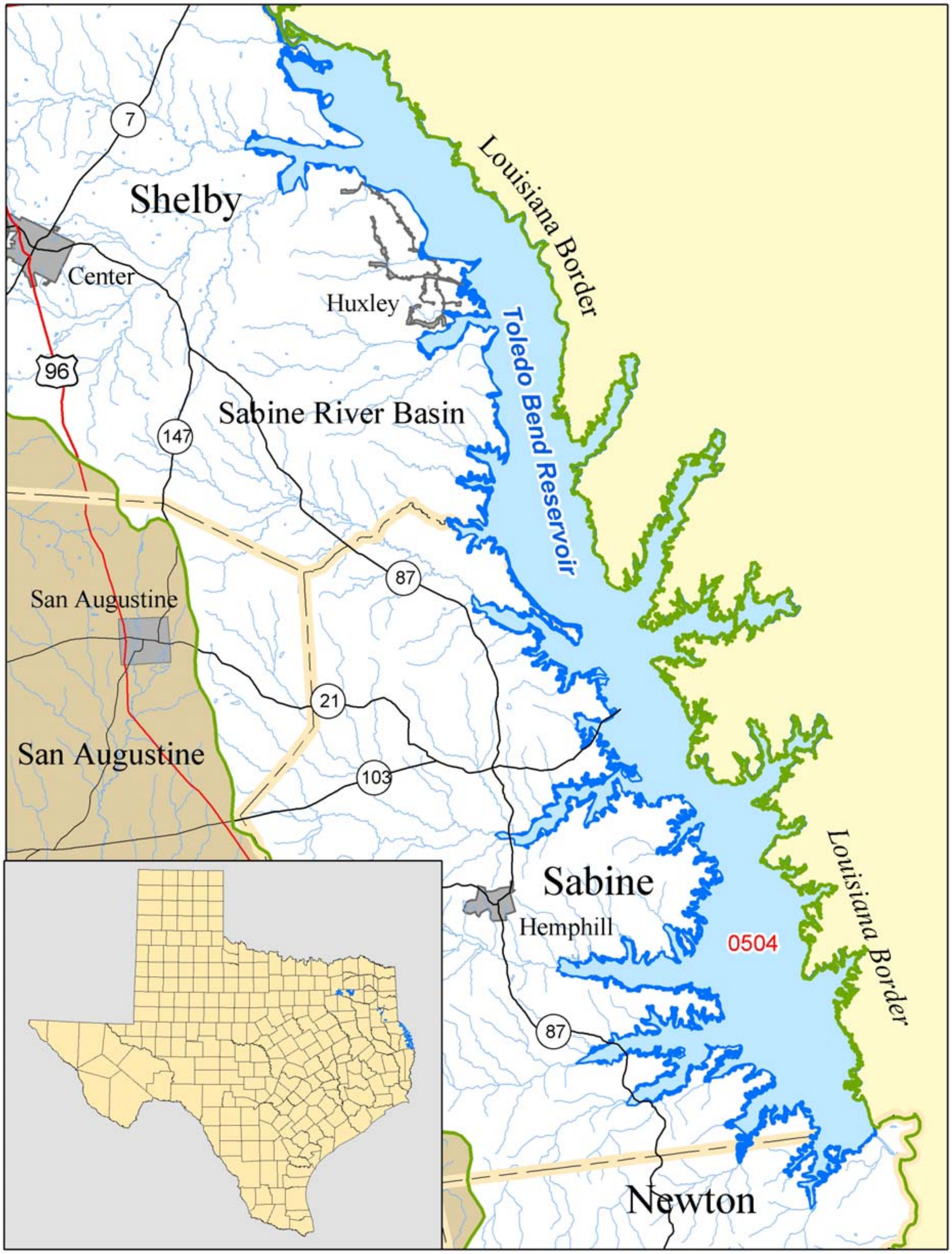

Figure 2.8 Toledo Bend (172' msl) Location Map

Table 2.6 Area Capacity Data for Toledo Bend

Elevation (Ft-MsL)	Capacity (Ac-Ft)	Area (Acres)
70	NA	NA
75	NA	NA
80	0	0
85	144	60
90	704	170
95	1,916	325
100	4,076	554
105	10,926	2,550
110	31,801	6,000
115	74,851	11,400
120	147,208	17,513
125	252,865	25,000
130	399,065	33,800
135	593,265	44,200
140	843,854	56,578
145	1,161,793	71,100
150	1,559,843	88,400
155	2,047,443	106,900
160	2,632,247	127,309
165	3,321,901	148,900
170	4,123,426	171,950
175	5,043,801	196,300
180	6,088,725	222,048

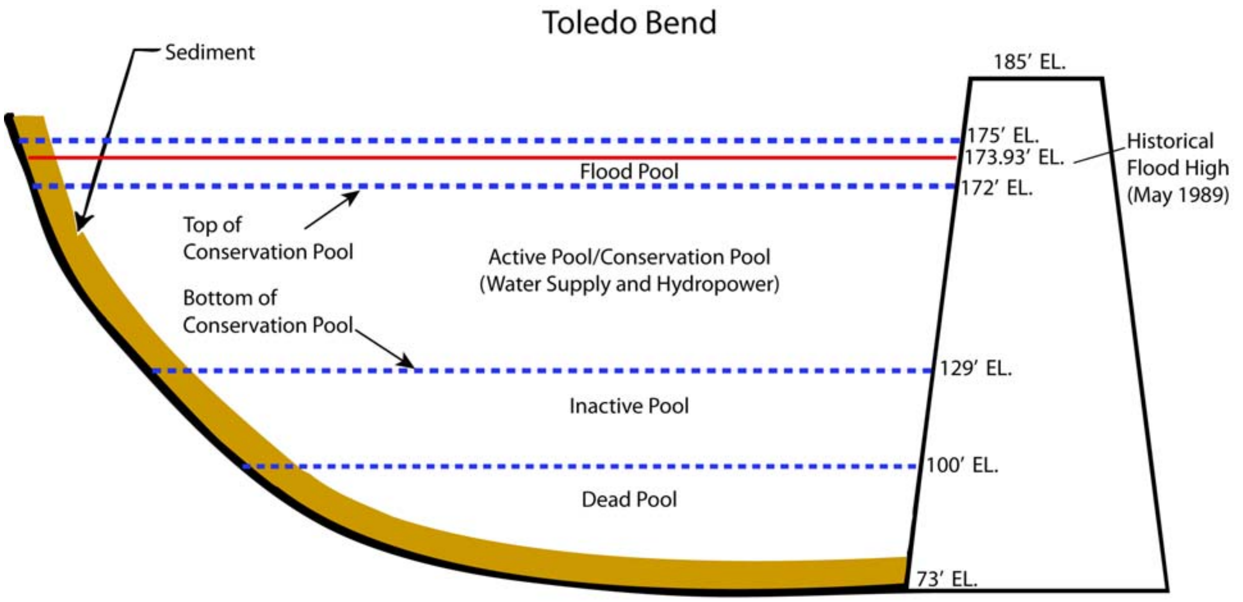

Figure 2.9 Storage Profile for Toledo Bend

2.5.2 Available Water Supply

This water supply alternative would be a contract or lease of water from Toledo Bend with the SRA and therefore listed as a reliable long-term temporary water supply of up to 700,000 afpy[37]. The water supply would be provided to Region C as an interbasin transfer.

2.5.3 Ecological and Environmental Impacts

Potential ecological and environmental impacts associated with the interbasin transfer of water from Toledo Bend reservoir could include:

- Changes in flow to the Sabine Lake Estuary.
- Changes in Instream Flow for affected river segments.
- Impact on spills at Toledo Bend Dam.
- Decrease to Toledo Bend lake levels and habitat associated with those levels.
- Changes in water quality (blending).
- Changes in biodiversity (spread of non-native/invasive aquatic plants and animals).

Pipeline construction could also have additional impacts including forests and/or wetland areas. Mitigation will be required for those areas that are disturbed.[134]

2.5.4 Socioeconomic Evaluations

Two specific studies have been conducted related to the Toledo Bend reservoir as a water supply alternative for Region C. Both studies were conducted by R.W. Beck, Inc. The first study, conducted in 2005, was later updated as part of a report on interbasin transfers commissioned by the TWDB. The report examines the positive and negative impacts for both the basin of origin and the receiving basin, determining an overall positive net economic impact of the water supply alternative.

Further discussion of the socioeconomic data gaps related to the Toledo Bend reservoir are found in Section 4.3.4. of this report.

2.5.5 Summary

- Toledo Bend Reservoir is a large existing reservoir located in Region I on the Texas and Louisiana border in the Sabine River Basin.
- Studies are presently being conducted to determine instream, bay and estuary flow needs for the Sabine River Basin.
- The transfer of water through pipeline is approximately 250 miles from Toledo Bend to the Dallas / Fort Worth area, near Benbrook Lake. The conservation pool elevation for Toledo Bend is 172’ msl and 694’ msl at Benbrook Lake, an elevation difference of 522 feet.
- Available water supply of up to 700,000 afpy as an interbasin transfer to Region C.
- Environmental concerns associated with interbasin transfer and pipeline construction.
- Discussions relating to contract water purchases have been underway between SRA-TX and DWU, NTMWD, and TRWD since 2000.

3.0 DATA GAP ANALYSIS

This study was commissioned by the Study Commission in the fall of 2008 to determine the viability of water supply alternatives for the Region C Regional Water Planning area including additional water supplies from Lake Texoma, Wright Patman, Toledo Bend Reservoir, Lake Wright Patman, Lake O' the Pines, as well as new supplies from the proposed Marvin Nichols Reservoir.

The primary objective of this task is to identify potential data gaps in existing information and recommend future studies to evaluate the viability of obtaining additional water supply for Region C.

3.1 MARVIN NICHOLS RESERVOIR

3.1.1 Data Gap Analysis

This section will identify potential data gaps for the Marvin Nichols reservoir water supply options to Region C.

3.1.1.1 Environmental and Socio-economic Impacts

The following are potential data gaps related to the development of Marvin Nichols reservoir**.**

The proposed Marvin Nichols Reservoir is located approximately 105 miles Northeast of Dallas, in Red River and Titus Counties, Texas.[13] At present, there has been little to no definitive environmental studies conducted on the proposed Marvin Nichols Reservoir project area. According to the TWDB Report 370, the proposed reservoir site will inundate over approximately 67,000 acres at the top of the conservation pool. The reservoir will impact wetlands but, presently, none of these impacted areas have been identified in the field or quantified. [13] The inundation of Marvin Nichols reservoir will specifically impact bottomland hardwoods, riparian vegetation, and fish and wildlife habitat units, as well as other biological and natural resources.

A study by Freese and Nichols was initiated in 2001 to better understand how much land needs to be acquired to meet the federal and state required environmental mitigation requirements.[259] Aerial photography and helicopter reconnaissance was used to evaluate and identify land use and vegetation type within the proposed project area. The land use was divided into forested bottomlands, pasture and grasslands, agricultural land, and open water. The study allowed for general inferences to be made about the cost of the replacement land needed for the reservoir and mitigation requirements.[259] Although these numbers were never considered definite, the land needed to meet the project requirements was estimated to be at $700 / acre; this figure was increased to $735 in the Freese and Nichols "*Marvin C. Nichols Reservoir: Site Selection Study*" in January 2003.[259] It was determined that the total cost of land need to build the reservoir and meet mitigation requirements in 2003 were $170.3 million for Marvin Nichols I and $162.6 million for Marvin Nichols IA (both without contingencies). Table 3.1 presents a summary of other considerations that may be significant between the two proposed Marvin Nichols sites I and IA.[259]

Table 3.1 Summarizes Significant Considerations for Selecting Proposed Alternate Marvin Reservoir Sites I or IA. [259]

Proposed Marvin Nichols Reservoir Site I and Site IA Significant Considerations for Selection *(compiled from Sulphur Basin Group, January 2003)*		
	Marvin Nichols I	**Marvin Nichols IA**
Total Estimated Cost (including technical services and contingencies)	$1,742,000,000	$1,729,000,000
Federal Land	Purchase 3,500 acres	No federal land is needed
Lignite	Submerge 10,900 acres; unknown risk of adverse acquisition for land	No lignite deposits within the proposed reservoir boundaries
Yield	620 mgd	615 mgd
Environmental impact	**Negative:** Reservoir inundation	**Negative:** Reservoir inundation; **Positive:** submerge "logjam" downstream from Highway 37 solving issues that has severely impacted the environmental quality of the adjacent land by inundation
Mitigation Concerns	More timber and bottomlands are needed; Land Purchase $116,726,000; Federal Land Contingency $116,726,000 Lignite Contingency $4,016,000; Land Acquisition $42,710,000	Less acreage of land required (fewer timber and forested lands will be impacted); the land effected has a lesser environmental value due to the affects of the "logjam"; the upstream site allows for more land within eh basin to be utilized for mitigation; Land Purchase $108,139,000; Land Acquisition $37,849,000
Dam Operation Costs	Higher operating cost	Less operating cost since it has shorter pipeline and higher starting water surface elevation
Land Acquisition Concerns	Unknown; considered the same until more data has been acquired and analyzed.	Unknown; considered the same until more data has been acquired and analyzed.

3.1.1.2 Areas Impacted

The landscape in this area of East Texas is dominated by timber land. According to the Texas Forestry Chart Book,[260] timber land is forested land capable of producing commercial grade timber. Timberland forest covers approximately 55% of East Texas. Bottomlands and floodplain areas within the proposed reservoir area are made up of bottomland hardwood species typical to east and southeast Texas.[101] The proposed Marvin Nichols site location is frequently flooded which is an ideal habitat for bottomland hardwood swamp species such as blackgum, willow, green ash, river birch, willow oak, and American hornbeam.[162] The total area of forestland inundated to the top of the conservation pool (312 ft-msl) is approximately 67,957 acres. [260, 226] The conservation pool includes 36,178 acres of bottomland hardwood and 19,453 acres of upland hardwood. The reservoir flood pool (322.5 to 312 ft-msl) includes 4,735 acres of bottomland hardwood and 10,662 acres of upland hardwood.[260, 226] All other area within the proposed reservoir include water, grassland, agricultural crops or managed grassland, and bare land.[226]

The riparian wetlands in this portion of East Texas are habitat to a number of waterfowl species (mallards and breeding and wintering wood ducks).[162] The impacted wetlands are considered to have "…important sources of nutrients that drive the energetic qualities of heavily forested river systems."[162] The habitat for numerous plant species and animal species, possibly over a 100 species of special concern, will be impacted by the development of the Marvin Nichols reservoir.[162, 279] The loss of bottomland forest and wetland habitats due to inundation will directly impact migratory species; however, to date, no scientific studies have been conducted to increase understanding of migratory patterns in the vicinity of the proposed Marvin Nichols reservoir. As stated earlier, the USACE will approve the amount of mitigation area that will be required for Marvin Nichols after an EIS has been completed.

3.1.1.3 Water Quality:

Water quality data used in the Region C 2001 Water Plan34 was collected in October 1979 through July 1987. More recent or updated water quality data should be obtained. The Sulphur River segment 303 was included on the 303(d) list for lower DO,118 elevated pH,118 elevated levels of Atrazine118 in the finished drinking water (where the raw water was obtained from Lake Wright Patman which is fed by Sulphur River), and higher concentrations of iron and aluminum. A water quality study would improve the understanding of water quality in incoming streams and reservoir impact on the water quality that may affect the aquatic ecology and water treatment.

3.1.1.4 Socioeconomic:

3.1.1.5 Data gap for the socioeconomic portion of this report is provided in Section 4.3.1.2.

3.1.1.6 Yield

Table 3.2 provides yield estimates for Marvin Nichols. Although the yields vary amount of variation is not significant. Therefore no additional evaluation is recommended at this time.

Table 3.2 Marvin Nichols Yield Values

Report	Yield Reported in afpy	Dam Site
Region C 2006 Water Plan	612,300[37]	1A
Region C 2001 Water Plan	619,100[34]	1
RJ Brandes et. al.	602,000[249]	1A
Region D 2001 Water Plan	624,000[116]	1

3.1.2 Data Gap Summary

Planning Data Gaps:

- What role could recent rules for mitigation banking play in the mitigation of Marvin Nichols?

Permitting/Design Data Gaps:

- TCEQ (interbasin transfer permitting issues, additional water rights permitting, water right ownership, etc.).
- What is the current procedure and process utilized to determine the amount of mitigation required and development of a Mitigation Plan?
- Amount of water needed for local area.

- Environmental permitting (EIS, 404 issues, water quality issues, habitat and ecological analysis, instream flow issues, etc).
- Updated cost estimates (construction of dam, pipeline, mitigation, permitting, etc.).

3.2 LAKE WRIGHT PATMAN

Additional water supply could be available from Lake Wright Patman for Region C. Lake Wright Patman is a recommended water strategy for Dallas Water Utilities and an alternate water management strategy for Irving, NTMWD, TRWD, and UTRWD. The Riverbend Water Resources organization (RWR) was recently formed to provide leadership in the planning and development of Lake Wright Patman. RWR has been designated the local representative of Lake Wright Patman for entities such as TCEQ, TWDB, USACE and TPWD. RWR will be involved in the planning process for Lake Wright Patman.

Several strategies are identified as potentially feasible for use in Region C in the Region C Water Plan.[37] These strategies included:

9. Voluntary Redistribution of Water Resources – Purchase water from City of Texarkana under its existing water right;
10. Reallocation of Reservoir Storage – Convert flood storage to conservation storage and make the increased yield available to Region C. This storage conversion would be up to a constant elevation of 228.64 msl; and,
11. Reservoir System Operation – Operate Lake Wright Patman as a system with Jim Chapman Lake to further increase yield and make it available to Region C.

One additional strategy from Lake Wright Patman is to increase the conversion of flood storage to water supply to higher elevations than 228.64 feet. Each of these alternatives will have potential impacts and concerns, and additional evaluations will be needed and are discussed in the following sections.

3.2.1 Voluntary Redistribution of Water Resources

According to the TCEQ Water Rights Database, the City of Texarkana (Texarkana) currently owns water rights totaling 180,000 afpy in Lake Wright Patman.[110] The water right grants 45,000 afpy for municipal use and 135,000 afpy for industrial use. Texarkana has a contract/agreement with International Paper (IP) for 120,000 of the 135,000 afpy industrial use, and it has obligations to several small cities totaling about 2,500 of the 45,000 afpy municipal use.[110] Currently, the USACE operates Lake Wright Patman at an elevation of 220.0 feet. Texarkana also has a contract with the USACE for water stored above elevation 220.0. The full use of the water right would require the activation of the contract between Texarkana and the USACE for additional conservation storage in Lake Wright Patman.[65] The activation of the contract would also trigger the additional payment of the debt service from Texarkana to USACE.

Texarkana Water Utilities, a city department that is jointly operated by the Cities of Texarkana, Texas and Arkansas, suggested that Texarkana would consider meeting with the Regional Water Planning Groups to discuss providing water for Region C. Texarkana Water Utilities also confirmed that IP has the contract for up to 120,000 afpy of the Texarkana water right from Lake Wright Patman; therefore, IP would be involved in any negotiations for voluntary redistribution of its contracted water supply.[108]

As stated earlier, Texarkana has contracts for 122,500 of the 180,000 afpy currently held water rights.[110] The remainder of the water right is approximately 57,500 afpy and could be available for Region C. The Region C Water Plan[37] lists the maximum supply available from Texarkana as 100,000 afpy. The current contract with IP would have to be modified to create additional water supply for Region C above 57,500 afpy. Contracting this additional supply to Region C would require additional studies including environmental, mitigation, pipeline capacity, and pump station capacity. Again, this water supply would be a contract with Texarkana and be listed as a long-term temporary supply.

3.2.2 Reallocation of Reservoir Storage

Reallocation of flood storage to conservation storage is one of the strategies identified in the Region C Water Plan. The USACE commissioned a study, "System Operation Assessment of Lake Wright Patman and Lake Jim Chapman", in 2003, to evaluate the increase in reservoir yield from the reallocation of flood storage. The report also evaluated the increase of reservoir yield by operating Lake Jim Chapman and Lake Wright Patman as a system (including reallocation). The study presented results for many differing assumptions for conservation storage and minimum elevations.[65] The reallocation strategy presented in the 2006 Region C Water Plan is based on the modeling simulations in that report. The report presented an increase in the stand-alone yield of Lake Wright Patman to 364,000 afpy.[65] This increase was solely based on the conversion of flood storage to conservation storage and did not include system operations with Jim Chapman (increase in yield from system operations is discussed in the next section). The increase in Lake Wright Patman yield to 364,000 afpy comes from allowing the level of the conservation pool to reach 228.64 feet msl throughout the year and allowing a drawdown to a minimum of 215.25 feet. Operating Lake Wright Patman at a constant pool elevation of 228.64 feet would constitute a reallocation of flood storage to conservation storage exceeding 50,000 acre-feet and would require Congressional authorization.[109]

The drawdown level of 215.25 feet is an assumed minimum level available (above the sedimentation pool). Water supply operation below the 220 feet level will require modifications to existing pump stations including Texarkana and possibly IP. The USACE report limited the top of conservation pool elevation to 228.64 feet. No additional simulations were performed with a conservation pool above 228.64 feet because of concerns that higher elevations may inundate the White Oak Creek Wildlife Management Area (WOCWMA). The WOCWMA covers over 25,000 acres and contains bottomland hardwood forest, natural wetlands, and constructed mitigation wetlands.

WOCWMA is managed by TPWD under a license agreement with the USACE. TPWD provided evaluation, concerns and potential impacts of the management strategies to support the USACE study in an office memorandum dated July 30, 2002.[248] Also, on May 29, 2008, TPWD staff developed a consensus on the acceptable level of inundation for WOCWMA resulting from raising the level of the conservation pool. The conclusions included a statement that the operation of Lake Wright Patman could change to a constant pool elevation of up to 230 feet with minimal adverse impacts to the WOCWMA. Any further increases in elevation would generate significant adverse impacts to the habitats of the WOCWMA and would need to have additional studies and investigations.[160] Additional analysis could be performed to evaluate the additional yield of Lake Wright Patman between the elevations of 228.64 feet and 230 feet.

The stand-alone total yield of Lake Wright Patman under the above mentioned operations is approximately 364,000 afpy. Therefore, the total available water supply to Region C from this reallocation of flood storage to conservation storage could be approximately 180,000 afpy.

3.2.3 Reservoir System Operation

Another potential strategy to provide water from Lake Wright Patman that was discussed in the Region C Water Plan was utilizing the total system of Lake Jim Chapman (formerly Cooper Lake) and Lake Wright Patman (Table 3.3). The 2003 report estimated that when operated as a system the reservoir yield for the two projects could be increased approximately 108,000 afpy. This increase would be available to Region

C as additional water supply. System operation will require a pipeline from Lake Wright Patman to Jim Chapman Lake and a pump station at Lake Wright Patman and booster pumps and storage tanks at Jim Chapman. The plan includes preliminary cost estimates for these facilities. Systems operation would include the same issues as addressed above for reallocation and redistribution.

Therefore, the total amount of additional water available from the Wright Patman system (if system operations are utilized) is 108,000 afpy, plus 180,000 afpy from stand-alone reallocation of flood storage, plus 57,500 afpy from water right purchase or contract. The total system additional yield is 345,500 afpy. The Region C Water Plan identified this potential strategy to provide 390,000 afpy additional water supply for Region C. As described earlier, the difference in the two estimates is the water right commitments that Texarkana has with IP. If the additional water supply is to be 390,000 afpy Texarkana will have to modify the contract with IP.

Table 3.3 Water Rights Listing for Lake Jim Chapman

Water Right Number	Owner	Use Type	Amount (acre-ft/yr)	Priority
CA 4797	Sulphur River Municipal Water District	Municipal	23,746	11/19/1965
		Industrial	11,560	11/19/1965
		Total	35,306	11/19/1965
CA 4798	North Texas Municipal Water District	Municipal	57,214	11/19/1965
CA 4799	City of Irving	Municipal	44,820	11/19/1965
		Industrial	9,180	11/19/1965
		Total	54,000	11/19/1965

3.2.4 Reallocation of Flood Storage over Elevation 230 feet

One additional strategy for increased water supply from Lake Wright Patman is to increase the conversion of flood storage to higher elevations than 230 feet. This strategy will be the most difficult alternative to achieve. As stated previously, the TPWD determined that the conservation pool elevation of Lake Wright Patman could be raised to approximately 230 feet without significant impact to the WOCWMA.[269] The TPWD also stated that raising the elevation above 230 feet would have significant impact to the WOCWMA.

In a letter to dated February 2, 2007, TPWD discussed raising the elevation of the conservation pool in Lake Wright Patman over 230 feet. The letter utilized the existing data and analysis from the 2003 system operation report commissioned by the USACE and extrapolated an increased yield for an elevation of 236 feet. This extrapolated yield estimate was 620,000 afpy. This stand-alone yield would be a 440,000 afpy increase over the existing 180,000 afpy yield. As stated in the letter, this additional yield is "very approximate", and additional yield modeling would need to be performed to provide a more accurate estimation of the actual yield that could be realized from increasing the conservation pool elevation.[270] Additional modeling scenarios can also be performed at differing elevations to determine the most appropriate elevation by balancing the increased additional yield and the impacts to the WOCWMA.

There are many issues that will need to be addressed if the conservation pool of Lake Wright Patman is raised over 230 feet. Raising the conservation pool elevation above 230 feet would begin to inundate the hardwood forests, natural wetland areas, and constructed mitigation wetlands. The following is a list of potential obstacles and/or impacts that would need to be evaluated if the conservation pool is raised above 230 feet:

- Congressional authorization for conversion of more than 50,000 af from flood to conservation storage;
- Inundation of mitigation wetlands (mitigation for replacing previous mitigation areas);
- Impact to USACE infrastructure (levee system) and water control devices;
- Loss of acreage in the WOCWMA, including hardwood forests;
- Inundation of property within the determined elevation (Lone Star Ammunition, Red River Army Depot, etc.);
- Additional flood damage downstream of Lake Wright Patman (if any);
- Loss or gain of habitat;
- Loss or change in sedimentation storage over the life of the needed water demand; and,
- Additional concerns and/or impacts identified in the 2003 USACE yield report.

3.2.5 Data Gap Summary

Planning Data Gaps:

- What volume of water is available from Lake Wright Patman after giving consideration to existing water rights holders, anticipated local needs over the term of a contract period, unexpected local need and retained local excess surplus supply for drought protection?
- How much water is available from existing water rights holders for sale or contract? Which parties would be selling or contracting water?
- What operating level of Lake Wright Patman is reasonable due to the WOCWMA facility and how will operations be modified?
- What is the expected yield of Lake Wright Patman under the most reasonably achievable operating scenarios?

Permitting/Design Data Gaps:

- In order to increase the water supply yield of Lake Wright Patman, what action is needed from the following organizations or agencies?
  - US Congress (Congressional authorization for reallocation of flood storage to water supply over 50,000 ac-ft) or 15% of total storage.
  - USACE (operating changes, WOCWMA structures, additional flood impact analysis, impact on downstream navigation from loss of flood storage, potential replacement of flood protection and mitigation for Jim Chapman Lake).
  - Region C Regional Water Planning Group – incorporation as a recommended water management strategy for specific water user groups.
  - Project Sponsor(s) – Apply for permits and implement strategy.
  - TWDB. (approval of applicable regional water plan and adoption of State Water Plan Amendment)
- Environmental permitting (EIS, 404 issues, water quality issues, habitat and ecological analysis, pipeline mitigation, etc).
- Cost estimating (pipeline, mitigation, permitting, etc.).
- What is the mitigation impacts for each change in reservoir operation considered?
- What is the current procedure and process for evaluating mitigation and developing a Mitigation Plan?
- What role could recent rules for mitigation banking play in each scenario?

3.3 LAKE TEXOMA

The analysis completed during Task 1 revealed the potential available water supply from Lake Texoma as follows:

Strategy 1: Develop Oklahoma's yield that is not currently contracted (160,673 afpy) for Texas in 2060; and,

Strategy 2: Reallocate additional hydropower storage for water supply in Texas.

3.3.1 Strategy 1: Develop Oklahoma's Unused Water Supply Allocation

The 2006 Region C Water Plan assumes water within Lake Texoma allocated to Oklahoma is not available for use in Texas. However, it is theoretically possible for Oklahoma to allow Texas to purchase and/or use water currently allocated to Oklahoma. If this option is to be utilized the Oklahoma moratorium for sale of water to Texas would have to be lifted.

3.3.2 Strategy 2: New Reallocation from Hydropower to Water Supply

Of the 37 studies reviewed per Task 1 for Lake Texoma, the 2006 Region C Water Plan is the only document that discusses the possibility of developing additional hydropower storage. However, the 2006 Region C Water Plan also mentions that no entities are currently pursuing reallocation of hydropower to water supply. The reality of hydropower storage reallocation at this time is not feasible.

The 2006 Region C Water Plan assumed Oklahoma water would be available to Texas by 2060. However, it is theoretically possible for Oklahoma to allow Texas to purchase and/or use water allocated to Oklahoma in the future. Reallocation of hydropower storage (150,000 afpy for Texas) was authorized under the Water Resources Development Act (WRDA) in 1986. In 2001, the USACE initiated a study to evaluate the reallocation and complete the related environmental assessment in 2006. Additional environmental studies were complete in 2008. The reality of hydropower storage reallocation at this time is not feasible. If it become feasible in the future the environmental issues identified in Section 1 will need to be addressed (ie desalination, brine disposal, etc.).

3.3.3 Data Gap Summary

<u>Planning Data Gaps:</u>

- No large data gaps in the planning phase.

<u>Permitting/Design Data Gaps:</u>

- Long term Oklahoma law will need to be assessed to determine if Oklahoma will be able to sell water to Texas.
- If additional water from Oklahoma portion of Lake Texoma is sold to Texas environmental permitting will have to be completed (EIS, impact of the invasive Zebra Mussel, etc.).
- If additional water from Oklahoma portion of Lake Texoma is sold to Texas water quality will need be further evaluated (blending, desalination, brine disposal, etc.).
- If additional water from Oklahoma portion of Lake Texoma is sold to Texas the TCEQ interbasin transfer permitting issues will need to be addressed.
- It is unlikely that additional hydropower storage could be converted to water supply. However, if this alternative is to be evaluated congressional authorization would need to be obtained.

3.4 TOLEDO BEND RESERVOIR

Three major water suppliers (NTMWD, TRWD and DWU) from Region C are considering water from Toledo Bend as an alternative water supply. The SRA considers water from Toledo Bend as a potential water supply. The costs, feasibility and impacts of implementing this transfer of water have yet to be fully considered. The notes and lists below identify potential gaps found from the literature review of existing studies and other information gathering efforts.

3.4.1 Water Supply Alternative, Amount and Responsible Entity

The alternative (Supply from Toledo Bend) varies in nature depending on the participation of NTMWD, TRWD and SRA, as in the Region C report, or if others participate such as DWU, UTRWD and SRA-LA. Quantity varies from report to report. Region C report recommends 200,000 afpy for NTMWD, 200,000 afpy for TRWD and 100,000 for SRA in Upper Basin of the Sabine and also includes 200,000 afpy as an alternate supply for DWU (a 40% increase).

Water supply alternatives can vary greatly depending on the timing of the demand (typically reported as needed in 2060) and success at implementing other supplies. Recommendations in both Region C and I Water Plans identify and a transfer of 400,000 afpy for Region C from Region I. The DWU report[15] calls for 100 MGD from Toledo Bend, and notes that Upper Sabine could need 100,000-200,000 afpy.

It is unclear which entity (ies) would be responsible for the development of infrastructure and how operations and maintenance (O&M) would be carried out among them.

3.4.2 Yield

Yield of over 1,000,000 afpy for the Texas share (1,043,000 afpy) reported in Region C study is based on an older (1991) yield study;[5] and does not use current data used in WAM.

Yields using water availability models typically range from 5 to 10% lower than the yield from the 1991 report,[174, 139] depending on assumptions. The lowest yield reported is from 2005 TCB report and was 911,000 afpy assuming: 1) no modification to hydropower operations; 2) no instream flow requirements; and 3) no bay and estuary flow requirements. All but one yield run ignored hydropower releases. Condition A yield run from the East Texas Region Special Study No. 1: Inter-Regional Coordination on the Toledo Bend Project[134] assessed the potential water availability under the current hydropower release scenario. Instream flows and Bay and Estuary requirements are not accounted for in most yield analyses. The East Texas Region Special Study No. 1[134] states "Currently, 144 cfs is constantly released from the reservoir to maintain the aquatic habitat immediately downstream of the dam." Senate Bill 3 requires that instream flow requirements and bay and estuary requirements be provided by December 2010. Studies are currently being performed to address this requirement. The resulting yield of Toledo Bend will need to be evaluated once these environmental flow requirements are in place.

Future sedimentation is typically not accounted for in the yield. The 2006 Region Water Plan[37] showed a 37,500 afpy reduction due to sedimentation by 2060.[37]

Summary of yield estimates: Texas share of reservoir yield is 1,043,000 afpy from the 1991 study.[5] Reported estimates using TCEQ WAM Run 3 vary between 911,000 to 974,500 afpy.[174, 139]

Although none of the reports proposed to purchase Louisiana's share of Toledo Bend water, Louisiana does have yield equivalent to the Texas share yields reported above.

3.4.3 Water Rights Permits and Commitments

SRA Texas has a permit to withdraw 750,000 afpy, with 20,000 ac-ft already committed to stay within the Sabine River Basin.

SRA Texas has a permit pending with TCEQ for an additional 293,300 afpy withdrawal (that is administratively complete).

SRA Louisiana does not have a permitting process but does have 65,529 afpy committed in contracts or options.

3.4.4 Cost

2006 Region C Water Plan[37] Table 4D.2 lists $2,428,789,000 for its share of capital costs for Toledo Bend Reservoir (maximum supply available to Region C: 600,000 afpy) and $1,920,000,000 for the recommended strategy of 400,000 afpy to the Metroplex (200,000 afpy each for both NTMWD and TRWD) from Toledo Bend (p. 4D.9). The unit costs were reported as $1.50 per 1,000 gallons for the 600,000 ac-ft strategy and between $1.56 and $1.92 per 1,000 gallons for the recommended strategy. The costs are presented in Tables U-17 and U-18 of the 2006 Region C Water Plan.[37]

Toledo Bend Group Summary Report on Alternatives 9 and 10,[35] which may have formed a partial basis for information used in the Region C report, lists the following capital costs: Alternate 9 - $3.20 billion and Alternate 10 - $4.04 billion. Alternate 9 is most similar to the recommended strategy from Region C report, but it has 600,000 afpy going to the Metroplex (200,000 afpy to each entity – DWU, NTMWD and TRWD) Alternate 10 was for 1,000,000 afpy.

East Texas Region Special Study No. 1: Inter-Regional Coordination on the Toledo Bend Project[134] is the most recent report documenting costs for the Toledo Bend to Region C alternative. The initial capital cost of the project is $4.6 billion (2007 dollars) for a total supply of 700,000 afpy and $2.4 billion for a supply of 500,000 ac-ft per year (both of these figures includes a 100,000 ac-ft supply to the Upper Sabine. This equates to $2.43/1000 gallon for the larger project and $2.63/1000 gallons without DWU participation. Unit costs for each participant vary significantly depending on pipeline distance and operational considerations.

See page 2-8 of the East Texas Region Special Study No. 1: Inter-Regional Coordination on the Toledo Bend Project[134] for comparison of updated Toledo Bend route costs to those from 2006 Region C Plan: The capital costs for the updated routes for the 700,000 afpy project are 40% higher than the costs estimated for the 2006 plans. For the 500,000 afpy project, the total cost increases are approximately 25%.

Costs did not include cost to purchase raw water from Toledo Bend. Water transmission costs are contingent on routes, destinations (i.e. which reservoir and/or treatment plant the water is moving to) and participating entities; and no set route has been established.

A plan for phasing in of supply as demand increases is not documented.

3.4.5 Permitting Requirements

Permitting for interbasin transfers is a definite requirement for this alternative water supply plan and can take many years to complete. Permitting should be considered for estimating costs and establishing a timeline for this option.

- Interbasin Transfer required.
- TCEQ Water Rights Permitting by SRA.
- Environmental permitting, mainly 404 and wetlands, related to the pipeline route (which is not set).
- A study is needed to determine the cost and time needed for permitting.
- As a result of the FERC re-licensing process, operational changes may be required for the reservoir in the future which could potentially affect (positively or negatively) the availability of additional firm yield water.

3.4.6 Identified Environmental Impacts (Water Quality listed separately)

There are many environmental factors to take into consideration with this alternative water supply option. An environmental impact study needs to be conducted based on routing configurations.

- Reduced instream flows and bay and estuary flows – additional study needed
- BBEST Study currently in progress - Work will be completed by August 2009 and the report should include analysis of various conditions at selected control points and the utilization of the WRAP computer program to analyze water availability at selected control points along the Sabine and Neches Rivers. Part of the analysis of conditions involves using the "Use of Hydrologic Data in the Development of Instream Flow Recommendations for the Environmental Flows Allocation Process" report.
- In A Natural Resource Survey for Proposed Reservoir Sites and Selected Stream Segments in Texas[169] Toledo Bend Reservoir stream segment is designated Code E for Endangered Species. Additional study may be needed to determine risk to threatened and endangered species (i.e., entrainment at intake, water quality, etc.)
- A study is needed to determine loss of habitat/mitigation requirements for construction of the pipeline.
- Fluctuation in lake levels could be detrimental to fish communities and spawning.[58]
- See East Texas Region Special Study No. 1: Inter-Regional Coordination on the Toledo Bend Project[134] 177, Section 4.2.1 for Recommended Target Freshwater Inflows
- TPWD issued a report entitled Freshwater Inflow Recommendations for the Sabine Lake Estuary of Texas and Louisiana (March 2005)
- Invasive species

3.4.7 Water Quality

- Potential change in water quality of receiving reservoir study may be needed.
- Study is needed to evaluate a potential decrease in DO and increase in TDS in Toledo Bend and downstream in the Sabine River when downstream discharges are reduced from reduced releases and hydropower.
- Study is needed to determine salinity of downstream estuaries due to reduction in downstream flows.

- East Texas Region Special Study No. 1: Inter-Regional Coordination on the Toledo Bend Project [134] Section 3.2 Water Quality for water quality criteria and anticipated data needed for modeling impacts to water quality.

3.4.8 Operation Considerations

- Hydropower impacts on yield are not known.
- Hydropower is presumed to decrease in lieu of water supply in the future, but this is not substantiated.
- Lower reservoir levels could affect the amount of hydropower generation.[58] Normally, the lake level stays within the top 9.8 feet of storage (i.e., between elevation 162.2 feet and elevation 172.0 feet), which is the specified operating range of the power pool. Hydropower generation will temporarily halt when water level elevation falls below the top of the power head tool.
- Operation with other reservoirs has not been documented.

3.4.9 Summary

Refinements to pipeline routing studies appear to be necessary to determine cost, feasibility and environmental impacts involved in the process. Permitting for the pipeline could involve a number of entities and should be considered proactively. The firm yield for Toledo Bend Reservoir is influenced by hydropower generation, instream flows and sedimentation rates, all of which have some impact on the available supply. Recommendations for water quality data can be found in East Texas Region Special Study No. 1: Inter-Regional Coordination on the Toledo Bend Project,[134] but a study is needed to determine impact to water quality in both the transferring and receiving reservoirs once a pipeline route is established.

3.4.10 Data Gap Summary

Planning Data Gaps:

- How often will the transfer and sale of water from Toledo Bend impact the ability of the reservoir to provide hydropower?

Permitting/Design Data Gaps:

- Cost estimates are outdated and need to be updated. If supply is not economical now these revised cost estimates will also be out of date in the short term future. Cost analysis of Toledo Bend Reservoir should be done later in the process.
- FERC licensing issues.
- Texas water rights and contract from SRA.
- Interbasin transfer permitting issues.
- Water quality impact evaluation, instream and Sabine Lake inflows analysis.
- Mitigation for pipeline, storage and/or pump stations.
- Louisiana issues?

3.5 LAKE O' THE PINES

3.5.1 Introduction

Currently available water supply from LOP is approximately 88,000 acre-feet after all current commitments have been met.[43] An interbasin transfer permit would be required to move Cypress Basin water to the Metroplex area. Three strategies are presented that warrant additional study and consideration.

3.5.2 Water Supply Strategies

3.5.2.1 Strategy 1: Acquire Available Supply

Enter into discussions and contract with NETMWD for the procurement of the available 88,000 ac ft/yr. Construction of new pipelines and pump intakes, etc. will have to be designed and constructed. Two potential pipeline routes and costs have been estimated at $215 million and $202 million within the LOP/Cypress Basin Water Supply Study dated 2003. [44] The distance to Tarrant County to LOP is approximately 120 miles.[70] Additional estimates and costs will need to be updated.

3.5.2.2 Strategy 2: Additional Water Available

Per NETMWD, there is in addition to the 88,000 afpy available, potential additional water from current members and the industrial steel customer. There is water available from current members.[113] NTMWD and NETMWD are in active discussions concerning the supply of water.

Investigate potential water available from current NETMWD customers and end-users for additional water availability. There exists a Cypress Basin Operating Agreement among the TWDB, Titus County Fresh Water Supply District No. 1, the Franklin County Water District, NETMWD, and the Lone Star Steel Company that can be used to assess water availability scenario options.[43]

3.5.2.3 Strategy 3: Flood Storage

The highest water surface elevation in LOP was 245.1 feet and occurred during a flood in 1966.[246] The emergency flood pool begins at 249.5 feet above msl. There is a potential to reallocate flood storage to water supply in LOP.

Investigate the potential to convert flood storage for use. The USACE will not consider a reallocation without a full commitment of the water available such that the 88,000 afpy currently available will have to be allocated with investigation of conversion of flood storage concurrently. There are also considerations with full allocation plus additional flood storage volume to ensure the downstream obligations to Caddo Lake, potential environmental inflows, sufficient flood protection, and severe drought.[246] Again, this strategy will be the most difficult to achieve based on the reallocation of flood storage.

3.5.3 Data Gap Summary

Planning Data Gaps:

- What volume of water is available from LOP including permitted water that has not been contracted below elevation 228.5 feet msl? Are there any other consideration for existing water rights holders (including contracts that may not be fully utilized), anticipated local needs over the term of a contract period, unexpected local need and retained local excess surplus supply for drought protection?
- Has sedimentation impacted the total volume of LOP (this would reduce the amount of water available for sale)? A hydrographic study could be performed to evaluate the impact of sedimentation in the reservoir and improve the answer to how much water is available for sale to Region C; the TWDB is currently under contract to conduct a hydrographic study.

Permitting/Design Data Gaps:

- TCEQ interbasin transfer permitting.
- What is the current procedure and process utilized to determine the amount of mitigation required and development of a Mitigation Plan for pipeline construction?
- Environmental permitting for pipeline and pump station construction (EIS, 404 issues, Giant Salvinia, water quality issues, wetlands, pipeline mitigation, etc).
- Cost estimating (pipeline, intake structure and pump station, mitigation, permitting, etc.).
- Is there additional flood storage over the elevation of 228.5 feet that could be reallocated to water supply? Is so, would congressional authorization be needed (over 50,000 ac-ft) or 15% of total storage.

4.0 SOCIOECONOMIC IMPACT ANALYSIS

4.1 INTRODUCTION

In response to SB 3 from the 80th Regular Texas Legislative Session, the Study Commission on Region C Water Supply was tasked with "analyzing the socioeconomic impacts of water supply alternatives on geographic regions where the alternatives are located." Section 3 of this report is the result of the efforts associated with Phase I of the legislatively mandated study to meet this goal.

Phase I of this study sought to review currently existing socioeconomic studies which have been conducted for five specific water supply alternatives including:

- Marvin Nichols Reservoir
- Lake Wright Patman
- Lake Texoma
- Toledo Bend Reservoir
- Lake O' the Pines

Once the relevant literature was identified, a data gap analysis was to be performed. The goal of the data gap analysis was to provide guidance to the Study Commission on the perceived strengths and/or weaknesses of the methodologies and/or results of the previously conducted socioeconomic studies. A further goal of the data gap analysis was to identify areas that might require additional clarification, analysis, or evaluation to produce a useful measure of the socioeconomic impact on the basin of origin of each identified water supply alternative. Upon review of the data gap analysis by the Study Commission, it is the Project Team's intent to seek guidance from the Study Commission on the methodologies and/or techniques to be employed in continuing the socioeconomic impact analysis under Phase II of this study.

4.2 INTRODUCTION TO SOCIOECONOMIC ANALYSIS

At its core, socioeconomics involves the study of the social impact of economic change. For example, the closing of a local factory would not only have an economic impact to a community, but also an impact on the social elements of that community. Local economic growth would deteriorate due to the loss of personal income and contributions to local charitable organizations may also suffer due to the loss of community income. Socioeconomics seeks to quantify this interaction between and among the economic and social environments.

In evaluating water supply alternatives, one of the benefits of socioeconomic analysis is to determine the result of the positive and negative impacts of a water supply alternative, or the net economic impact, to the economy and individuals in the area where the water supply is to be located, otherwise known as the basin of origin. Once determined, this net socioeconomic impact can be compared amongst alternatives, giving decision makers another piece of information with which to make critical water planning decisions.

Socioeconomic impact analysis is, in simplified terms, a "what-if" analysis. It seeks to apply a numerical result to a real-life event. While simple on its face, such analyses can quickly become complex and difficult to understand. Even among professionals, there are many methods and economic and mathematical models utilized to develop the results of such studies. Each method or model has its strengths and weaknesses, and may be appropriate for one analysis and inappropriate for another. Further, as a what-if analysis, socioeconomic studies must rely on assumptions. What one researcher or economist assumes may be completely different than what his or her peers and colleagues may utilize.

Given that there is no exact method for conducting socioeconomic impact analysis, it is important to understand the researcher's methods, assumptions, and goals for their study when evaluating a socioeconomic analysis.

The three components of socioeconomic analysis can be graphically illustrated as follows:

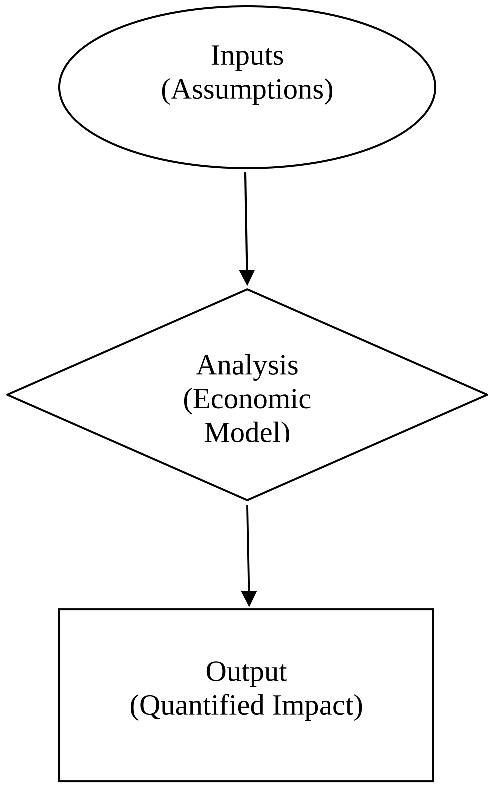

Figure 4.1 Three Components of Socio-Economic Analysis

When reviewing studies, it is important to understand the assumptions utilized, the analysis conducted, and how the output is presented along with what the output is attempting to quantify. Even slight changes in any of these areas can provide vastly different results which could cause the analysis to be misinterpreted. Further, differences in any of these areas could make comparing studies of the same event extremely difficult.

4.2.1 Input-Output Analysis

Possibly the most utilized type of economic model in conducting socioeconomic impact analysis is an input-output model. An input-output model is a computerized program which looks at the output from an industry, and how that output becomes an input to other industries. For example, the output of a farm is fresh fruits and vegetables. This output then becomes an input into the restaurant industry and is modified into food served to customers. A change in the amount of fruits and vegetables demanded by restaurants will have an impact on the farm industry. Input-output analysis examines these interactions and provides a numerical measure of this interaction. For example, if a restaurant closes down and fruits and vegetables are no longer demanded, there will be a corresponding negative impact to the farm industry from this loss. Across the nation, and specifically within the water industry in Texas, the most popular and often used input-output model is the IMPLAN Software and data packages produced by the Minnesota IMPLAN Group, or MIG, Inc.

A more detailed discussion related to the IMPLAN model is contained in Appendix D of this report.

4.3 LITERATURE REVIEW

As part of the scope of services for Phase I of this study, the Project Team has reviewed previously conducted studies for each of the identified water supply alternatives. This review is discussed briefly below by water supply alternative. It should be noted that in conducting the literature review, the Project Team also examined a variety of studies not specifically related to any of the identified water supply alternatives. A comprehensive comparative matrix of all the studies reviewed is presented in Appendix E to this report.

4.3.1 Marvin Nichols Reservoir

4.3.1.1 Literature Review

With potentially the exception of the Toledo Bend Reservoir, which is discussed below, no other reservoir has been subjected to more socioeconomic impact analysis than Marvin Nichols. Two studies have been conducted specific to the reservoir and its potential impact, while a third study provides comment on these two studies. What follows is a brief summary and discussion of each study:

The Economic Impact of the Proposed Marvin Nichols I Reservoir to the Northeast Texas Forest Industry[1]
In August of 2002, Weihuan Xu of the Texas Forest Service produced an economic analysis of the Proposed Marvin Nichols Reservoir I. The purpose of Xu's study was to "assess the economic impact of the potential reduction of timber supply to the local forest industry and the local economy." Xu examined the loss of timber supply from the flood pool of the reservoir, along with the potential loss of timber supply associated with environmental mitigation requirements. In quantifying these losses, Xu utilized input-output analysis, through application of the IMPLAN economic model and databases.

The Economic, Fiscal, and Developmental Impacts of the Proposed Marvin Nichols Reservoir Project[2]
In March of 2003, Dr. Bernard Weinstein and Dr. Terry Clower of the University of North Texas produced an economic analysis of the Marvin Nichols Reservoir. This analysis examined the economic impact of lake construction (including dam, pipeline, and pump station), lake operation, new residential development around the lake, recreational spending from lake visitors, and impacts to the timber industry. Like Xu, Weinstein and Clower also utilized input-output analysis through the use of IMPLAN.

Technical memorandum reviewing and critiquing the draft economic impact analysis of the proposed Marvin Nichols reservoir conducted by Weinstein, L.B. and Clower, T.L. (March

[1]Weihuan, Xu., "The Economic Impact of the Proposed Marvin Nichols I Reservoir to the Northeast Texas Forest Industry." Prepared by the Texas Forest Service of the Texas A&M University System. Publication 162. August, 2002.

[2] Weinstein, L.B. and Clower, T.L. "The Economic, Fiscal and Developmental Impacts of the Proposed Marvin Nichols Reservoir Project." Prepared for the Sulphur River Basin Authority. March, 2003.

2003) and a review of the economic impact analysis conducted by Weihuan, Xu of the Texas Forest Service (August 2002)[3]

Dr. Ray Perryman was engaged by Freese & Nichols, Inc. to review the above two studies and provide an independent assessment of the analyses. Perryman ultimately finds the use of the IMPLAN model appropriate in both cases, but does state that the assumptions regarding mitigation requirements in the Xu study may be exaggerated. He also states that some of the findings by Weinstein and Clower lack substantial foundation.

4.3.1.2 Data Gap Analysis

Based on a review of the above studies, the following data gaps are evident in socioeconomic studies for the Marvin Nichols reservoir:

1. Location of Reservoir Dam Site

   The above studies were conducted in 2002 and 2003, respectively. Since that time, the Marvin Nichols reservoir has undergone further study and the planned site of the reservoir dam has changed. In order to affirm the findings of these studies, the Project Team believes that it may be necessary for these studies to be updated to reflect the most recent plans for the reservoir.

2. Mitigation Requirements

   While both the Xu and Weinstein and Clower studies attempt to quantify the potential mitigation requirements for the reservoir, their assumptions regarding the mitigation requirements vary significantly in terms of the quantity, quality, and location of the mitigation area. Further discussion with the USACE, the agency with ultimate responsibility for determining mitigation requirements, is necessary to affirm that the assumptions regarding mitigation utilized in socioeconomic study are an accurate reflection of what may potentially be experienced as part of reservoir construction.

3. Study Focus

   As discussed, the Xu study focuses solely on the potential impacts to the timber industry due to the construction of Marvin Nichols. In contrast, the Weinstein and Clower study broadens the economic analysis to include a much wider range of potential economic impacts. While both studies are appropriate for their intended purposes, an attempt to compare the studies can lead the reader to vastly different conclusions. As further study is conducted regarding Marvin Nichols, it will be important for the focus of future studies to be broad, so as to encompass all potential economic impacts. On the other hand, if the study is focused solely on a specific economic impact, the focus of the study should be clearly noted in attempt to prevent inappropriate conclusions from being drawn.

[3] Perryman, Dr. Ray. Technical memorandum reviewing and critiquing the draft economic impact analysis of the proposed Marvin Nichols Reservoir conducted by Weinstein, L.B. and Clower T.L, (March 2003) and a review of the economic impact analysis conducted Weihuan, Xu of the Texas Forest Service (August 2002). Prepared for Mr. John Rutledge of Fresse and Nichols, Inc. December, 2002.

4.3.2 Lake Patman Lake

4.3.2.1 Literature Review

During the course of the literature review, the Project Team was unable to locate any socioeconomic impact studies conducted related to water supply alternatives from Lake Wright Patman. News articles were found which refer to events at the lake and the positive economic impact of such events, but the Project Team is unaware of any comprehensive analysis that has been conducted on the use of Wright Patman as an alternative water supply for Region C.

4.3.2.2 Data Gap Analysis

Given that no studies have been conducted concerning water supply alternatives from Wright Patman, the data gap for this analysis is that there is no data. As part of Phase II of this study, the Project Team would recommend that efforts be made to conduct an initial socioeconomic impact study related to water supply alternatives for Region C from Wright Patman.

4.3.3 Lake Texoma

4.3.3.1 Literature Review

In reviewing available literature for Lake Texoma and the economic impact of this reservoir as a water supply alternative for Region C, the Project Team found significant data via news articles and presentations regarding the economic contributions of Lake Texoma. Such contributions include, but are not limited to, the economic impact of shoreline development and the local spending from lake visitors. Much of this data would be collected as part of a socioeconomic impact regarding Lake Texoma as a water supply alternative. However, to-date, no comprehensive analysis appears to have been conducted concerning Lake Texoma as a water supply alternative.

4.3.3.2 Data Gap Analysis

While no specific studies have been conducted concerning Lake Texoma as a water supply alternative, ample data exists as to the economic impact Lake Texoma has on the local area. The most evident data gap that exists for Lake Texoma is that this economic data has not been compiled and applied specifically to the lake as a water supply alternative. While a comprehensive socioeconomic analysis may be helpful to decision makers, it is the Project Team’s opinion that such a study is not necessarily needed to fulfill the objectives of the Study Commission on Region C Water Supply as this water supply alternative would only impact Region C and not Region D.

4.3.4 Toledo Bend Reservoir

4.3.4.1 Literature Review

Two specific studies have been conducted related to the Toledo Bend reservoir as a water supply alternative for Region C. Both studies were conducted by R.W. Beck, Inc.. The first study, conducted in 2005, was later updated as part of a report on interbasin transfers commissioned by the TWDB. This report is discussed in further detail below:

Socioeconomic Analysis of Selected Interbasin Transfers in Texas[4]
This study performed by R.W. Beck, Inc. and funded by the TWDB, evaluates the socioeconomic impact of selected interbasin transfers in Texas, one of which is the interbasin transfer of water from the Toledo Bend Reservoir to Region C. In conducting this study, the authors analyze the positive and negative impacts for both the basin of origin and the receiving basin, determining an overall positive net economic impact of the water supply alternative. Similar to other studies conducted, the IMPLAN economic software and databases were utilized in the application of input-output analysis.

4.3.4.2 Data Gap Analysis

Based on the review of the above updated economic study of the Toledo Bend Reservoir the Project Team identified the following gap related to the analysis of this water supply alternative:

1. Constraint of Economic Analysis / Study Focus

   While the study conducted by R.W. Beck is comprehensive in its focus, including examining the impact of pipeline construction and the impact the additional water will have to support incremental populations in Region C, the study assumes unlimited growth potential over and above the state approved population projections. In other words, the study attempts to examine the economic value of the water supply itself, not necessarily the economic impact that will be realized under realistic growth that can be supported by the incremental water supply. While the study is valid for its intended purpose, it may, on its face, appear to overstate the economic impact if the study's intent is not taken into account.

   Overall, at this time, the Project Team does not feel that the above data gap is necessarily one that must be overcome by the Study Commission on Region C Water Supply. The negative impacts of this supply alternative to Region D are minimal and are, most likely, limited to the short-term impact associated with pipeline construction. It is the Project Team's opinion that no further study of the Toledo Bend Reservoir needs to be undertaken as part of the Study Commission's efforts.

4.3.5 Lake O' the Pines

4.3.5.1 Literature Review

Similar to the Project Team's efforts related to Lake Wright Patman, the Project Team was also unable to locate any socioeconomic impact studies related to water supply alternatives from Lake O' the Pines. Despite an exhaustive search, the Project Team is unaware of any comprehensive analysis that has been conducted on the use of Lake O' the Pines as an alternative water supply for Region C.

4.3.5.2 Data Gap Analysis

Again, similar to water supply alternatives from Lake Wright Patman, the data gap for Lake O' the Pines is that there is no data. As part of Phase II of this study, the Project Team would recommend that efforts

[4] Stowe, Jack. "Socioeconomic Analysis of Selected Interbasin Transfers in Texas." Prepared by R.W. Beck, Inc. for the Texas Water Development Board. October, 2007.

be made to conduct an initial socioeconomic impact study related to water supply alternatives for Region C from Lake O' the Pines.

4.3.6 Summary of Data Gap Analysis

In conducting the literature review and data gap analysis, the Project Team has identified the following data gaps and/or trends that should be noted by the Study Commission.

1. No Data and/or Economic Analysis

   As discussed above, limited or no economic data has been compiled and/or analysis developed for water supply alternatives related to Wright Patman and Lake O' the Pines. As part of Phase II of this study, the Project Team would recommend that initial economic analysis be conducted on these water supply alternatives.

2. Varied Focus of Study Efforts

   In those studies that have been conducted, the studies have either been limited in their scope to a single sector or type of economic impact, or they have been broad, encompassing a variety of economic impacts. This can lead to conclusions being drawn regarding a water supply alternative which may or may not be fully accurate. For example, for the Marvin Nichols reservoir, if an individual considered only the Xu study, they may conclude that the reservoir would have a significant negative economic impact. While this conclusion may be applicable for the impact to the timber industry, the whole economic picture is not presented as Xu focuses solely on impacts to one sector. On the other hand, the Weinstein and Clower study is broader in its focus and provides an analysis of the entire economic impact. The focus of a study must be clearly delineated so that the study is not used to draw inappropriate conclusions regarding a water supply alternative.

3. Lack of Justification for Assumptions

   As previously discussed, socioeconomic impact analysis is dependent on many assumptions. In performing the literature review, the Project Team did note that in certain instances, the assumptions utilized were not adequately identified along with the justification, rational and/or foundation behind the use of the particular assumption. In order for a particular socioeconomic analysis to be properly understood, it is important that researchers properly document their assumptions, the data sources relevant to the development of the assumption, if applicable, and the reasoning as to why the researcher believes the assumption to be appropriate.

4. Consistency in Methodologies Utilized

   Also during the literature review, the Project Team noted that several different types of analyses were utilized in the development of the socioeconomic analysis. For example, while the majority of studies use input-output analysis through the use of the IMPLAN model, some recognize the timing associated with water supply alternatives while others do not. While each type of analysis utilized may be appropriate, a more consistent methodology may produce studies which are more easily comparable, giving decision makers a more refined tool with which to make critical water supply planning decisions.

4.4 RECOMMENDATIONS FOR OVERCOMING DATA GAPS

As discussed in Section 4, there are essentially two types of data gaps which exist related to socioeconomic analysis of the water supply alternatives to be considered by the Study Commission on Region C Water Supply. These include:

1. Limited or no economic data compiled and/or analysis developed for a specific water supply alternative; and/or
2. Inconsistencies in the methodologies, assumptions, and/or focus of studies conducted.

The first of the identified data gaps were applicable to Lake O' the Pines, Lake Wright Patman, and Lake Texoma. To the knowledge of the Project Team, no formal socioeconomic impact analysis has been conducted related to these water supply alternatives. To overcome this data gap, as part of Phase II of this study, the Project Team would recommend that the Commission conduct initial socioeconomic impact analyses for Lake O' the Pines and for Lake Wright Patman. The Project Team is of the opinion that socioeconomic impact analysis is not necessary for Lake Texoma, as this water supply alternative has no direct socioeconomic effect on Region D.

In regards to the second type of data gap identified, this gap was most applicable to the Marvin Nichols Reservoir and the Toledo Bend Reservoir. As sufficient analysis has been conducted on these water supply alternatives, the Project Team does not believe further analysis is warranted at this time. However, the Commission may wish to develop a specific methodology and/or recommended techniques or guidelines for conducting future socioeconomic analysis so as to produce analyses which are sufficiently broad in scope. The development of such a methodology would assist in providing a comprehensive evaluation of the anticipated socioeconomic impact associated with a water supply alternative. As listed below, the Project Team has identified certain objectives the Commission may wish to consider in the development of methodologies, techniques, and/or guidelines for conducting future socioeconomic impact studies.

- **Objectivity** – The chosen methodology should produce an objective result. The analytical data utilized in assumptions should come from widely accepted and publicly available sources, and sufficient citation should be provided so as to allow an objective third-party to verify the analytical inputs.

- **Broad in Focus** – The chosen methodology should seek to evaluate and/or quantify as many impacts as may be identified for a specific supply alternative.

- **Quantifiable** – Where possible, all impacts should be objectively quantified. In the event that data is unavailable to objectively quantify an impact, the impact should be qualitatively identified.

- **Conservative** – The chosen methodology should produce conservative results, that is, economic impacts should not be overly inflated. All assumptions should be based on historical performance where possible so as to prevent unreasonable outputs.

- **Reproducible** – The methodology and results of said methodology should be well explained, documented, and easily reproducible by an objective third-party.

- **Professionally Accepted** – The methodology should use data and/or analytical concepts which have been widely used and/or industry accepted.

In an effort to assist the Study Commission in overcoming this data gap, the Project Team has developed an initial outline of a potential methodology to be used for conducting socioeconomic impact analysis as part of Phase II of this study. This methodology is presented in Appendix F of this report. Further, for example purposes, the methodology has been applied to the Toledo Bend Reservoir as a water supply alternative. This analysis is illustrated in Appendix G of this report.

EXECUTIVE SUMMARY PHASE II

The Study Commission on Region C Water Supply (Study Commission) was established by Senate Bill 3, Section 4.04, of the 80th Texas Legislative Session. Section 4.04 (e) charged the Study Commission with eight tasks regarding water supply alternatives available to the Region C Regional Water Planning Area. Senate Bill 3 requires the Study Commission to perform these eight tasks. The objective of the Study Commission is to evaluate water supply alternatives to determine if a reasonably equivalent alternative to the Marvin Nichols project is available. This study was commissioned by the TWDB in the later part of 2008. Based on available funding from the TWDB, the Study Commission divided the scope of work defined in Senate Bill 3 into two Phases. This report is a summary of activities performed in Phase II of that division of work.

Phase II of the Study Commission task took the recommendations from Phase I and focused on further data collection and analysis on Lake Wright Patman and Lake O' the Pines as equivalent alternatives to the Marvin Nichols project. Phase II is divided into eleven tasks (1.1 – 1.11) and these tasks are summarized below. Phase II also will summarize the steps needed to quantify the socioeconomic effect to the area from using this water in Region C.

TASK 1.1 Potentially Available Water From Lake Wright Patman

Certificate of Adjudication No. 03-4836 (Appendix I) lists the City of Texarkana (Texarkana) as the water right holder of 180,000 acre feet per year (afpy) of water from Lake Wright Patman. Based on the permitted water rights available to Texarkana (180,000 afpy), the total amount of unused permitted water from Lake Wright Patman can be determined by subtracting contracted water rights from the total permitted water rights. Through discussions with Texarkana and Riverbend Water Resources, as well as review of the TCEQ Water Rights database, it was determined that Texarkana has contracts for approximately 122,500 afpy of the 180,000 afpy permitted water. The remaining 57,500 afpy of un-contracted water rights could be available for contract through Texarkana (Table ES 1). The use of this 57,500 afpy would also require future contracts between Texarkana and the entities that would utilize the water. In order to obtain 180,000, Texarkana would need to get USACE to change their lake operating procedure.

Table ES 1. Lake Wright Patman Estimated Available Water

City of Texarkana Water Rights	Industrial	Municipal	Total
Permitted Water Rights (afpy)	135,000	45,000	180,000
Contracted Water Rights (afpy)	(120,000)	(2,500)	(122,500)
Un-contracted Water Rights (afpy)	15,000	42,500	**57,500**

TASK 1.2 Water Available From Existing Owners of Lake Wright Patman Water Rights

Espey Consultants, Inc. (EC) conducted discussions with the Texarkana, Riverbend Water Resources and International Paper Corporation (IP) to determine quantities of "unused" contracted water rights. Review of data provided by IP show the average diversion of raw water, over a 14 year period (1994–2007), to be approximately 36,828 afpy. Preliminary communications with Texarkana and IP indicate a willingness to discuss the redistribution of portions of this "unused" contracted water. It is estimated that about 60,000 afpy of water could be available from IP to redistribute to new water users (Table ES 2). Information found in Table ES 2 is defined in more detail later in this report. Again, the redistribution of the "unused" contracted water would require new contracts for the new water users.

Table ES 2. Potentially Available Unused Water from International Paper Corporation

International Paper Water Rights	afpy
Contracted Water Rights	120,000
Average Annual Diversion (1994-2007)	(36,000)
Estimated Retained Water for Unexpected Needs	(24,000)
Potentially Available Unused Water	**60,000**

TASK 1.3 Lake Wright Patman Operating Levels With Consideration for White Oak Creek Wildlife Management Area

To assist in determining a reasonable operating level, EC held meetings and discussions with Texarkana, the Texas Parks and Wildlife Department (TPWD) and the United States Army Corp of Engineers (USACE). As a result of these meetings, the EC team identified several operation levels of interest. These levels consisted of conservation pool elevations of 228.6, 230.0, 235.0, and 240.0 feet msl. To determine the amount of land inundated and impact to sensitive ecosystems, EC analyzed the latest Texas Ecological Systems Database dated November 30, 2009 as well as data provided directly by TPWD. Table ES 3 provides an estimate of Lake Wright Patman firm yield as well as acreage of land area and ecosystem type inundated if the lake were operated at elevations 230 and 240 feet msl. Contour information was not available for elevations of 228.6 or 235.0 msl.

The challenges with each of these operating levels are discussed in detail in this report. For the purposes of this summary a ranking of the difficulty of these operating levels is included in Tables ES 3 and ES 4. The difficulty of operating Lake Wright Patman at these levels is subjective and is based on current knowledge derived from information obtained as part of this report as well as discussions with the TPWD, USACE and Texarkana. The difficulty levels are based on factors such as inundation area, reallocation procedures, mitigation decisions, environmental permitting, impact to the WOCWMA, etc.

Table ES 3. Estimated Firm Yield, Land Area and Ecosystem Area Inundated

	Lake Wright Patman Operating Scenarios	
Upper Conservation Pool Operating Elevation	**230 foot (msl)**	**240 foot (msl)**
Estimated Total Firm Yield*	514,505	790,800
WOCWMA Land Inundated	521	3,596
Area - Wide Land Inundated	11,961	32,666
WOCWMA Hardwood Type Ecosystem Inundated	349	2,712
Area - Wide Hardwood Type Ecosystem Inundated	8,101	24,123
WOCWMA Wetland Type Ecosystem Inundated	0	224
Area - Wide Wetland Type Ecosystem Inundated	221	557
Implementation Difficulty	difficult	very difficult

* Estimated Yield based on flat operating curve and 215.25 lower conservation pool elevation

TASK 1.4 Expected Yield of Lake Wright Patman

Yield analysis of Lake Wright Patman was performed using the latest available TCEQ WAM input files for the Sulphur River Basin dated August 6, 2008. Table ES 4 provides firm yield estimates for lake operating scenarios up to 240 feet msl.

Table ES 4. Lake Wright Patman Firm Yield Estimates at Various Operating Elevations

Reservoir Reallocation Scenario	Upper Conservation Pool Elevation (msl)	Lower Conservation Pool Elevation (msl)	Estimated Total Firm Yield (afpy)	Implementation Difficulty
Ultimate Curve (1)	224.89 - 228.64 feet	220 feet	184,591	likely
Ultimate Flat Curve (1)	228.64 feet	215.25 feet	363,717	likely
Scenario 1 (2)	230 feet	215.25 feet	514,505	difficult
Scenerio 2 (2)	235 feet	215.25 feet	669,790	medium difficulty
Scenario 3 (2)	240 feet	215.25 feet	790,800	very difficult

(1) Freese and Nichols, System Operation Assessment of Lakes Wright Patman and Jim Chapman, 2003
(2) 2010 Espey Consultants, Inc. firm yield estimate

TASK 1.5 Additional Information Needed to Allow Consideration of Each Operating Scenario

For each of the three operating scenarios proposed (230.0, 235.0, and 240.0 msl) additional information will need to be collected and analyzed to allow consideration of these strategies as equivalent alternatives to the proposed Marvin Nichols Reservoir.

Scenario No. 1 – 230 foot Constant Operational Level of Lake Wright Patman
Communications with the USACE indicate that operating Lake Wright Patman at or above a flat conservation pool elevation of 228.64 feet would constitute a reallocation of flood storage to conservation storage exceeding 50,000 acre-feet and would require Congressional authorization[5].

Additional Information Needed:

- Information to support a reallocation plan that meets state and federal requirements;
- Sources of funding would need to be identified;
- Determine impact to WOCWMA ecosystems caused by higher operating levels and the backwater effect;
- Evaluate integrity of levee system at higher lake operating levels;
- Identify ecological benefits of higher water elevations;
- Evaluate changes to floodplain resulting from higher releases and increase in lake elevation;
- Estimate impact of shoreline erosion caused by higher lake operating level;
- Update Sulphur Basin WAM input files to include drought of 2002 – 2004;
- Predict any loss or change in sedimentation storage over the life of the needed water demand;
- Determine the impact of a lower bottom of conservation pool elevation of 215.25 feet;
- Design a flexible wetland management plan

Scenario No. 2 – 235 foot Constant Operational Level of Lake Wright Patman
In addition to the information needed for Scenario 1 to be considered an equivalent alternative to Marvin Nichols Reservoir, Scenario 2 would need the following additional information gathered:

Additional Information Needed:

- Due to the complexity and number of possible impacts caused by this scenario, a Basin Wide Study is recommended
- There is inconsistent data regarding the elevation of the lowest control structure in the WOCWMA – Verify this elevation

- Determine the feasibility of raising the elevation of the lower water control structures in the WOCWMA to minimize the impact of a 235 foot operating level
- Determine the feasibility of adding pumps to assist in the management of the WOCWMA wetlands and bottomland hardwood forest ecosystems
- Determine impact of shoreline erosion caused by a higher lake operating level
- Determine inundation of property at the modified surface water elevation;
- Collect LiDAR data of Lake Wright Patman, WOCWMA and surrounding areas to support GIS habitat/ecosystem mapping using one foot contour lines
- Determine potential for additional flood damage downstream of Lake Wright Patman

Scenario No. 3 – 240 foot Constant Operational Level of Lake Wright Patman
For Scenario 3 to be considered a reasonable alternative to Marvin Nichols Reservoir much of the same information for Scenario 1 and 2 would need to be gathered. Due to the increased operational level of Lake Wright Patman to 240 feet, Freese and Nichols (2003) estimated that approximately 3,800 acres of WOCWMA land would be inundated (approximately 15 percent of the total 25,500 WOCWMA). At this operational level approximately 33,000 acres of Lake Wright Patman area-wide habitat would be inundated. Additional detailed study would need to be conducted to determine the effect of this operational level on the groundwater table and soil saturation zone in the affected areas. An elevated groundwater table may negatively impact more acreage of hardwood forest than is represented by the contour line at a 240 foot elevation. The higher costs for environmental and cultural resource investigation would need to be determined as well as the need to determine mitigation for losses at Atlanta State Park.

Additional Alternatives
In 2003, Freese and Nichols estimated that an additional 108,000 afpy could be made available to Lake Wright Patman by system operation of Lakes Wright Patman and Jim Chapman. Further study would need to be conducted to determine the impact of raising the upper conservation pool elevation of Lake Wright Patman above 228.64 feet and its affect on system operations of these two reservoirs.

Other issues that could also effect the selection of operation scenarios include possible restrictions of moving water from one reservoir to another. These restrictions could be based on invasive vegetation or animals that are found in the source reservoir and should not be transferred into the receiving reservoir. Storage volumes in Lake Wright Patman are owned by a water provider. Any increased yield could potentially only benefit those owners.

TASK 1.6 Cost Estimate for Wright Patman Conveyance

The costs to increase storage in Lake Wright Patman and construct a conveyance system to water suppliers in Region C were estimated using cost estimation procedures documented in the 2011 Initially Prepared Water Plan for Region C and Table Q-29 of the 2011 IPP as a template for unit cost calculations. Cost elements associated with increasing storage and reallocation of flood storage were based on limited information available from USACE. More definitive cost data for these elements will be available after completion of the Sulphur River Basin Feasibility Study proposed by USACE.

Cost estimates in 2008 dollars for Phase 1 and 2 pipelines from Lake Wright Patman to the Region C area are summarized in Table ES 5. A comparison of project costs for Lake Wright Patman and Marvin Nichols Reservoir are presented in Table ES 6. Costs for Marvin Nichols were obtained from the 2011 IPP for Region C. The cost analysis for Lake Wright Patman contained more detail in route location, pumping elevation, pump design and cost, pipeline routing in the Region C area (reservoir to reservoir), etc. Additional cost detail should be added to the Marvin Nichols estimate to ensure the comparability of the cost estimates. At the time of this report the additional details for the cost estimates of Marvin Nichols were not available.

Table ES 5. Cost Estimate to Convey Water From Lake Wright Patman to Region C

Operating Elevation Scenario	**230 feet**	**235 feet**	**240 feet**
Water Volume (afpy)	**500,005**	**655,290**	**776,300**
Phase 1 Costs			
Raw Water Improvements	$159,778,000	$305,777,000	$460,275,000
Phase 1 Pipeline	$1,504,135,000	$1,637,049,000	$1,878,374,000
Phase 1 Pump Station	$284,225,000	$314,886,000	$347,775,000
Sub Total Phase 1 Construction Costs	**$1,948,138,000**	**$2,257,712,000**	**$2,686,424,000**
Phase 2 Costs			
Phase 2 Pipeline	$1,381,912,000	$1,621,453,000	$1,861,866,000
Phase 2 Pump Station	$210,245,000	$307,076,000	$339,965,000
Sub Total Phase 2 Construction Costs	**$1,592,157,000**	**$1,928,529,000**	**$2,201,831,000**
Total Construction Costs	**$3,540,295,000**	**$4,186,241,000**	**$4,888,255,000**
Phase 1 Permitting and Mitigation	**$35,403,000**	**$41,862,000**	**$48,883,000**
Phase 1 Interest	$237,030,000	$274,696,000	$326,857,000
Phase 2 Interest	$193,718,000	$234,644,000	$267,897,000
Total Interest	**$430,592,000**	**$509,340,000**	**$594,754,000**
Phase 1 Costs	$2,220,571,000	$2,574,270,000	$3,062,164,000
Phase 2 Costs	$1,785,875,000	$2,163,173,000	$2,469,728,000
Total Project Costs	**$4,006,446,000**	**$4,737,443,000**	**$5,531,892,000**
Phase 1 Annual Costs			
Operation & Maintenance	$22,147,000	$24,243,000	$27,478,000
Electricity ($0.09/kWh)	$56,358,000	$67,667,000	$76,811,000
Debt Service 6% for 30 years	$161,322,000	$190,306,000	$222,463,000
Raw Water Purchase (100,000 afpy Texarkana)	$10,101,000	$10,101,000	$10,101,000
Total Annual Cost Phase 1	**$249,928,000**	**$292,317,000**	**$336,853,000**
Phase 2 Annual Costs			
Operation & Maintenance	$19,075,000	$23,891,000	$27,118,000
Electricity ($0.09/kWh)	$43,631,000	$67,667,000	$75,990,000
Debt Service 6% for 30 years	$129,742,000	$157,152,000	$179,423,000
Total Annual Cost Phase 2	**$192,448,000**	**$248,710,000**	**$282,531,000**
Unit Costs (until amortized)			
per Acre-foot Phase 1	$1,000	$882	$868
per Acre-foot Phase 2	$770	$759	$728
per Acre-foot Total	$885	$821	$798
Unit Costs (after amortization)			
per Acre-foot Phase 1	$354	$311	$295
per Acre-foot Phase 2	$251	$279	$266
per Acre-foot Total	$303	$295	$280

These estimates are based on the scenario to develop 390,000 afpy from Lake Wright Patman presented as Table Q-29 in the 2011 Initially Prepared Water Plan for Region C and revised with information provided by the Fort Worth District of USACE. Additional details are provided in Section 1.6 of this report.

Table ES 6. Comparison of Cost Estimates to Convey Water From Lake Wright Patman and Marvin Nichols Reservoir to Region C

Water Supply Project	Lake Wright Patman			Marvin Nichols I[1]
Operating Elevation Scenario	**230 feet**	**235 feet**	**240 feet**	**Reservoir and Transmission System**
Water Volume (afpy)	**500,005**	**655,290**	**776,300**	**495,300**
Total Project Costs	$4,006,446,000	$4,737,443,000	$5,531,892,000	$3,300,565,000
Cost per Acre-foot (until amortized)	$885	$821	$798	$677
Cost per Acre-foot (after amortization)	$303	$295	$280	$187

[1]From Table Q-20, 2011 Initially Prepared Water Plan for Region C.

TASK 1.7 Volume of Available Water from Lake O' the Pines

Permitted Versus Contracted Water Rights

The 2011 Region D Initially Prepared Water Plan (IPP) [1] for TWDB lists water supply from LOP to be 182,000 afpy through 2060. The IPP lists the projected water demand through existing contracts of NETMWD to be 148,000 afpy. The difference between this available supply and the contracted demand is estimated at 34,000 afpy (Table ES 7). The use of this 34,000 afpy would also require future contracts between NETMWD and the entities that would utilize the water.

Table ES 7. Lake O' the Pines Water Supply, Contracted Demand and Un-contracted Water

Supply and Demand	Water (afpy)	Estimated Water Available (afpy)
Available Water Supply *	182,000	
NETMWD Contracted Water Demand *	(148,000)	
Estimated Un-Contracted Permitted Water		**34,000**

* Region D Initially Prepared Water Plan. March 2010

Redistribution of Existing Water Rights

In addition to un-contracted water rights, it may be possible to purchase a portion of unused water from the current users and owners of these water rights. EC had discussions with NETMWD and determined an estimate for the unused portion of the existing contracts. The amounts of unused water that could be redistributed to other entities are summarized in Table ES 3. The NETMWD estimates the volume of available water in Lake O' the Pines to be approximately 100,000 afpy (See Table ES 8).

Table ES 8. Lake O' The Pines Estimated Available Water

Owner / Water Contract Holder	Estimated Available Water* (afpy)
NETMWD Uncontracted Water	34,000
US Steel Corporation	31,000
NETMWD Member Cities	36,000
Total Estimated Available Water	**101,000**

* Estimated water availability data provided by the NETMWD

TASK 1.8 Lake O' the Pines Water Right Holder Considerations, Needs, Surplus and Drought Protection

Water demand data listed in the Region D 2011 IPP[1], as well as discussions with the NETMWD regarding unused water from US Steel Corporation and the Member Cities, indicate that NETMWD's estimate of available water (100,000 afpy) takes into consideration anticipated and unanticipated local needs, existing water right holders, releases for Caddo Lake, and retained local surplus for drought protection.

TASK 1.9 Lake O' the Pines Cost Estimate

Cost estimate data for Lake O' the Pines conveyance to Region C area is summarized in Table ES 9.

Table ES 9. Cost Estimate to Convey Water from Lake O' the Pines to Region C

Water Destination	DWU East Side WTP[1]	NTMWD Leonard New WTP[2]	TRWD Rolling Hills WTP[3]
Water Volume (afpy)	**101,000**	**101,000**	**101,000**
CONSTRUCTION COSTS			
Pipeline	$458,818,000	$382,577,000	$604,893,000
Pump Station	$81,556,000	$71,844,000	$119,834,000
Sub Total Construction Costs	**$540,374,000**	**$454,421,000**	**$724,727,000**
Sub Total Permitting and Mitigation	**$5,404,000**	**$4,544,000**	**$7,247,000**
Interest during construction (24 months)	**$44,132,000**	**$37,113,000**	**$88,178,000**
Total Project Costs	**$589,910,000**	**$496,078,000**	**$820,152,000**
ANNUAL COSTS			
Operation & Maintenance	$6,627,000	$5,622,000	$9,045,000
Electricity ($0.09/kWh)	$13,623,000	$10,788,000	$20,588,000
Debt Service 6% for 30 years	$42,856,000	$36,040,000	$59,583,000
Raw Water Purchase	$9,873,000	$9,873,000	$9,873,000
Total Annual Cost	**$72,979,000**	**$62,323,000**	**$99,089,000**
Unit Costs (until amortized)			
per Acre-foot	$723	$617	$981
Unit Costs (after amortization)			
per Acre-foot	$298	$260	$391

[1]Based on the scenario to develop 89,600 afpy from Lake O' the Pines presented as Table Q-30 in the 2011 Initially Prepared Water Plan for Region C.

[2]Based on the scenario to develop 87,900 afpy from Lake O' the Pines presented as Table Q-31 in the 2011 Initially Prepared Water Plan for Region C.

[3]Based on the scenario to develop 87,900 afpy from Lake O' the Pines presented as Table Q-32 in the 2011 Initially Prepared Water Plan for Region C.

TASK 1.10 Reallocation of Flood Storage Over the Elevation of 228.5 msl

Firm Yield of Lake O' the Pines was modeled using the TCEQ Run 3 (Full Authorization) input files dated January 13, 2010. Firm yield modeling results and conservation storage data for several conservation pool elevations are provided in Table ES 10. Additional firm yield may be available to users based on new water rights and contracts.

Table ES 10. Lake O' the Pines Firm Yield Estimates at Various Operating Levels

Upper Conservation Pool Elevation (msl)	Estimated Total Firm Yield (afpy)	Conservation Storage (afpy)
228.5	153,500	251,000
231	167,000	301,000
235	187,600	392,000

* Conservation storage based on 1958 survey, USACE New Orleans District

TASK 1.11 Lake O' the Pines Reservoir Reallocation Process and Congressional Approval

Congressional Approval

Per the Water Supply Act of 1958, changes in existing allocated storage capacities greater than approximately 50,000 ac-ft or 15 percent of the total storage capacity allocated to all authorized project purposes would result in the need for Congressional approval. Based on data obtained from the original 1958 area/capacity survey of Lake O' the Pines, it is concluded that an increase in the upper conservation pool elevation above approximately 230.5 feet msl would result in a change in storage capacity greater than 50,000 ac-ft which would trigger the Congressional approval requirement.

USACE Reservoir Reallocation Process

When reallocation of a USACE reservoir is desired, numerous federal and state requirements must be met. USACE Official Headquarters guidance on reallocations can be found in engineering regulation ER 1105-2-100 (Planning Guidance Notebook). Periodic Engineering Circulars and Policy Guidance Memorandums can also be issued on this procedure.

There are significant amounts of information still needed for the reallocation process for Lake Wright Patman and Lake O' the Pines. Some of these include mitigation impacts, mitigation ratios, detailed supply analysis, additional cost analysis, economic impacts, conservation pool elevation, cultural resource evaluation, etc. The Sulphur Basin study proposed by the USACE should be performed to assist in developing these and other analyze.

Socioeconomic Impact

Given the variations in water supply alternatives and the varying degrees of economic impact that can be experienced, it is important that when quantifying the anticipated economic impact, each alternative must be studied carefully to determine the total net impact on landowners, agricultural and natural resources, businesses and industries, and taxing entities. It is also important to recognize that some impacts cannot be as easily quantified. The inability to quantify an impact does not decrease its importance – these impacts must also be identified and qualitatively evaluated in order to understand the total impact of a water supply alternative. The steps needed to quantify these impacts are defined in this report.

Conclusion

Additional water is available from Lake Wright Patman and Lake O' the Pines. The amount of water available varies depending on the strategy implemented. There is water available from both reservoirs from existing un-contracted water rights, "unused" contracted water rights, and firm yield created from reallocation of USACE storage. The implication of each of these scenarios is defined in this report. There are still many issues that will need to be addressed if these alternatives are to be developed. Most of these issues can be addressed if the basin-wide study of the Sulphur River Basin is performed. Therefore, it is recommended that the basin-wide study be initiated to obtain the data needed to allow these projects to be evaluated fully.

5.0 INTRODUCTION PHASE II

The Study Commission on Region C Water Supply (Study Commission) was established by Senate Bill 3, Section 4.04, of the 80th Texas Legislative Session. Section 4.04 (e) charged the Study Commission with eight tasks regarding water supply alternatives available to the Region C Regional Water Planning Area. Senate Bill 3 requires the Study Commission to perform these eight tasks. The objective of the Study Commission is to evaluate water supply alternatives to determine if a reasonably equivalent alternative to the Marvin Nichols project is available.

This study was commissioned by the TWDB in the later part of 2008. Based on available funding from the TWDB, the Study Commission divided the scope of work defined in Senate Bill 3 into two Phases. Phase I activities included the collection and review of existing literature and analysis of data gaps associated with five water management alternatives for Region C (the proposed Marvin Nichols Reservoir Site IA and existing Lake Wright Patman, Toledo Bend Reservoir, Lake Texoma, and Lake O' the Pines). In addition, review of existing socioeconomic studies of the five alternatives was performed to identify discrepancies and/or additional data gaps.

Espey Consultants, Inc. (EC) was awarded the contract to complete Phase II, a continuation of the Phase I report completed earlier in 2010. This report constitutes Phase II of the Study Commissions' scope of work as defined in Senate Bill 3. The Phase II Draft Schedule of Work includes tasks that focus primarily on Lake Wright Patman and Lake O' the Pines. Analysis of both of these water bodies was performed to determine the volume of remaining permitted water available, the volume of water that could be reallocated, and cost estimates for each alternative.

Lake Wright Patman was further evaluated to identify reasonable operating levels and the firm yield of the reservoir at those proposed levels. Operating level scenarios were selected using four water surface elevations: 228.64, 230, 235 and 240 feet msl. Lake O' the Pines was studied in detail to determine firm yield estimates and the feasibility of reallocating flood storage. A detailed summary of the reallocation process is also provided in this report.

6.0 PROJECT TASKS

6.1 TASK 1.1 LAKE WRIGHT PATMAN - WATER AVAILABLE FROM LAKE WRIGHT PATMAN

To assist in determining the volume of water potentially available from Lake Wright Patman, EC conducted discussions and held meetings with stakeholders including the City of Texarkana (Texarkana), Riverbend Water Resources (Riverbend), International Paper Corporation (IP) and the United States Army Corp of Engineers (USACE). The 2006 TWDB Region D Water Plan and the 2011 Region D Initially Prepared Water Plan (IPP) were also reviewed to determine potentially available water while giving consideration to existing water rights holders, anticipated local needs, unexpected local need and retained local surplus supply for drought protection.

6.1.1 Permitted and Contracted Water Rights

- Permitted Water Rights
  Water authorized for diversion by the owner of the water right.
- Contracted Water Rights
  Permitted Water Rights that have been "Contracted" by the owner to a user.
- Un-contracted Water Rights
  Permitted Water Rights that have NOT been "Contracted" by the owner to a user.

Water rights are issued by the State of Texas through the issuance of Certificates of Adjudication (COA). Among other things, a COA includes the name of the owner of the permitted water right, the volume and uses allowed for the permitted water, as well as a priority date. The owners of the water rights may "contract" all or a portion of their permitted water. These water right owners may not currently utilize or contract all of their permitted water. As a result, these unused or "un-contracted" water rights may be available for purchase directly from the owner of the permitted water right.

Certificate of Adjudication No. 03-4836 (Appendix I) lists Texarkana as the water right owner of 180,000 acre feet per year (afpy) of water from Lake Wright Patman. This water right allows for diversion of 45,000 afpy for municipal purposes and 135,000 afpy for industrial purposes. Through meetings and discussions with Texarkana, Riverbend, IP, and other local entities, as well as review of the Texas Commission on Environmental Quality (TCEQ) Water Rights database, EC has determined that Texarkana has contracted approximately 122,500 afpy of their 180,000 afpy of permitted water. Based on the permitted water rights available to Texarkana (180,000 afpy), the total amount of unused permitted water from Lake Wright Patman can be determined by subtracting contracted water rights from the total permitted water rights. The remaining 57,500 afpy of un-contracted water rights could be available for contract through Texarkana (Table 6.1). The use of this 57,500 afpy would also require future contracts between Texarkana and the entities that would utilize the water.

Table 6.1 City of Texarkana Permitted and Contracted Water Rights

City of Texarkana Water Rights	Industrial	Municipal	Total
Permitted Water Rights (afpy)	135,000	45,000	180,000
Contracted Water Rights (afpy)	(120,000)	(2,500)	(122,500)
Un-contracted Water Rights (afpy)	15,000	42,500	**57,500**

6.1.2 Region D Water Plan

The 2006 Region D Water Plan[11] and the 2011 Region D IPP[1] were reviewed to identify trends in surface water supplies and demands. The 2011 Region D IPP[1] documents water availability of 180,000 afpy from 2010 through 2060 for Lake Wright Patman. The projected demands for Texarkana are listed as being 108,661 afpy through 2060 (The 2011 Region D IPP lists several entities as needing contract increases to meet projected demand). The difference in supply and demand through 2060, as presented in the 2011 Region D IPP, is 71,339 afpy (Table 6.2).

Table 6.2 Lake Wright Patman Supply and City of Texarkana Demand (afpy)

Year	*Lake Wright Patman Available Supply (afpy)	City of Texarkana Total Demand (afpy)	Potential Surplus (afpy)
2010	180,000	108,661	**71,339**
2020	180,000	108,661	**71,339**
2030	180,000	108,661	**71,339**
2040	180,000	108,661	**71,339**
2050	180,000	108,661	**71,339**
2060	180,000	108,661	**71,339**

*In order to obtain 180,000, Texarkana would need to get USACE to change their lake operating procedure.

The difference between the more conservative estimate of "un-contracted" water right availability (57,000 afpy) and the water potentially available as listed in the Region D 2011 IPP (71,339 afpy) amounts to about 14,000 afpy. This difference may be justified as excess water for unexpected local water needs, contract adjustments to meet projected demand and retained local surplus for drought protection.

6.2 TASK 1.2 LAKE WRIGHT PATMAN - WATER AVAILABLE FROM EXISTING OWNERS

Discussions with IP revealed that IP does not utilize the full amount of the water contracted from Texarkana. The following discussion provides details utilized to estimate the amount of water that could be available to redistribute to other users.

6.2.1 International Paper Corporation – Unused Water Rights

International Paper Corporation (IP) is under contract for 120,000 afpy of Texarkana's 122,500 afpy of contracted water rights. The remaining 2,500 afpy of water rights are contracted with municipal users. IP provided EC copies of water use data from 1994 to 2007 (Figure 6.1). IP also provided discharge data from January 2007 through December 2009 (Appendix J). Review of the water use data shows the average diversion of raw water, over the 14 year period (1994–2007), to be approximately 36,828 afpy (Figure 6.1). Therefore, on average IP did not use 83,000 afpy of the contracted water from Texarkana. Therefore, a portion of that water could be redistributed to other users.

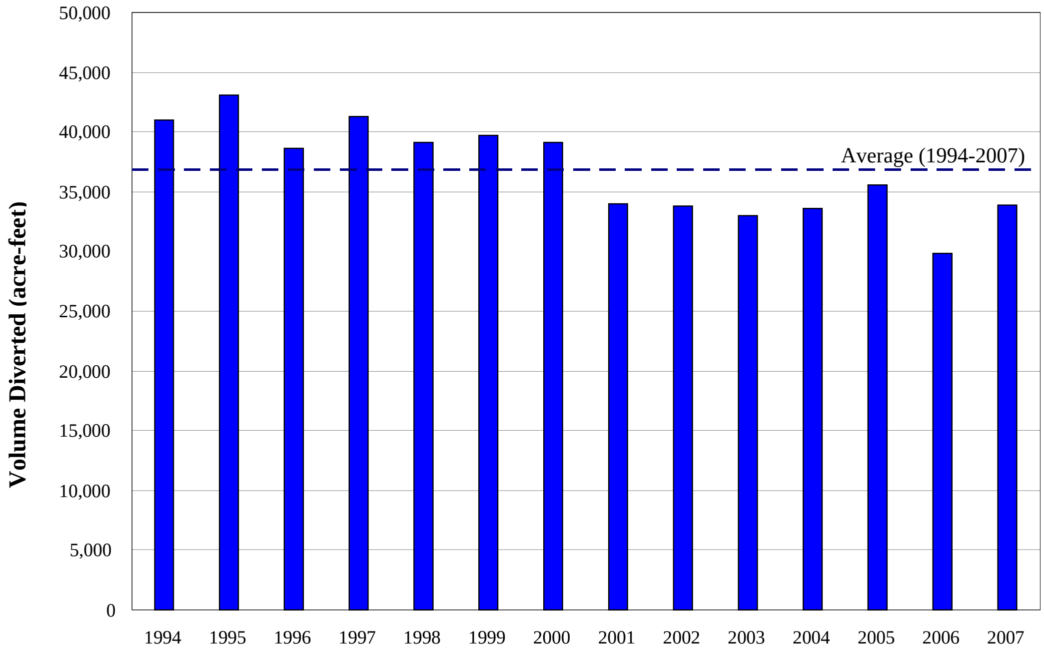

Figure 6.1 International Paper Raw Water Diversion

Preliminary communications with Texarkana and IP indicate a willingness to discuss the redistribution of a portion of this "unused" contracted water. The actual amount of unused water to be redistributed was not discussed. Two approaches to estimate the water available from IP were reviewed and included:

IP Maximum Annual Use Approach

Data provided by IP show the maximum annual water diversion over the 14 year period ending 2007 to be about 43,000 afpy. If this maximum annual diversion is subtracted from the total permitted water right (120,000 afpy) an estimated surplus of 77,000 afpy is obtained. The total of 77,000 could be redistributed for use to other users from IP if no additional water is foreseen to be needed by IP.

IP Average Historical Use Approach

The average annual water diversion over the 14 year period ending 2007 was approximately 36,000 afpy. It could be assumed that IP would want to retain a portion of their unused water for future needs or growth. To obtain a more conservative estimate of water available from IP, it was assumed that IP would retain 20 percent of its existing contracted water (24,000 afpy) in addition to its estimated average annual diversion (36,000 afpy). Therefore, 60,000 afpy could be redistributed to new users (See Table 6.3).

Table 6.3 International Paper - Potentially Available Unused Water

International Paper Water Rights	afpy
Contracted Water Rights	120,000
Average Annual Diversion (1994-2007)	(36,000)
Estimated Retained Water for Unexpected Needs	(24,000)
Potentially Available Unused Water	**60,000**

Therefore, an estimate of the total available water from Lake Wright Patman from un-contracted and unused contracted water can be determined. This amount is calculated by subtracting the contracted water and the unused contracted water from the total permitted water rights. The total water available for use from Lake Wright Patman is 117,500 afpy (See Table 6.4). Again, the redistribution of the "unused" contracted water would require new contracts for the new water users.

Table 6.4 Lake Wright Patman Total Potentially Available Water

City of Texarkana Water Rights	Industrial	Municipal	Total
Permitted Water Rights (afpy)	135,000	45,000	180,000
Contracted Water Rights (afpy)	(120,000)	(2,500)	(122,500)
Water Not Used by International Paper Corp. (afpy) *	60,000		60,000
Potentially Available Water (afpy)	75,000	42,500	**117,500**

* Estimate from data provided by International Paper Corporation

6.2.2 International Paper Discharge Implications

Additional considerations for the redistribution of IP contract water should be given to the discharge of the IP Mill Plant. The discharge of water from IP's Mill Plant contributes to the Sulphur River Basin. The TCEQ requires the discharge from the plant be regulated by the amount of flow in the river. This restriction is primarily in place to protect the water quality of the river. If the river flow is low the amount of discharge allowed from the plant is curtailed. Figure 6.2 illustrates IP's return flow as a percent of Sulphur River flow. The average percent of Mill Plant return flow to river flow over a 36 month period (2007 – 2009) is approximately 14 percent. During this 36 month period there were eight months in which return flow exceeded 20 percent of the river flow. The average annual return flow during the period was approximately 30,661 afpy. Additional study would need to be conducted to determine the affect of changes in return flow and/or river flow on water quality and the associated ecosystems if more of the water from Lake Wright Patman were utilized.

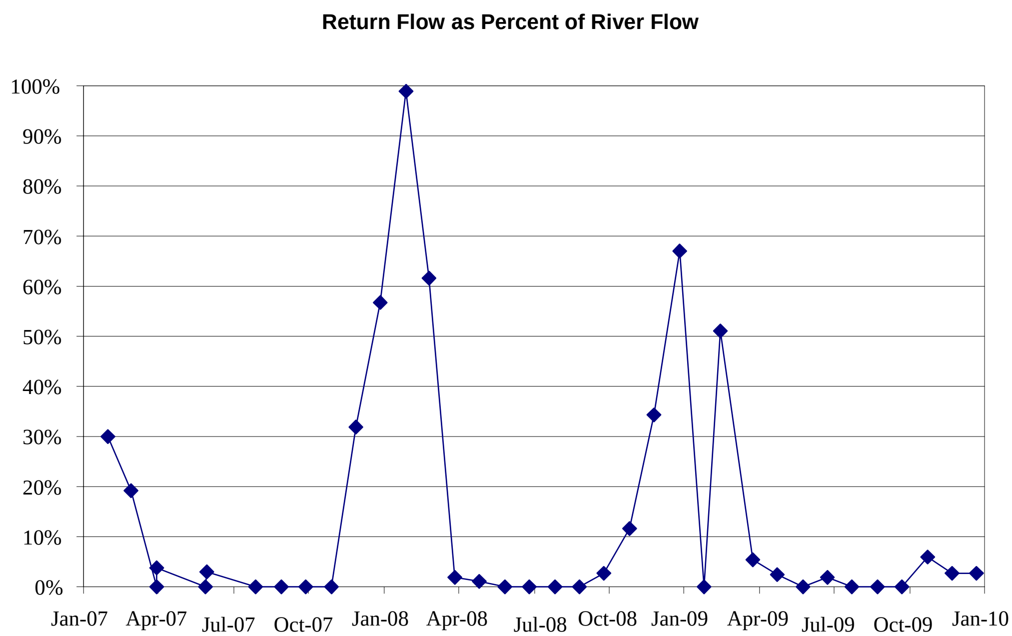

Figure 6.2 International Paper Corporation Return Flow as a Percent of Sulphur River Flow

6.2.3 Major Water Right Holders Who Could Potentially Contract Water:

Texarkana Water Utilities
801 Wood Street
Texarkana, Texas 75501

International Paper Corporation
Texarkana Mill
9978 Farm Market Road 3129
Queen City, Texas 75572
903 796-7101

6.3 TASK 1.3 LAKE WRIGHT PATMAN - REASONABLE OPERATING LEVELS AND THE EFFECTS ON WHITE OAK CREEK WILDLIFE MANAGEMENT AREA

6.3.1 White Oak Creek Wildlife Management Area

The White Oak Creek Wildlife Management Area (WOCWMA) was created as mitigation area for the construction of Lake Jim Chapman. The management area is located in Bowie, Cass, Morris and Titus counties, in northeast Texas, near the Arkansas, Oklahoma and Texas border. The WOCWMA covers approximately 25,777 acres which include 17,000 acres of bottomland hardwood forest[2]. This land is located at the confluence of the Sulphur River and White Oak Creek and is contiguous with other USACE lands. This large extensive tract of bottomland hardwood forest creates a critical corridor of high quality habitat for resident and migratory wildlife species[3]. The area is managed under a license agreement by the Texas Parks & Wildlife Department (TPWD). Outdoor recreation includes hunting, fishing, hiking, horseback riding and wildlife viewing.

6.3.2 Lake Wright Patman Reasonable Operating Levels

To determine reasonable operating levels of Lake Wright Patman, the EC team identified several conservation pool elevations of interest (228.6, 230.0, 235.0, and 240.0 msl). An evaluation was performed to determine the impact of these proposed elevations on the WOCWMA as well as other land within Lake Wright Patman. The difficulty of operating Lake Wright Patman at these levels is subjective and is based on current knowledge derived from information obtained as part of this report as well as discussions with the TPWD, USACE and Texarkana. Previous literature was reviewed to gain insight into the reallocation process, land use and habitat impacts, in addition to the quantity of land area inundated at the various conservation pool elevations. Although reallocation of Lake Wright Patman's flood control pool may provide a valuable source of water, the gains in firm yield that result from modified pool elevations must be weighed against impacts to the WOCWMA and Lake Wright Patman area-wide lands as well as the costs associated with a project of this size and scope.

To assist in determining a reasonable operating level, EC conducted meetings and discussions with the Texarkana, TPWD staff and the USACE. EC also requested additional information (Appendix K) such as:

- Cultural Surveys,
- Archeological Survey and/or site assessments,
- Boundary lines for USACE property,
- Flood easement coverage,
- Recreational facility locations (coverage), including area and site specifics,
- Vegetative mapping,

- WOCWMA boundary coverage,
- Bottomland hardwood boundary coverage (for WOCWMA and USACE),
- Infrastructure in WOCWMA (Roads, Bridges, Levees, water control),
- Public use (hunting, trails, etc.),
- Wildlife impacts (eagles, endangered species),
- Atlanta State Park, and
- LiDAR data and/or any contour data better than the NED 10 meter contour dataset

6.3.3 Impacts Caused by Higher Conservation Pool Elevations

To determine the amount of land and the habitat types that may be inundated at a higher conservation pool elevation, EC analyzed the latest Texas Ecological Systems Database dated November 30, 2009. This database provides GIS information as well as the Texas Vegetation Classification Project: Interpretive Booklet for Phase II. This GIS data combined with the information acquired, enabled EC to determine the approximate area of ecosystem inundation at several conservation pool elevations. Current survey data is only available at 10 foot contour lines thus habitat inundation area is not available at elevation 235 msl. Table 6.5 provides a summary of the estimated total firm yield of Lake Wright Patman as related to estimates of habitat inundation for WOCWMA land and Lake Wright Patman area-wide land at various upper conservation pool elevations.

Table 6.5 Lake Wright Patman Elevation, Firm Yield and Inundation Area

Upper Conservation Pool Elevation (msl)	Estimated Total Firm Yield(1) (afpy)	Estimated WOCWMA Habitat Inundation(2) (acres)	Lake Wright Patman Area-Wide Estimated Habitat Inundation(2) (acres)
228.6	363,717(3)	USACE Contract Elevation	USACE Contract Elevation
230.0	514,505	521	11,961
235.0	669,790	No Data	No Data
240.0	790,800	3,596	32,666

(1) Total Firm Yield based on flat operating curve and 215.25 ft lower conservation pool elevation

(2) TPWD, Letter and Freedom of Information Act response documents dated March 22(14)

(3) Freese and Nichols, Inc., 2003, System Operation Assessment of Lakes Wright Patman and Jim Chapman

Overall acreage inundated by increased reservoir operating levels does not reflect the specific ecosystems that may be affected. To more accurately determine the impact of increased reservoir conservation pool elevations on specific ecosystems, EC reviewed data provided by the TPWD and performed analysis of the Texas Ecological Systems Database to specifically identify Hardwood and Wetland type ecosystems affected. To determine the ecosystem area impacted, EC created vegetation maps showing the area and associated vegetation classifications inundated at the 230 and 240 foot elevations. EC also created a subset of classification types that included the name "hardwood" in the vegetation class common name (Hardwood Type Ecosystem) and a second subset that included the name "wetland" in the common name (Wetland Type Ecosystem). The "Hardwood Type" ecosystem classification list includes numerous ecosystem types. These ecosystem classification types, elevation, respective area locations and acres inundated are listed in Table 6.6. Figure 6.3 shows the relationship between hardwood type ecosystem inundation at 230 and 240 foot msl elevations.

Groundwater level effects from increase conservation pool elevations should also be evaluated. Elevated groundwater levels could impact certain vegetative species depending on the root zone and uptake of each of the plants. Additional detailed study would need to be conducted to determine the effect of increasing the lake operation level on the groundwater table and soil saturation zone in the hardwood forest and other sensitive habitat/ecosystem areas.

Table 6.6 Lake Wright Patman Hardwood Type Ecosystem Area Inundated at 230 and 240 foot Elevations

Hardwood Related Ecosystem Classification Codes	Area-Wide Approximate Acres Inundated at 240 ft	WOCWMA Approximate Acres Inundated at 240 ft	Area-Wide Approximate Acres Inundated at 230 ft	WOCWMA Approximate Acres Inundated at 230 ft
59 Pineywoods: Bottomland Seasonally Flooded Hardwood Forest	10,948	2,060	4,151	197
19 Pineywoods: Upland Hardwood Forest	3,257	16	908	0
55 Pineywoods: Bottomland Temporarily Flooded Hardwood Forest	2,362	543	1,103	147
68 Pineywoods: Small Stream and Riparian Seasonally flooded Hardwood Forest	2,094	33	518	0
64 Pineywoods: Small Stream and Riparian Temporarily flooded Hardwood Forest	1,835	35	504	0
4 Post Oak Savanna: Post Oak Motte and Woodland	1,791	6	453	0
78 Pineywoods: Hardwood Flatwoods	1,473	0	409	0
14 Pineywoods: Northern Mesic Hardwood Forest	140	13	28	0
71 Pineywoods: Wet Hardwood Flatwoods	89	0	0	0
18 Pineywoods: Pine / Hardwood Forest Plantation	85	0	22	0
77 Pineywoods: Longleaf or Loblolly Pine / Hardwood Flatwoods or Plantation	25	0	0	0
9 Post Oak Savanna: Oak / Hardwood Slope Forest	10	0	0	0
13 Pineywoods: Northern Mesic Pine / Hardwood Forest	8	0	0	0
54 Pineywoods: bottomland Temporarily Flooded Mixed Pine / Hardwood Forest	5	0	0	0
9 Post Oak Savanna: Oak / Hardwood Slope Forest	0	5	0	0
Remaining Hardwood Classifications (< 5 acres inundated)	1	1	5	5
Total Hardwood Ecosystem Acres Inundated	**24,123**	**2,712**	**8,101**	**349**

* TPWD Data and Letter to Dr. Harkins, Espey Consultants, Inc., dated March 22,2010

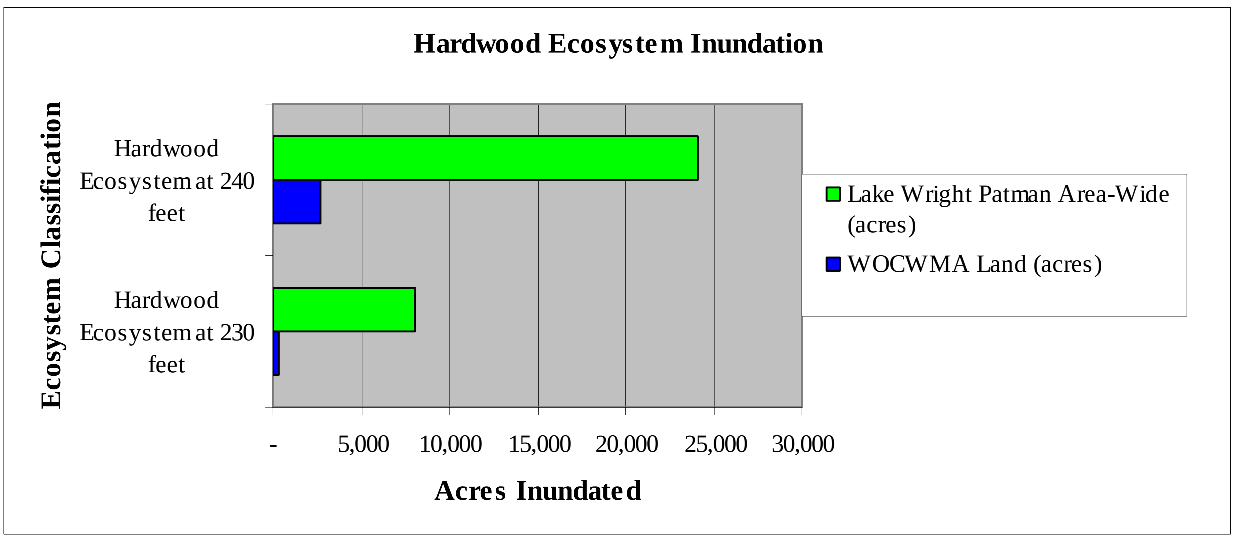

Figure 6.3 Lake Wright Patman Hardwood Ecosystem Inundation at 230 and 240 foot Elevations

Area-wide herbaceous wetland type ecosystem inundation at a conservation pool elevation of 240 feet msl affected approximately 557 acres compared to 221 acres at a 230 foot elevation. Within the boundaries of the WOCWMA, herbaceous wetland ecosystem inundation at a conservation pool elevation of 240 feet affected 224 acres compared to zero acres being inundated at the 230 foot elevation (Figure 6.4).

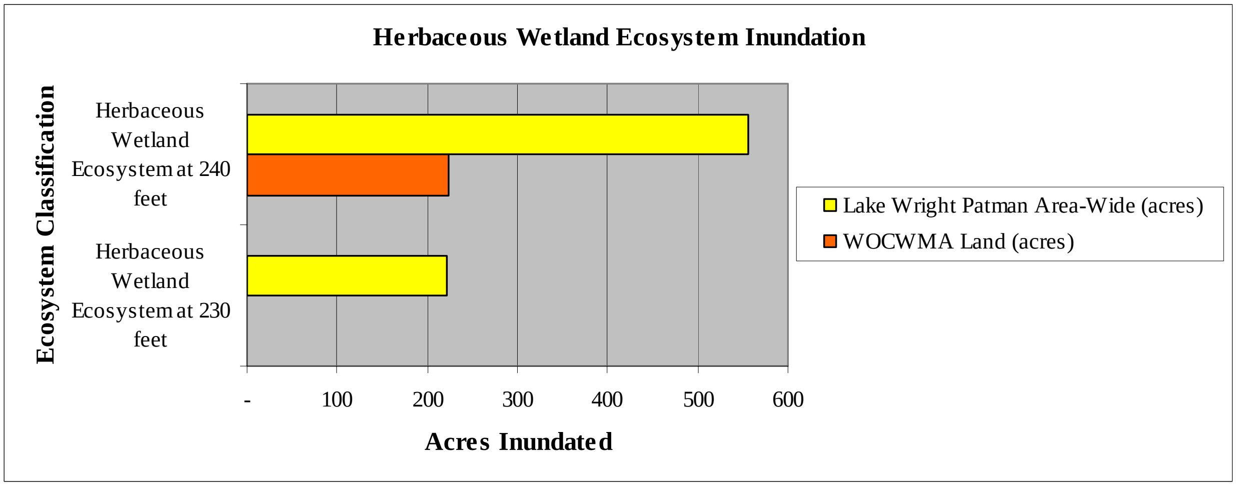

Figure 6.4 Lake Wright Patman Wetland Ecosystem Inundation at 230 and 240 foot Elevations

6.3.4 Upper Conservation Pool Elevations 228.64 and 230

Currently the USACE operates Lake Wright Patman under the Interim Rule Curve[4]. Under these rules the reservoir has a seasonally varying conservation storage pool and variable low-flow releases. The interim rule curve maintains a seasonally varying top of conservation pool elevation ranging from 220.6 to 227.5 feet msl[3]. Texarkana has a contract with the USACE for water stored above elevation 220.0 feet[5]. USACE contracts DACW29-68-A-0103 and DACW29-69-C-0019 between the USACE and Texarkana specify another conservation rule curve for Lake Wright Patman associated with the completion of Lake Jim Chapman. This rule curve is referred to as the "Ultimate Rule Curve." Under the ultimate rule curve the upper conservation pool elevation varies from 224.89 to 228.64 feet[3]. Texarkana's full use of their water right would require activation of its contract with the USACE for additional water storage in Lake Wright Patman[3]. "Although the ultimate curve has been authorized, it is subject to the processes and procedures defined in the National Environmental Policy Act of 1970 (NEPA) and by the Council on Environmental Quality, the part of the Executive Branch of the Federal Government that oversees the NEPA process". Reallocation will most likely require an environmental assessment to be completed before the reallocation of flood storage can be implemented. If reallocation is shown to have significant environmental impacts, a detailed Environmental Impact Statement will also be required." [3]

Based on a memo and letters from the TPWD dated 2002[5], 2009[6] and 2010[4], it would be presumed that a water surface elevation of 228.64 feet is reasonable for water supply and operations of the WOCWMA. It would also indicate that operating Lake Wright Patman at a constant conservation pool elevation of 230 msl would be reasonable with only slight impact to the WOCWMA. According to TPWD, operating Lake Wright Patman at "any level above a 230 foot elevation would certainly have direct impacts on the natural resources and TPWD management capabilities"[4]. Increasing Lake Wright Patman to a constant elevation of 228.64 feet would require Congressional approval because this reallocation of flood storage would exceed the 50,000 acre foot flood pool reallocation threshold for Congressional approval[5].

Review of the above mentioned documents reveal the general consensus of the TPWD. As stated in a 2002 TPWD memo from John Jones to Nathan Garner "the proposed maximum elevation increase to 230 feet above msl could have minimal effects on the WOCWMA." In the August 2009 TPWD letter[7] from Luke Baker it states "a maximum elevation increase to 230' would not affect the normal operations of the managed wetland units."

Table 6.7 provides impact data for WOCWMA infrastructures caused by various operating level elevations of Lake Wright Patman[4].

Table 6.7 White Oak Creek Wildlife Management Area - Infrastructures Affected

INFRASTRUCTURES AFFECTED	230 ft (msl)	235 ft (msl)	240 ft (msl)
No Infrastructures Affected	X		
2 Water Control Structures		X	
3 Managed Wetland Units (480)		X	
1 Concrete Bridge		X	
10 Water Control Structures			X
1 High Water Bridge			X
7.32 Miles of Levees			X
10 Miles of Equestrian Trails			X
11.5 Miles of ATV Trails			X
1.5 Miles of Boundary Lines			X
3,596.2 Acres of Public Hunting Land			X

* TPWD Letter to Dr. Harkins, Espey Consultants, Inc., dated March 22,2010

6.3.5 Upper Conservation Pool Elevation 230 - 240 feet

In order to achieve higher firm yield values, the operation of Lake Wright Patman at elevations between 230 and 240 should also be given additional consideration and further study. The total firm yield of the lake at these elevations is estimated to be approximately 514,000 and 791,000 afpy respectively. As with any reallocation of reservoir flood storage capacity, there would be impacts and implications. In addition to State and Federal Reservoir Reallocation requirements, raising the conservation pool elevation of Lake Wright Patman could have the following associated implications:

- Mitigation for Inundated Lands;
- Affects on WOCWMA Infrastructures;
- State and Federal Permitting;
- Environmental and Cultural Assessments;
- Habitat and Ecological Analysis;
- Instream flow Issues;
- Water Quality Issues;
- Additional Flooding Analysis;

As stated in the Draft TWDB Region C Phase I Water Supply Report[5], there are many issues that will need to be addressed if the conservation pool of Lake Wright Patman is raised over 230 feet. Raising the conservation pool elevation above 230 feet would begin to inundate the hardwood forests, natural wetland areas, and constructed mitigation wetlands of the WOCWMA. Inundation of the WOCWMA would result in the need for the USACE to determine estimates for mitigation impacts. A mitigation ratio would need to be established to help determine the acreage and specific types of ecosystems appropriate to replace the flooded management area lands. The basin-wide study for the Sulphur River basin would provide answers to these questions as well as others and is recommended. The following is a list of additional obstacles/impacts that would need to be evaluated if the conservation pool is raised above 230 feet (and contribute to the subjectivity of the ranking of the difficulty of each project):

- Congressional authorization for conversion of more than 50,000 ac-ft from flood to conservation storage;
- Inundation of mitigation wetlands (mitigation for replacing previous mitigation areas);
- Impact to USACE infrastructure (levee system) and water control devices;

- Loss of acreage in the WOCWMA, including hardwood forests;
- Identify inundated property associated with the proposed water surface elevation increases (Lone Star Ammunition, Red River Army Depot, etc.);
- Additional flood damage downstream of Lake Wright Patman (if any);
- Loss or gain of habitat;
- Loss or change in sedimentation storage over the life of the needed water demand; and,
- Additional concerns and/or impacts identified in the 2003 USACE System Operations report[3].

Raising the conservation pool elevation to 235 msl would also impact the WOCWMA. The impact of a 235 foot conservation pool elevation on the WOCWMA may be minimized by increasing the elevation of WOCWMA water control structures and installing pumps to assist in draining the wetland areas when needed. Further study would be needed to evaluate the feasibility of these management techniques.

Figure 6.5 illustrates the area of inundation at the WOCWMA and lands around Lake Wright Patman when the water surface elevation is at 240 feet. The actual area of inundation within the WOCWMA may vary depending on the backwater effect of the lake when operated at a 240 foot elevation and the impact this backwater has on the river inflow during flood conditions.

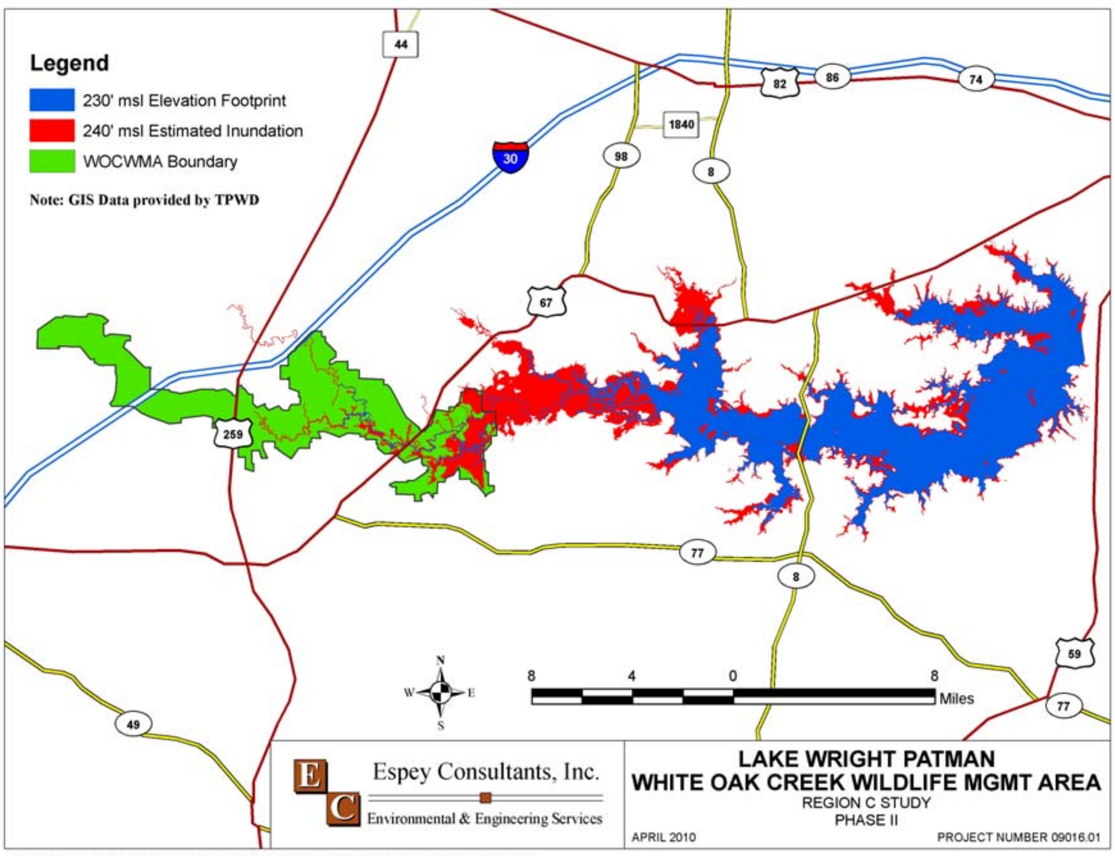

Figure 6.5 Lake Wright Patman and WOCWMA at 230 and 240 foot Elevations

For illustration purposes a storage profile of Lake Wright Patman with a conservation pool elevation of 240 feet is provided in Figure 6.6. This figure shows the top of the dam and the top of the flood control pool at 286 feet and 259.5 feet (msl) respectively. A conservation pool elevation of 240 feet msl would require a reallocation of the current flood control pool capacity.

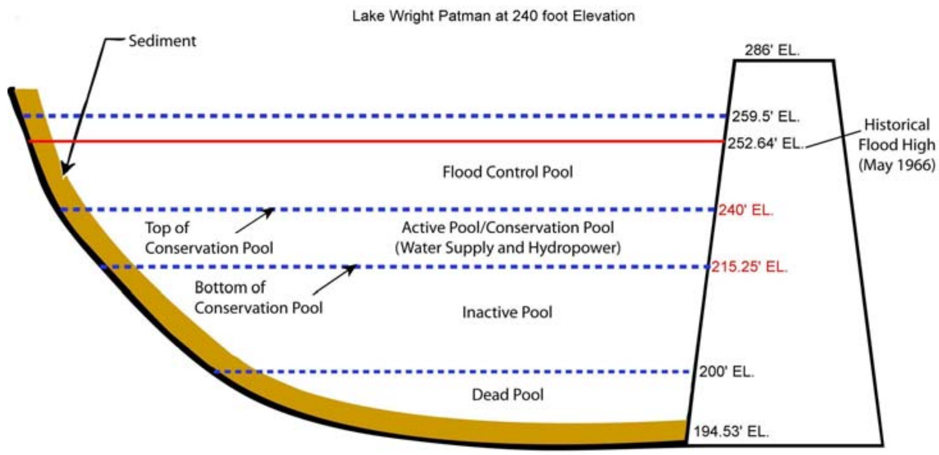

Figure 6.6 Lake Wright Patman Storage Profile at 240 foot Elevation

6.4 TASK 1.4 LAKE WRIGHT PATMAN - EXPECTED FIRM YIELD AT DIFFERING OPERATING LEVELS

To best determine the estimated firm yield of Lake Wright Patman at various operating levels, EC conducted discussions with the TCEQ, Texarkana, the TPWD, the USACE, Riverbend, IP and others. The EC project team reviewed existing literature, including the 2003 USACE System Operation Assessment of Lake Wright Patman and Lake Jim Chapman[3] report, to provide insight to various existing modeling scenarios.

EC selected three conservation pool elevations to perform the firm yield modeling scenarios. These elevations were selected based on potential impact to the WOCWMA, and input from the USACE, and the TPWD. The proposed conservation pool elevations selected for modeling were 230, 235, and 240 feet above msl.

The estimated firm yields at the operating scenarios for Lake Wright Patman were modeled using the latest available TCEQ WAM input files for the Sulphur River Basin dated August 6, 2008. The TCEQ WAM files were used in this modeling effort to maintain consistency with the State of Texas water rights permitting process. These input files were modeled using the WRAP program version dated September 2, 2009. Although more recent surveys of Lake Wright Patman are available[7], meetings with TCEQ staff[8] confirmed the use of the original reservoir area capacity data, available from the TWDB[9], for the purpose of firm yield modeling. Firm yield was determined by modifying the WAM Run3 (Full Authorization) to the specifications listed in Table 6.8, Lake Wright Patman - WAM Modeling Criteria.

Table 6.8 Lake Wright Patman - WAM Modeling Criteria

Modeling Criteria	Scenario 1	Scenario 2	Scenario 3
Upper Conservation Pool Elevation (msl)	230	235	240
Lower Conservation Pool Elevation (msl)	215.25	215.25	215.25
Priority Date for FY Simulations	12/31/2009	12/31/2009	12/31/2009
WR Type	Type 1	Type 1	Type 1
Modified WAM Area/Capacity Table (Volume / Area)	440K / 38K	515K / 43K and 650K / 50K	650K / 50K and 900K / 60K
Modified WAM WS Reservoir Storage Capacity at top of Conservation Pool Elevation	440,000	650,000	900,000
Modified WAM WS Reservoir Storage Volume at Bottom of Conservation Pool Elevation	65,000	65,000	65,000
Modified WAM MS Monthly Storage	440,000	650,000	900,000
Dual Simulation Run	YES	YES	YES
Subordination	NO	NO	NO

Table 6.9 provides estimates of total firm yield and unpermitted available water. Firm yield estimates based on the "Ultimate" curve and an "Ultimate Flat" operating curve at 228.6 feet msl are provided in addition to the three conservation pool elevation scenarios. Again, ranking of each alternative is subjective and is based on current knowledge derived from information obtained as part of this report as well as discussions with the TPWD, USACE and Texarkana.

Table 6.9 Lake Wright Patman - Firm Yield and Unpermitted Available Water Estimates

Reservoir Reallocation Scenario	Upper Conservation Pool Elevation. msl	Lower Conservation Pool Elevation msl	Estimated Total Firm Yield	Permitted Water Rights (1) afpy	Unpermitted Available Water afpy	Implementation Difficulty
Ultimate Curve (2)	224.89 - 228.64 feet	220 feet	184,591	180,000	4,591	likely
Ultimate Flat Curve (2)	228.64 feet	215.25 feet	363,717	180,000	183,717	likely
Scenario 1 (3)	230 feet	215.25 feet	514,505	180,000	334,505	difficult
Scenerio 2 (3)	235 feet	215.25 feet	669,790	180,000	489,790	medium difficulty
Scenario 3 (3)	240 feet	215.25 feet	790,800	180,000	610,800	very difficut

(1) TWDB Study Commission on Region C Water Supply, Phase I Revised Draft Report (12-08-09)
(2) Freese and Nichols, System Operation Assessment of Lakes Wright Patman and Jim Chapman, 2003
(3) 2010 Espey Consultants, Inc. firm yield estimate

The firm yield of Lake Wright Patman, when operated by "Ultimate" curve guidelines, was estimated by Freese and Nichols[3] to be approximately 184,600 afpy (Table 6.9). As described in the Phase I report[5], the ultimate curve is the contractual curve of choice to be utilized in model runs for Lake Wright Patman. The contractual implementation of the ultimate curve at Lake Wright Patman would require reallocation of flood storage and the likelihood of an environmental assessment and Congressional approval if the reallocation of flood storage exceeds 50,000 afpy. Freese and Nichols, in their 2003 System Operation Assessment of Lake Wright Patman and Lake Jim Chapman[3] report, estimated a firm yield from Lake Wright Patman at 364,000 afpy. The Freese and Nichols 2003 yield estimate was not determined using the TCEQ WAM model. Although the lake was modeled as being operated according to a flat curve at 228.6 feet msl with a lower conservation pool elevation of 215.25, this yield estimate was derived using a custom modeling approach that implements a daily time step without consideration for water rights.

Operation of the lake by these rules will require Congressional approval[5]. This same 2003 report listed the area inundated within the WOCWMA at 496 acres and 3,800 acres at conservation pool elevations 230 and 240 feet respectively.

EC's analysis of Lake Wright Patman total firm yield at upper conservation pool elevations of 230, 235, and 240 feet msl (Scenarios 1, 2, and 3) are approximately 514,000, 670,000, and 790,000 afpy respectively. When these firm yields are reduced by the existing permitted water rights (180,000 afpy) the unpermitted available water is obtained for each scenario (Table 6.9).

6.5 TASK 1.5 LAKE WRIGHT PATMAN - ADDITIONAL INFORMATION NEEDED FOR REALLOCATION CONSIDERATION

As presented in the Phase I Draft Report[5], the Marvin Nichols Reservoir is recommended as a water management strategy for the North Texas Municipal Water District, Tarrant Regional Water District, and the Upper Trinity Regional Water District. Estimates of firm yield for the Marvin Nichols Reservoir range from 602,000 to 624,000 afpy[10,11,12,13,14]. For reporting purposes, EC will use the 620,000 afpy estimate of firm yield for the proposed Marvin Nichols Reservoir. Discussions between the reservoir sponsors indicate that approximately 80% of the total yield, or 495,000 afpy, could be allocated to Region C and the remaining 20% of Marvin Nichols water could be reserved for local demands[5].

Each of the three operating scenarios discussed earlier will require additional information to allow consideration of these strategies as reasonable alternatives to the proposed Marvin Nichols Reservoir. The following sections outline additional informational needs for each strategy.

6.5.1 Scenario No. 1 – 230 foot Constant Operational Level of Lake Wright Patman

To allow consideration of Scenario 1, additional information would need to be gathered. Letters from the TPWD[6,7] dated 2002 and 2009 indicate "the proposed maximum elevation increase to 230 feet could have minimal effects on WOCWMA." "However, while 230 feet could be a tolerable maximum elevation, a more accurate analysis of increased flood severity must be completed before a final determination can be made."

Communications with the USACE indicate that operating Lake Wright Patman at or above a constant flat pool elevation of 228.64 feet would constitute a reallocation of flood storage to conservation storage exceeding 50,000 acre-feet and would require Congressional authorization[5]. In addition to Congressional approval, this reallocation of Lake Wright Patman flood pool would require the gathering of information to support a reallocation plan that meets state and federal requirements.

6.5.1.1 Reallocation plan requirements:

- Identify new use and users
- Evaluate impacts on other projects
- Determine price to be charged new users
- Determine compensation, if any, to existing users
- Perform an environmental assessment and possible EIS
- Section 404 permit requirements
- Federal Energy Regulatory Commission (FERC) requirements
- Determine possible mitigation ratio
- Inventory and assessment of culturally significant, historical and archaeological sites or artifacts
- Identification of third parties impacted by the reallocation
- Determine priority date restrictions and impacts on other water rights

- Develop a reservoir accounting plan

In addition to the information necessary to complete a reallocation plan for Lake Wright Patman, there is a need to determine specific impacts that a higher conservation pool elevation would have on the WOCWMA and surrounding lands.

6.5.1.2 Impacts to WOCWMA and downstream stakeholders resulting from water surface elevation increase to 230 feet:

- What impacts would be expected to the managed wetland units and bottomland hardwood forest?
- What impact is expected from backwater effects on other ecosystems?
- Determine the integrity of the levee system when higher water elevations are maintained.
- Estimate added maintenance costs due to higher water elevations.
- Determine ecological benefits of an increased conservation pool elevation to 230 feet.
- Design a flexible wetland management plan to maximize wetland function and utility.
- Effects of increased water surface elevation and releases on downstream flooding.

6.5.1.3 Other information needed:

- Sources of funding would need to be determined.
- Determine ownership and cost of firm yield gained by reallocation.
- Evaluate changes in floodplain resulting from higher releases and increase in lake elevation.
- Update Sulphur Basin WAM input files to include drought of 2002 – 2004.
- Determine loss or change in sedimentation storage over the life of the needed water demand.
- Determine the impact of a lower bottom of conservation pool elevation of 215.25 feet.

6.5.2 Scenario No. 2 – 235 foot Constant Operational Level of Lake Wright Patman

In addition to the information needed for Scenario 1 to be considered an alternative to Marvin Nichols, Scenario 2 would need the following additional information gathered:

- Determine impact of shoreline erosion caused by higher lake operating level.
- Collect LiDAR data for Lake Wright Patman, WOCWMA and surrounding areas to support GIS habitat/ecosystem mapping using one foot contour lines.
- Determine inundation of property at the modified surface water elevation.
- Determine potential for additional flood damage downstream of Lake Wright Patman.
- Verify inconsistent data regarding the elevation of the lowest control structure in the WOCWMA.
- Determine the feasibility of raising the elevation of the lower water control structures in the WOCWMA to minimize the impact of a 235 foot operating level.
- Determine the feasibility of adding pumps to assist in the management of the WOCWMA wetlands and bottomland hardwood forest ecosystems.

6.5.3 Scenario No. 3 – 240 foot constant operational level of Lake Wright Patman

For operation of Lake Wright Patman at an elevation of 240 feet to be a reasonable alternative to Marvin Nichols Reservoir much of the same information for Scenario 1 and 2 would need to be gathered. Due to the increased operational level of Lake Wright Patman to 240 feet it is estimated that approximately 3,600 acres[4] of WOCWMA land would be inundated (approximately 15 percent of the total 25,500 WOCWMA). At this operational level approximately 33,000 acres of Lake Wright Patman area-wide habitat would be inundated[4].

Approximately 17,000 acres of the 25,500 acres of WOCWMA are bottomland hardwood forests[3]. Using GIS data provided by the TPWD[4], EC estimates that approximately 2,700 acres of hardwood type ecosystem would be inundated. Additional detailed study would need to be conducted to determine the effect of this operational level on the groundwater table and soil saturation zone in the affected areas. At the 240 foot operational level the lateral extent of inundated land increases greatly. The adjusted costs for environmental and cultural resource investigation would need to be determined as well as the need to determine mitigation requirements for the loss of approximately 2,421 feet of trails and parts of both boat ramps at Atlanta State Park[4].

6.5.4 Additional Alternatives

The volume of water available from Lake Wright Patman (unpermitted yield) may be enhanced by the addition of (un-contracted) water rights obtained from Texarkana and unused water from IP. In 2003, Freese and Nichols[3] estimated that an additional 108,000 afpy could be made available to Lake Wright Patman by system operation of Lakes Wright Patman and Jim Chapman. Further study would need to be conducted to determine the impact of raising the upper conservation pool elevation above 228.64 feet and its affect on system operations of these two reservoirs. When these additions to firm yield are added to the unpermitted available water estimates (Table 6.9), the total estimated available water is obtained (Table 6.10).

Other issues that could also effect the selection of operation scenarios include possible restrictions of moving water from one reservoir to another. These restrictions could be based on invasive vegetation or animals that are found in the source reservoir and should not be transferred into the receiving reservoir.

6.5.5 Combination of Alternatives

Various combinations of alternatives to supply additional water to the Region C Water Planning Area are possible. Table 10 provides estimates of available water for various operating scenarios including additions to firm yield from sources such as Texarkana and IP. The addition of 108,000 afpy firm yield resulting from system operations of Lakes Wright Patman and Jim Chapman is not included in Table 10 due of the uncertainty of this yield as a result of increases in the operating elevation of Lake Wright Patman. Further study would be needed to determine the system operation yield under these conditions.

Table 6.10 Lake Wright Patman - Combination of Yield Alternatives

Lake Wright Patman Reservoir Reallocation Scenario	Ultimate Curve (2)	Ultimate Flat Curve (2)	Scenario 1 (3)	Scenerio 2 (3)	Scenerio 3 (3)
Upper Conservation Pool Elevation (msl)	224.89 - 228.64 feet	228.64 feet	230 feet	235 feet	240 feet
Lower Conservation Pool Elevation (msl)	220 feet	215.25 feet	215.25 feet	215.25 feet	215.25 feet
Estimated Total Firm Yield (afpy)	184,591	363,717	514,505	669,790	790,800
Permitted Water Rights (afpy)	180,000	180,000	180,000	180,000	180,000
Firm Yield Minus Permitted Water Rights (afpy)	4,591	183,717	334,505	489,790	610,800
Water Rights Available from Texarkana (afpy) (1)	57,500	57,500	57,500	57,500	57,500
Water Rights Available from International Paper (afpy)	60,000	60,000	60,000	60,000	60,000
Total Estimated Available Water (afpy)	**122,091**	**301,217**	**452,005**	**607,290**	**728,300**
Implementation Difficulty	likely	likely	difficult	medium difficulty	very difficult

(1) TWDB Study Commission on Region C Water Supply, Phase I Revised Draft Report (12-08-09)
(2) Freese and Nichols, System Operation Assessment of Lakes Wright Patman and Jim Chapman 2003
(3) Espey Consultants firm yield estimates based on August 6, 2008 WAM input files

As presented in Table 6.10, Scenario 2 has the possibility of providing similar firm yield as the proposed Marvin Nichols Reservoir. Scenario 3 may provide an estimated yield of about 100,000 afpy more than the expected yield of Marvin Nichols Reservoir. The possibility of additional firm yield from system operations of Lakes Patman and Chapman could also increase the total estimated water available to the current water right holders. In comparison, the 2011 Region C IPP identifies the total estimated yield from Marvin Nichols Reservoir at approximately 620,000 afpy.

6.5.6 Basin Wide Study

The nature and extent of the data required to determine the feasibility of these alternatives to Marvin Nichols Reservoir indicate that the basin-wide study of the Sulphur River should to be performed. A summary of a portion of the information needed that could be obtained from a basin wide study is presented in Table 6.11.

Table 6.11 Sulphur River Basin Wide Study Benefits

Additional Information Needed	Addressed by Basin Wide Study
Mitigation Ratios	Yes
WOCWMA Operations and Impact	Yes
Effects on Downstream Flooding	Yes
Assessment of Cultural and Archaeological Sites	Yes
USACE and State Reallocation Requirements	Partially
Water Right Ownership / Contract	
Instream Flow / Environmental Assessment	Yes
IP Discharge and Impact on Receiving Waters	
Funding	

6.6 TASK 1.6 LAKE WRIGHT PATMAN - COST ESTIMATE FOR CONVEYANCE OF WATER

Espey Consultants, Inc. estimated preliminary costs for conveyance of water from Lake Wright Patman to a group of water suppliers in Region C for each of the three proposed Lake Wright Patman operating scenarios. This group of scenarios was selected to be consistent with a scenario for delivery of 495,300 afpy from the proposed Marvin Nichols I Reservoir to a group of five water suppliers in Region C. These costs were estimated using cost estimation procedures documented in the 2011 IPP for Region C and Table Q-29 of the 2011 IPP as a template for unit cost calculations. Included in the estimates are costs for real estate, reservoir storage purchased from the USACE, facility relocation cost, mitigation, NEPA evaluation, reallocation Congressional approval, permitting, financing, acquisition, and contingencies. Annual cost estimates include debt service, electricity, raw water purchase and operation & maintenance. In developing these estimates, EC relied upon information presented in the 2006 Regional Water Plan for Region C, the 2011 IPP for Region C, TWDB guidance on cost estimation for regional water planning, and data provided by the Fort Worth District of USACE. The estimates presented in this report were based on TWDB procedures used in the regional planning process and utilized standard unit costs in September 2008 dollars presented in Appendix Q of the 2011 IPP for Region C.

The cost estimates have two components:

- Initial capital costs, including interest during construction, engineering and construction costs, and
- Average annual costs, including annual operation and maintenance as well as debt service over 30 years.

Unit cost estimates were determined on a cost per acre foot. These estimates were calculated for the period during loan amortization as well as after amortization. The data presented in Table 6.12 provides a summary of the costs associated with each of the three operating level scenarios for Lake Wright Patman. The greatest area of uncertainty in these estimates is with the costs of storage, mitigation, NEPA evaluations, and Congressional approval of reallocation. These costs are grouped under the line item of Raw Water Improvements in Table 6.12 and range from about 4 to 8 percent of the total project cost for the three scenarios. EC contacted USACE to request additional data to support these estimates, but this information has not been received at the time of submittal of this report. Costs presented in Table 6.12 could be modified based on receipt of additional information from USACE. In addition, more definitive cost data for these elements will be available after completion of the Sulphur River Basin Feasibility Study proposed by USACE.

A comparison of project costs for Lake Wright Patman and Marvin Nichols Reservoir are presented in Table 6.13. Total project costs for the Lake Wright Patman scenarios range from about 20 to 70 percent higher than costs for Marvin Nichols Reservoir. Unit costs for the Lake Wright Patman scenarios are about 20 to 30 percent higher during the debt repayment period and about 50 to 60 percent higher after debt is retired. Unit costs after debt retirement are higher for the Lake Wright Patman scenarios because of the additional distance and elevation change to convey water to the Dallas-Fort Worth area.

Costs for Marvin Nichols were obtained from the 2011 IPP for Region C. The cost analysis for Lake Wright Patman contained more detail in route location, pumping elevation, pump design and cost, pipeline routing in the Region C area (reservoir to reservoir), etc. Additional cost detail should be added to the Marvin Nichols estimate to ensure the comparability of the cost estimates. At the time of this report the additional details for the cost estimates of Marvin Nichols were not available.

Table 6.12 Cost Estimate to Convey Water From Lake Wright Patman to Region C

Operating Elevation Scenario	**230 feet**	**235 feet**	**240 feet**
Water Volume (afpy)	**500,005**	**655,290**	**776,300**
Phase 1 Costs			
Raw Water Improvements	$159,778,000	$305,777,000	$460,275,000
Phase 1 Pipeline	$1,504,135,000	$1,637,049,000	$1,878,374,000
Phase 1 Pump Station	$284,225,000	$314,886,000	$347,775,000
Sub Total Phase 1 Construction Costs	**$1,948,138,000**	**$2,257,712,000**	**$2,686,424,000**
Phase 2 Costs			
Phase 2 Pipeline	$1,381,912,000	$1,621,453,000	$1,861,866,000
Phase 2 Pump Station	$210,245,000	$307,076,000	$339,965,000
Sub Total Phase 2 Construction Costs	**$1,592,157,000**	**$1,928,529,000**	**$2,201,831,000**
Total Construction Costs	**$3,540,295,000**	**$4,186,241,000**	**$4,888,255,000**
Phase 1 Permitting and Mitigation	**$35,403,000**	**$41,862,000**	**$48,883,000**
Phase 1 Interest	$237,030,000	$274,696,000	$326,857,000
Phase 2 Interest	$193,718,000	$234,644,000	$267,897,000
Total Interest	**$430,592,000**	**$509,340,000**	**$594,754,000**
Phase 1 Costs	$2,220,571,000	$2,574,270,000	$3,062,164,000
Phase 2 Costs	$1,785,875,000	$2,163,173,000	$2,469,728,000
Total Project Costs	**$4,006,446,000**	**$4,737,443,000**	**$5,531,892,000**
Phase 1 Annual Costs			
Operation & Maintenance	$22,147,000	$24,243,000	$27,478,000
Electricity ($0.09/kWh)	$56,358,000	$67,667,000	$76,811,000
Debt Service 6% for 30 years	$161,322,000	$190,306,000	$222,463,000
Raw Water Purchase (100,000 afpy Texarkana)	$10,101,000	$10,101,000	$10,101,000
Total Annual Cost Phase 1	**$249,928,000**	**$292,317,000**	**$336,853,000**
Phase 2 Annual Costs			
Operation & Maintenance	$19,075,000	$23,891,000	$27,118,000
Electricity ($0.09/kWh)	$43,631,000	$67,667,000	$75,990,000
Debt Service 6% for 30 years	$129,742,000	$157,152,000	$179,423,000
Total Annual Cost Phase 2	**$192,448,000**	**$248,710,000**	**$282,531,000**
Unit Costs (until amortized)			
per Acre-foot Phase 1	$1,000	$882	$868
per Acre-foot Phase 2	$770	$759	$728
per Acre-foot Total	$885	$821	$798
Unit Costs (after amortization)			
per Acre-foot Phase 1	$354	$311	$295
per Acre-foot Phase 2	$251	$279	$266
per Acre-foot Total	$303	$295	$280
These estimates are based on the scenario to develop 390,000 afpy from Lake Wright Patman presented as Table Q-29 in the 2011 Initially Prepared Water Plan for Region C and revised with information provided by the Fort Worth District of USACE.			

Table 6.13 Comparison of Cost Estimates to Convey Water From Lake Wright Patman

Water Supply Project	**Lake Wright Patman**			**Marvin Nichols I[1]**
Operating Elevation Scenario	**230 feet**	**235 feet**	**240 feet**	**Reservoir and Transmission System**
Water Volume (afpy)	**500,005**	**655,290**	**776,300**	**495,300**
Total Project Costs	$4,006,446,000	$4,737,443,000	$5,531,892,000	$3,300,565,000
Cost per Acre-foot (until amortized)	$885	$821	$798	$677
Cost per Acre-foot (after amortization)	$303	$295	$280	$187
[1]From Table Q-20, 2011 Initially Prepared Water Plan for Region C.				

6.7 TASK 1.7 LAKE O' THE PINES - VOLUME OF AVAILABLE WATER FROM LAKE O' THE PINES

Available water remaining in Lake O' the Pines (LOP), including un-contracted water was estimated utilizing information gathered from meetings and discussions with the Northeast Texas Municipal Water District (NETMWD) and the USACE. EC performed an accounting/reconciliation of the water contracts sold by the NETMWD and compared this to the total volume of permitted water rights. Additionally, EC reviewed Certificates of Adjudication (COA), the TCEQ Water Right database and WAM input files for the Cypress Creek Basin.

6.7.1 Certificate of Adjudication Number 04-4590 - Northeast Texas Municipal Water District

Certificate of Adjudication (COA) number 04-4590 (Appendix I) lists the NETMWD as the owner of water rights totaling 241,800 afpy from LOP. This COA authorizes the NETMWD to store 251,000 ac-ft of water in LOP between elevations 201 feet and 228.5 feet above msl. The owner is authorized to divert 42,000 afpy of water for municipal purposes of which not more than 1,930 afpy may be diverted from Lake Bob Sandlin. The owner is further authorized to divert 161,800 afpy for industrial purposes of which not more than 10,000 afpy may be diverted from Lake Bob Sandlin. In addition, the owner is authorized to release sufficient amounts of industrial use water from LOP, to provide for the trans-watershed diversion of 18,000 afpy to the Sabine River Basin for electric utility cooling water uses. On December 15, 1995, the Texas Natural Resources Conservation Commission (TNRCC) granted an amendment (certificate No. 04-4590A) for an additional diversion of 20,000 afpy for municipal and industrial uses from LOP to the Sabine River Basin for use by the City of Longview, Texas.

6.7.2 Permitted versus Contracted Water Rights

The NETMWD has not utilized or "contracted" all of its 241,800 afpy of permitted water rights[15]. As a result, these unused water rights may be available for purchase directly from the NETMWD. To determine the amount of un-contracted water rights, EC contacted the NETMWD. Additionally, EC evaluated the TWDB 2011 Initially Prepared Water Plan, prepared for Region D – The North East Texas Regional Water Planning Group[1] (IPP). The NETMWD confirmed the demand values provided in the Region D IPP are reasonable for determining available water.[16] Table 6.14 provides the available water supply as listed in the Region D 2011 IPP (182,000 afpy) as well as the projected water demands (148,000 afpy)[1]. The difference of the projected supply versus demand values show an estimated surplus of 34,000 afpy.

Table 6.14 Lake O' the Pines Water Supply, Contracted Demand and Estimated Un-contracted Water

Supply and Demand	Water (afpy)	Estimated Water Available (afpy)
Available Water Supply *	182,000	
NETMWD Contracted Water Demand *	(148,000)	
Estimated Un-Contracted Permitted Water		**34,000**

* Region D Initially Prepared Water Plan. March 2010

6.7.3 Voluntary Redistribution of Existing Water Rights

In addition to un-contracted water rights, it may be possible to purchase a portion of unused water from the owners of water right contracts. US Steel Corporation has a senior water right, including backup rights from LOP, for up to 55,000 afpy[16]. Historically, US Steel has not utilized the majority of these water rights[16]. The NETMWD also provides water to the City of Longview, various "member cities", utilities and municipal systems. The 2011 Region D IPP lists the current demands on water supplied from the NETMWD as being constant with no increased demand through 2060. Discussions with the NETMWD indicate the member cities and US Steel are willing to discuss the sale or contract of their unused contracted water rights[16]. Table 6.15 lists potentially available water from US Steel and NETMWD member cities.

Table 6.15 Lake O' the Pines Potentially Available Water From Existing Water Owners

Owners of Water Contracts	Estimated Unused Water (afpy) *	Estimated Water Available (afpy)
NETMWD Member Cities **	36,000	
U.S. Steel Corporation **	31,000	
Water Available Through Existing Water Right Owners **		**67,000**

* Estimates of unused water provided by the NETMWD

** Available through re-negotiated contracts with NETMWD and US Steel Corporation and the Member Cities

6.7.4 Total Estimated Water Available from Lake O' the Pines

Therefore, the estimated volume of available water from LOP is approximately 100,000 afpy[16]. The total estimated available water can be seen in Table 6.16.

Table 6.16 Lake O' the Pines Total Estimated Available Water

Owner / Water Contract Holder	Estimated Available Water* (afpy)
NETMWD Uncontracted Water	34,000
US Steel Corporation	31,000
NETMWD Member Cities	36,000
Total Estimated Available Water	**101,000**

* Estimated water availability data provided by the NETMWD

6.8 TASK 1.8 LAKE O' THE PINES - WATER RIGHT HOLDER CONSIDERATIONS, NEEDS, SURPLUS AND DROUGHT PROTECTION

Meetings and discussions with the NETMWD revealed that existing water right holders, in particular the member cities and US Steel Corporation, have contracts that are not being fully utilized. The data provided in Table 6.17 lists surplus water available from the (NETMWD) member cities (Appendix L). Review of Certificates of Adjudication and discussions with the NETMWD involving US Steel Corporation[16] reveal that US Steel owns a senior cumulative water right for 55,000 afpy that first draws water from Ellison Reservoir and Run of the River availability[16]. Any demand not met from these sources is backed up by the NETMWD (Lake O' the Pines water). Since 1958, US Steel has not used more than 1,000 afpy from Lake O' the Pines[16]. Water demand data listed in the Region D 2011 IPP[1], as well as discussions with the NETMWD regarding unused water from US Steel and Member Cities, have indicated that NETMWD's estimate of available water (about 100,000 afpy) takes into consideration anticipated and unanticipated local needs, existing water right holders, releases from Caddo Lake, and retained local surplus for drought protection.

Table 6.17 NETMWD Member Cities – Surplus Water (afpy)

Entity	2,010	2,020	2,030	2,040	2,050	2,060
City of Avinger	1,464	1,460	1,456	1,453	1,453	1,453
City of Daingerfield	10,150	10,159	10,167	10,176	10,182	10,182
City of Hughes Springs	5,131	5,121	5,114	5,106	5,108	5,108
City of Lone Star	4,574	4,580	4,585	4,591	4,595	4,595
City of Jefferson	10,668	10,671	10,678	10,685	10,690	10,690
City of Pittsburg	1,455	1,421	1,387	1,365	1,339	1,305
City of Ore City	2,794	2,774	2,763	2,756	2,750	2,740
Total Member Cities Surplus	**36,236**	**36,186**	**36,150**	**36,132**	**36,117**	**36,073**

Data obtained from the 2011 Region D Initially Prepared Water Plan[1]

6.9 TASK 1.9 LAKE O' THE PINES COST ESTIMATE

Espey Consultants, Inc. estimated preliminary costs for conveyance of water from Lake O' the Pines to three different water suppliers in Region C consistent with the cost scenarios included in the 2011 Initially Prepared Water Plan. The scenarios include transmission facilities to the Dallas Water Utilities East Side Water Treatment Plant (WTP), a new NTMWD WTP near Leonard, and the Tarrant Regional Water District (TRWD) Rolling Hills WTP. Included in the estimates are construction costs for pipelines, ROW easements, engineering and contingencies, pump stations, storage tanks, permitting, mitigation and interest during construction. Annual cost estimates include debt service, electricity, raw water purchase and operation & maintenance. In developing these estimates, EC relied upon information presented in the 2006 Regional Water Plan for Region C, the 2011 Initially Prepared Water Plan for Region C, TWDB guidance on cost estimation for regional water planning, and data provided by the Fort Worth District of USACE. The estimates presented in this report were based on TWDB procedures used in the regional planning process and utilized standard unit costs in September 2008 dollars presented in Appendix Q of the 2011 Initially Prepared Water Plan for Region C. Details specific to each scenario are provided in Appendix M.

The cost estimates have two components:

- Initial capital costs, including engineering and construction costs
- Average annual costs, including annual operation and maintenance costs as well as debt service.

Unit cost estimates were determined on a cost per acre foot basis. These estimates were calculated for the period during loan amortization as well as after amortization. The data presented in Table 6.18 provides a summary of the costs associated with each of the three scenarios for LOP.

Table 6.18 Cost Estimate to Convey Water from Lake O' the Pines to Region C

Water Destination	**DWU East Side WTP[1]**	**NTMWD Leonard New WTP[2]**	**TRWD Rolling Hills WTP[3]**
Water Volume (afpy)	**101,000**	**101,000**	**101,000**
CONSTRUCTION COSTS			
Pipeline	$458,818,000	$382,577,000	$604,893,000
Pump Station	$81,556,000	$71,844,000	$119,834,000
Sub Total Construction Costs	**$540,374,000**	**$454,421,000**	**$724,727,000**
Sub Total Permitting and Mitigation	**$5,404,000**	**$4,544,000**	**$7,247,000**
Interest during construction (24 months)	**$44,132,000**	**$37,113,000**	**$88,178,000**
Total Project Costs	**$589,910,000**	**$496,078,000**	**$820,152,000**
ANNUAL COSTS			
Operation & Maintenance	$6,627,000	$5,622,000	$9,045,000
Electricity ($0.09/kWh)	$13,623,000	$10,788,000	$20,588,000
Debt Service 6% for 30 years	$42,856,000	$36,040,000	$59,583,000
Raw Water Purchase	$9,873,000	$9,873,000	$9,873,000
Total Annual Cost	**$72,979,000**	**$62,323,000**	**$99,089,000**
Unit Costs (until amortized)			
per Acre-foot	$723	$617	$981
Unit Costs (after amortization)			
per Acre-foot	$298	$260	$391

[1]Based on the scenario to develop 89,600 afpy from Lake O' the Pines presented as Table Q-30 in the 2011 Initially Prepared Water Plan for Region C.

[2]Based on the scenario to develop 87,900 afpy from Lake O' the Pines presented as Table Q-31 in the 2011 Initially Prepared Water Plan for Region C.

[3]Based on the scenario to develop 87,900 afpy from Lake O' the Pines presented as Table Q-32 in the 2011 Initially Prepared Water Plan for Region C.

6.10 TASK 1. 10 LAKE O' THE PINES - REALLOCATION OF FLOOD STORAGE OVER THE ELEVATION OF 228.5 MSL

Operation of Lake O' the Pines (LOP) at elevations higher than 228.5 feet msl was discussed during meetings and phone discussions with the USACE and the NETMWD[16]. A three foot increase in the operating level of LOP was assessed in the 1980's. This preliminary investigation concluded that land acquisition would be a significant issue. Further analysis was recommended[17]. An increase in LOP operating level would experience many of the same issues as seen with Lake Wright Patman. The January 12, 2010 meeting at the USACE Fort Worth District office[17] generated the following list of concerns and comments that would need to be addressed if LOP operating levels greater than 228.5 feet were implemented:

- Floodplain issues related to increased releases and change in water surface elevation greater than 228.5 are possible. Daily flood model details are needed
- Releases greater than 3,000 cfs result in complaints from downstream stakeholders
- Changes in the operational elevation of LOP may result in land mitigation for recreational areas impacted

- Elevation increases greater than 228.5 feet msl for extended periods of time may cause increased shoreline erosion and damage to private property
- Upstream lake stakeholders have concerns with respect to "estimated yield"
- Approval of US Congress needed if reallocation of greater than 15 percent of total lake capacity or 50,000 ac-ft
- Environmental and Cultural resource investigations will be expensive

Meeting participants discussed the need to improve model input data in an effort to better simulate the water resources of the Cypress Creek Basin. The USACE RiverWare model is available but it was recommended that input data through 2007 be added as well as adding rules regarding water right details that consider release rates.

In this EC study the Firm Yield of Lake O' the Pines was modeled using the TCEQ Run 3 (Full Authorization) input files dated January 13, 2010. Firm yield modeling results for several conservation pool elevations are provided in Table 6.19 and the modeling criteria utilized are listed in Table 6.20.

Table 6.19 Lake O' the Pines Total Firm Yield Estimates at Various Operating Levels

Upper Conservation Pool Elevation (msl)	Estimated Total Firm Yield (afpy)	Conservation Storage (afpy)
228.5	153,500	251,000
231	167,000	301,000
235	187,600	392,000

* Conservation storage based on 1958 survey, USACE New Orleans District

Table 6.20 Lake O' the Pines WAM Modeling Criteria

Reservoir (Upper Conservation Pool Elevation)	Lake O' the Pines (228.5)	Lake O' the Pines (231.0)	Lake O' the Pines (235)
Estimated Firm Yield, afpy	153,500	167,000	187,600
Upper Conservation Pool Elevation	228.5	231	235
Lower Conservation Pool Elevation	201	201	201
Priority Date for FY Simulations	NA	NA	12/31/2009
WR Type	Type 1	Type 1	Type 1
Modified WAM Area/Capacity Table	NO	Add 231.0 foot 309,000/20,800	Add 230.5 & 235 feet 300,000/20,500 400,000/24,250
Modified WAM WS Reservoir Storage	NO	301,000	392,000
Modified WAM MS Monthly Storage	NA	NA	NA
Dual Simulation Run	NO	NO	NO
Subordination	NO	NO	NO

* TCEQ WAM Run3 input files dated January 13, 2010 have had the .dat and .eva files corrected.
The original input files downloaded from TCEQ have no evaporation for LOP

These modeling results show that by increasing the conservation pool elevation from 228.5 to 231.0 feet msl the increase in firm yield would be approximately 13,500 afpy. By increasing the conservation pool elevation to 235 feet msl the increase in firm yield was approximately 34,100 afpy. This additional firm yield may be available to users subject to availability and seniority based on the priority date of the water right in question. The feasibility of this reallocation would in part depend on the ability to successfully address the concerns listed above.

6.11 TASK 1.11 LAKE O' THE PINES, RESERVOIR REALLOCATION PROCESS AND CONGRESSIONAL APPROVAL

"Reallocation of USACE reservoirs can provide an effective use of water by converting (flood) storage to additional water supply. Every reservoir has its own defining characteristics in terms of environmental impacts, reservoir storage use, downstream flooding risks and costs associated with reallocation. Entities evaluating reallocation of a federal reservoir must work closely with the USACE, state agencies and officials to meet the state and federal requirements as outlined in this report. Reallocation of reservoir storage in USACE reservoirs is a very complicated and time consuming process; however, reallocation of existing storage to dependable yield can be extremely beneficial depending on the individual reservoirs and surrounding demand centers."[17]

6.11.1 USACE Reservoir Reallocation Approval Authority

Per the Water Supply Act of 1958, reallocation is the reassignment of the use of existing water storage space in a reservoir project to a higher and better use. Authority for the USACE to reallocate existing storage space to municipal and industrial (M&I) water supply is contained in Public Law 85-500, Title III, Water Supply Act of 1958, as amended (72 Stat. 319). Section 301(b) of this Act states

> ". . . it is hereby provided that storage may be included in any reservoir project surveyed, planned, constructed or to be surveyed, planned, and/or constructed . . . to impound water for present or anticipated future demand or need for municipal and industrial water supply."

Section 301(d) of the Act states

> "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, will be made only upon the approval of Congress as now provided by law."

> "Reallocation or addition of storage that would seriously affect other authorized purposes of the existing reservoir or that would involve major structural or operational changes requires Congressional approval. Provided these criteria are not violated, 15 percent of the total storage capacity allocated to all authorized project purposes (flood control, hydropower, navigation, water supply, etc.) or 50,000 acre-feet, whichever is less, may be allocated from storage authorized for other purposes. This amount may also be added to the project to serve as storage for municipal and industrial water supply at the discretion of the Commander. For reallocations up to 499 acre-feet, the Commander has delegated approval authority to the division commander. Reallocations that exceed the Commander's authority may be approved at the discretion of the Secretary of the Army if such reallocations do not require Congressional approval as described above. The approval of the reallocation report, however, does not signify an approval to reallocate storage. Such approval is governed by the final signature of the water supply agreement."[18]

6.11.2 Lake O' the Pines Reallocation

Per the above authorization guidelines, changes in existing allocated storage capacities greater than approximately 50,000 ac-ft or 15 percent (which ever is less) of the total storage capacity allocated to all authorized project purposes, would result in the need for Congressional approval. Authorized project purposes include flood storage. The volume of LOP reservoir capacity that includes flood storage capacity is determined to be 842,100 ac-ft[10]. Based on data obtained from the original 1958 area/capacity survey of Lake O' the Pines[10], it is concluded that an increase in the upper conservation pool elevation above approximately 231.0 feet msl would result in a change in storage capacity greater than 50,000 ac-ft which would trigger the Congressional approval requirement. Table 6.21 provides firm yield, conservation storage, and change in conservation storage. The Congressional approval trigger is 50,000 ac-ft (the lower value of the two criteria) since 15% of the total reservoir capacity (842,100 ac-ft) is much greater than 50,000 ac-ft. Provided the 1958 area/capacity survey data used here is acceptable to all parties involved, this information can be used to assist in determining the need for Congressional reallocation approval.

Table 6.21 Lake O' the Pines Reallocation Data for Congressional Approval Determination

Upper Conservation Pool Elevation (msl)	Firm Yield (afpy)	Conservation Storage (ac-ft)	Change in Conservation Storage
228.50	153,500	251,000	NA
231.00	167,000	301,000	50,000
235.00	187,600	392,000	141,000

Conservation Storage Based on 1958 survey, USACE New Orleans District

6.11.3 USACE Reservoir Reallocation Process

When reallocation of a USACE reservoir is desired, numerous requirements must be met. The following sections outline both the federal and state reallocation processes. USACE Official Headquarters guidance on reallocations can be found in engineering regulation ER 1105-2-100 (Planning Guidance Notebook). Periodic Engineering Circulars and Policy Guidance Memorandums can also be issued on this procedure.

6.11.3.1 Federal Reallocation Process

Partner with USACE to Perform a Reallocation Study

- ID new Use and User(s)
- Evaluate Impacts on Other Project Purposes
- Determine Environmental Effects
- Determine Price to be Charged New User(s)
- Determine Compensation, if any, to Existing Users

Does Study Show Reallocation is Feasible and Practical?
Is Reallocation Volume at or Below USACE Discretionary Limit?

- Less than 50,000 ac-ft
- Less than 15 percent of total reservoir storage

Seek Congressional Approval if Above Discretionary Limit
Address Other Federal Requirements

- Environmental Assessment and Possible Environmental Impact Statement
- Section 404 Permit Requirements
- Federal Energy Regulatory Commission (FERC) Requirements
- Mitigation Requirements
- Inventory and Assessment of any Culturally Significant, Historical and Archaeological Sites or Artifacts

Address State of Texas Requirements
Formulate Multi-Disciplinary Plans and Specifications
Implement Reallocation

6.11.3.2 State of Texas Reallocation Process

Model Reservoir Reallocation in Current WAM
Do WAM Results Demonstrate Reallocation is Beneficial?
Apply for Water Right Permit with TCEQ

- ID Third Parties Impacted by Reallocation
- ID Priority Date Restrictions and Impacts on Other Water Rights
- Determine Possible Mitigation or Environmental Impact Alternatives
- Develop Reservoir Accounting Plan

Coordinate With TPWD for Environmental Concerns
Coordinate With USACE and the Prepared Reallocation Report
Obtain Financial Assistance for Reallocation Project

- If Reallocation is in State Plan then Consult with TWDB for Financial Assistance

If Water Right Permit Granted by TCEQ

- Formulate Detailed Plans and Specifications

7.0 SOCIOECONOMIC IMPACT ANALYSIS – STUDY PHASE II

7.1 INTRODUCTION

In response to SB 3 from the 80th Regular Session of the Texas Legislature, the Study Commission on Region C Water Supply ("Study Commission") was tasked with analyzing the socioeconomic impacts of water supply alternatives on geographic regions where the alternatives are located. Phase I of this study sought to review currently existing socioeconomic studies which have been conducted for five specific water supply alternatives including:

- Marvin Nichols Reservoir
- Wright Patman Lake
- Lake Texoma
- Toledo Bend Reservoir
- Lake O' the Pines

Once the relevant literature was identified, a data gap analysis was to be performed. The goal of the data gap analysis was to provide guidance to the Study Commission on the perceived strengths and/or weaknesses of the methodologies and/or results of the previously conducted socioeconomic studies. A further goal of the data gap analysis was to identify areas that might require additional clarification, analysis, or evaluation to produce a useful measure of the socioeconomic impact on the basin of origin of each identified water supply alternative.

Phase II of the Study sought to answer the more specific questions identified in SB 3 including:

1. What is the impact on the basin of origin for water supplies used to meet the needs of Region C, specifically, what is the economic impact on:
    - Landowners
    - Agricultural and Natural Resources
    - Business and Industry
    - Taxing Entities

2. In connection with water use from Wright Patman Lake, the effect on water availability in that lake and the effect on industries relying on that water availability.

The following discusses the general impacts anticipated and identifies additional information needed to perform a more detailed quantification of impacts.

7.2 SUMMARY OF PHASE I RESULTS

In conducting the literature review and data gap analysis in Phase I of the Study, the Project Team identified the following data gaps and/or trends that should be noted by the Study Commission.

1. No Data and/or Economic Analysis

    Limited or no economic data has been compiled and/or analysis conducted for water supply alternatives related to Wright Patman Lake and Lake O' the Pines. The development of initial economic analysis is necessary for these water supply alternatives so as to determine the impact of their use as alternative water supplies for Region C.

2. Varied Focus of Study Efforts

   In regards to the economic impact studies conducted to date, the studies have either been limited in their scope to a single sector or type of economic impact, or have been broad, encompassing a variety of economic impacts. This can lead to limited or inaccurate conclusions being drawn regarding a water supply alternative. For example, for the Marvin Nichols reservoir, if an individual considered only the Xu study, they may conclude that the reservoir would have a significant negative economic impact. While this conclusion may be applicable for the impact to the timber industry, the whole economic picture is not presented as Xu focuses solely on impacts to one sector. On the other hand, the Weinstein and Clower study is broader in its focus and provides an analysis of the entire economic impact. Therefore, the focus of a study must be clearly delineated so that the study is not used to draw inappropriate conclusions regarding a water supply alternative.

3. Lack of Justification for Assumptions

   As noted by the Project Team in the Phase I report, socioeconomic impact analysis is dependent on many assumptions. In performing the literature review, the Project Team did note that in certain instances, the assumptions utilized were not adequately identified along with the justification, rational, and/or foundation behind the use of the particular assumption. In order for a particular socioeconomic analysis to be properly understood, it is important that researchers properly document their assumptions, the data sources relevant to the development of the assumption, if applicable, and the reasoning as to why the researcher believes the assumption to be appropriate.

4. Consistency in Methodologies Utilized

   The Project Team noted that several different types of analyses were utilized in the development of previous socioeconomic analyses. For example, while the majority of studies use input-output analysis through the use of the IMPLAN model, some recognize the timing associated with water supply alternatives or the impact of the time-value of money while others do not. Although each type of analysis utilized may be appropriate, a more consistent methodology may produce studies which are more easily comparable, giving decision makers a more refined tool with which to make critical water supply planning decisions.

In summary, there were essentially two types of data gaps identified during Phase I related to socioeconomic analysis of the water supply alternatives to be considered by the Study Commission on Region C Water Supply. These are:

1. Limited or no economic data compiled and/or analysis developed for a specific water supply alternative; and/or
2. Inconsistencies in the methodologies, assumptions, and/or focus of studies conducted.

The first of the identified data gaps were applicable to Lake O’ the Pines, Wright Patman Lake, and Lake Texoma. To the knowledge of the Project Team, no formal socioeconomic impact analysis has been conducted related to these water supply alternatives. To overcome this data gap, initial socioeconomic impact analyses need to be conducted for Lake O’ the Pines and for Wright Patman Lake. The Project Team is of the opinion that socioeconomic impact analysis is not necessary for Lake Texoma, as this water supply alternative has no direct socioeconomic effect on Region D.

In regards to the second type of data gap identified, the inconsistencies in methodologies are most notable with regards to the studies concerning the Marvin Nichols Reservoir and the Toledo Bend Reservoir. Additional analysis may be necessary in regards to the proposed Marvin Nichols Reservoir as the existing analyses do not take into account the refinements made to reservoir location and size. Further, the Commission may wish to develop a specific methodology and/or recommended techniques or guidelines for conducting future socioeconomic analysis so as to produce analyses which are sufficiently broad in scope. The development of such a methodology would assist in providing a comprehensive evaluation of the anticipated socioeconomic impact associated with a water supply alternative. As listed below, the Project Team has identified certain objectives the Commission may wish to consider in the development of methodologies, techniques, and/or guidelines for conducting future socioeconomic impact studies.

- **Objectivity** – The chosen methodology should produce an objective result. The analytical data utilized in assumptions should come from widely accepted and publicly available sources, and sufficient citation should be provided so as to allow an objective third-party to verify the analytical inputs.

- **Broad in Focus** – The chosen methodology should seek to evaluate and/or quantify as many impacts as may be identified for a specific supply alternative.

- **Quantifiable** – Where possible, all impacts should be objectively quantified. In the event that data is unavailable to objectively quantify an impact, the impact should be qualitatively identified.

- **Conservative** – The chosen methodology should produce conservative results, that is, economic impacts should not be overly inflated. All assumptions should be based on historical performance where possible so as to prevent unreasonable outputs.

- **Reproducible** – The methodology and results of said methodology should be well explained, documented, and easily reproducible by an objective third-party.

- **Professionally Accepted** – The methodology should use data and/or analytical concepts which have been widely used and/or are industry accepted.

7.3 KEY ECONOMIC TERMS

The discussion below regarding economic impacts further defined in Phase II of the Study refers to the multiplicative effect, that is, the total economic response to a change in demand or production. This total economic impact is comprised of a variety of effects including direct, indirect, and induced effects. For purposes of this discussion, these effects are defined as follows:

- **Direct Effects -** A change in an industry that has a direct economic effect. For example, if a factory closes down, the economic loss of what that factory produces would be considered a direct economic effect.

- **Indirect Effects -** A change to a secondary industry due to the direct effect on the primary industry. For example, if a factory closed down (direct effect) and stopped purchasing raw material, the reduction in purchases of raw material would be considered an indirect economic effect.

- **Induced Effect -** An economic change in household spending due to a direct or indirect effect. For example, if a factory closes down and a worker is laid-off, the reduced purchases of the unemployed workers would be considered an induced economic effect.

7.4 DISCUSSION OF IMPACTS

In accordance with the Phase II Study activities and the requirement of SB 3, the following discusses the analysis of socioeconomic impacts to landowners, agricultural and natural resources, business and industry, and taxing entities.

7.4.1 Impacts to Landowners

Landowners within Region D could be impacted economically in several ways from the use of water supply by Region C, through either the taking of land for the creation of a reservoir, the loss of agricultural or ranching income due to the taking of land, or due to reduced availability of water supplies for crops and livestock.

In the event property is taken from a landowner for the creation of water supply, under state law they must be compensated for this taking. Because the landowner receives compensation in the event of a taking, any negative economic impact experienced by a landowner is partially mitigated. In the event that sufficient compensation is received, then the negative economic impact could be completely mitigated. In this instance, sufficient compensation would entail the landowners receiving adequate fiscal resources to "make them whole", that is, all of the costs to the landowner associated with the taking of their property would be compensated. This level of compensation would need to be determined on a case-by-case basis in order to properly offset the negative economic impact experienced.

However, despite receiving adequate compensation which mitigates the negative economic impact, the taking of land carries with it negative social impacts which must also be recognized. For example, there is inherent social value in land that is passed through a family line over multiple generations. The loss of this land creates negative social consequences which cannot be quantified numerically, but must still be identified and qualified as part of the socioeconomic impact analysis to the basin of origin.

In the event that the landowner derives income from the land (e.g., agriculture, ranching, mineral extraction, etc.), the negative economic impact of the loss of this industry production is not identified with the landowner as part of economic analysis, but is instead considered an induced effect of the reduction in industry output. The negative impact would be identified with the industry through application of the appropriate industry multiplier instead of being identified with the landowner.

Given the above discussion, it is the opinion of the Project Team that direct economic impacts of reservoirs as a water supply alternative on landowners may be mitigated through the provision of sufficient compensation, but this compensation should be determined on a case-by-case basis. Further, to the extent that social impacts are evident, they must be identified and qualitatively evaluated if possible.

7.4.2 Impacts on Agricultural and Natural Resources

The use of water supplies in Region D by Region C water suppliers could potentially have an impact on agricultural and natural resources. For example, productive agricultural land or land containing natural resources could be used for reservoir creation or related mitigation efforts. In addition, if available water supply is decreased due to use by Region C, this could also impact agricultural production and, potentially, the health and productivity of natural resources.

In terms of economic analysis, the loss of agricultural land and/or the reduction in agricultural output due to a decrease in available water supply can be quantified. In this process, the direct impact to the specific agricultural industry is determined based on available data and assumptions, and the multiplicative effect, the result of the indirect and induced effects, is then quantified with the use of an input-output economic analysis model, such as IMPLAN. As discussed earlier, in the event a landowner derives income from agricultural production, the impact to that landowner would be considered as part of the induced impact of agricultural production.

The impact to natural resources can only be measured quantitatively in as much as they represent a resource of the production cycle of other industries. For example, if a water supply alternative impacted available timber land, the reduction in available timber would result in reduced industrial output and would be quantified as a direct impact of the industry. For natural resources not used as a resource in the production cycle, a social impact may still exist due to a reduction or loss of these natural resources. However, such an impact would need to be identified and qualitatively evaluated.

7.4.3 Impacts to Business and Industry

Business and industry could be impacted by the use of Region D water supply by Region C in a number of ways. First, use by Region C could potentially reduce available long-term water supply to Region D which could impact production, particularly for those industries which are heavily dependent on water. Second, in the event of reservoir creation, land could be set-aside through mitigation and natural resources used in production could be lost.

Similar to determining the economic impact on reduced agricultural impact, the direct impact to each industrial sector needs to be determined based on available data and assumptions. Once determined, the direct impact can be modeled under input-output economic analysis to determine the total economic impact.

It should be noted that a negative direct impact to one business or industry may be offset by the creation of a new industry or expansion of production in other areas. For example, in the event a reservoir is created and timber land is set aside due to mitigation, there would be a loss to industries relying on available timber, such as paper and/or lumber mills. However, with the creation of the reservoir, recreational opportunities are created which, in turn, could support new retail establishments. Given this, it is important that in determining the economic impact to the basin of origin, all impacts, both positive and negative, should be taken into account so as to reflect the net economic impact.

7.4.4 Impacts to Taxing Entities

Just as landowners, agricultural and natural resources, and businesses and industries could be impacted by the use of Region D water supplies by Region C, taxing entities could also be impacted. For example, if land is flooded to create a reservoir and as additional land is set aside for mitigation efforts, a taxing entity’s tax base may decrease in size and/or value. In addition, if long-term water supplies are reduced, a loss of commercial or industrial output or movement of landowners out of an area could also have an impact on tax revenues.

Governmental entities who levy taxes have a direct economic impact through the transfer of dollars in the economy. An entity collects taxes from one taxpayer, and then uses that money to purchase goods or services or to subsidize the income of another taxpayer. In this transaction, there is no indirect or induced impact as dollars are simply transferred – the increase in economic activity is quantified as increases in production and/or increased expenditures from households. However, in the event a water supply alternative reduces governmental tax revenues, the extent of the direct impact of this loss will be dependent on the taxing authorities' decision to recoup lost tax revenues. For example, if a taxing entity sees a 1% reduction in revenues, in lieu of increasing taxes, an entity may choose to cut expenditures through a reduction in services provided. In quantifying the impact of water supply alternatives on taxing entities, it is important to understand the anticipated actions of the taxing entities. Specifically, it is important to determine if the particular entity can hold taxes constant through a reduction in service provided, or if it is necessary for the entity to raise taxes in order to mitigate the lost revenues.

Also, similar to the impacts on business and industry, a loss of tax revenue due to a water supply alternative could lead to alternative sources of revenue. For example, if a reservoir is created and taxable land is flooded, the reservoir will likely function as a recreation area, bringing in additional retail shops and associated sales tax revenues. In this instance, it is also important that both the positive and negative impacts to a taxing entity be taken into account when quantifying the economic impact to the basin of origin.

7.4.5 Summary

Given the variations in water supply alternatives and the varying degrees of economic impact that can be experienced, it is important that when quantifying the anticipated economic impact, each alternative must be studied carefully to determine the total net impact on landowners, agricultural and natural resources, businesses and industries, and taxing entities. It is also important to recognize that some impacts cannot be as easily quantified. The inability to quantify an impact does not decrease its importance – these impacts must also be identified and qualitatively evaluated in order to understand the total impact of a water supply alternative.

7.5 WRIGHT PATMAN

The language of SB 3 also requires the Study Commission to specifically consider the impact of Lake Wright Patman as an alternative water supply for Region C. Specifically, the Commission is to consider the effect on water availability in the lake and the effect on industries relying on the water source. The following provides a brief discussion of the economic considerations associated with the use of Wright Patman as an alternative water supply under the three (3) identified supply scenarios.

7.5.1 Voluntary Distribution of Water Resources

One proposed alternative for the use of Lake Wright Patman is the reallocation of existing water rights within the reservoir. Presently, the City of Texarkana possesses 180,000 afpy of water rights within the reservoir. Of this amount, the City has contracted out 120,000 afpy to International Paper ("IP") and approximately 2,500 afpy to other smaller cities. Given this, it appears that approximately 57,000 afpy currently could be available for use by Region C. However, this does not take into account any additional long-term incremental water needs within Region D. Assuming that only unused water supplies are used to meet the needs of Region C, then there would be no quantifiable negative economic impact to Region D. There may exist some impacts associated with easement acquisition for conveyance facilities to Region C, and these impacts may ultimately warrant further study.

However, the Region C water plan states that there are approximately 100,000 afpy of supplies available from Wright Patman. For Region C to acquire this much water, contract modifications between the City of Texarkana and IP would have to be made, which could limit available water supplies to IP and possibly have a negative economic impact through reduced production. Additionally, the long-term water needs of Region D will need to be considered to affirm that currently unused water is not needed by Region D to meet future, long-term water needs.

The Project Team believes that it would be beneficial to conduct further study of the water demands of Region D from Lake Wright Patman. An accurate estimate of long-term water demand is key to ensuring that contracting away large amounts of water from Lake Wright Payment will not jeopardize future growth in Region D or create significant economic impacts due to a decrease in industrial production.

7.5.2 Reallocation of Reservoir Storage

The second proposed water supply alternative associated with Lake Wright Patman is to reallocate a portion of the reservoir, currently used for flood storage, to use as water supply. Such a modification could potentially inundate portions of the White Oak Creek Wildlife Management Area ("WOCWMA"), which serves as constructed mitigation wetlands from the creation of Lake Jim Chapman. Additionally, modification of flood storage may also require adjustments to raw water intakes and/or pumping facilities of the City of Texarkana and/or IP.

Under this supply alternative, impacts to the WOCWMA could have negative economic impacts on the area. Given that the WOCWMA represents mitigation lands, additional inundation of this area could potentially require other mitigation efforts elsewhere in Region D. These additional mitigation lands could further reduce available timber supplies and potentially reduce production from industries relying on this natural resource.

As of the date of this report, initial efforts have been made to identify the land area that could be impacted by the modification of the flood pool. The Project Team recommends that further study be conducted to identify not only the land area impacted, but also to determine if additional mitigation would be required and what land area such efforts may ultimately impact. Additionally, it may be necessary to further study the impact this alternative would have on the existing facilities of the City of Texarkana and/or IP.

7.5.3 Reservoir System Operation

The third proposed method for developing more water supply from Lake Wright Patman is to operate the reservoir as a system in conjunction with Lake Jim Chapman. It is anticipated that this would create potentially 108,000 afpy in additional water supplies for use by Region C. To implement this alternative, a pipeline and pumping facilities would need to be constructed to connect the two reservoirs.

In implementing this alternative, the easements necessary to construct conveyance and pumping facilities would have an impact on current productive land; however, the easements would likely be minimal resulting in only a small loss of production. Further study is warranted to determine the necessary size of the easements required for these facilities as well as the potential land area impacted.

It should be noted that within the Region C water plan, all of these options are considered together to produce an estimated 390,000 afpy in additional water supplies by Region C. In evaluating the economic impact of these alternatives, it is important that each individual alternative be analyzed, and the impacts be added together to estimate the full economic impact on Region D. Given that these alternatives could collectively have a significant impact on Region D, the Project Team recommends that further study be undertaken of Lake Wright Patman as well as the above discussed alternatives.

7.6 BRIDGING STUDY GAPS

As previously stated, one of the identified goals of SB 3 was to determine how to bridge identified information gaps in order to evaluate the water supply alternatives available to Region C. Based on the above discussion, the Project Team proposes the following action items to bridge the information gaps associated with conducting socioeconomic impact analysis of Region C water supply alternatives.

1. Conduct initial, formal studies of Lake Wright Patman and Lake O' the Pines

   During the conduct of the literature review in Phase I, it was determined that no formal socioeconomic impact studies concerning Lake Wright Patman and Lake O' the Pines have been performed. Formal evaluation of the socioeconomic impacts of these reservoirs would provide valuable information regarding the local impact of the reservoirs and how water supply alternatives involving these reservoirs may impact the local economy.

   In addition, it is the Project Team's understanding that initial efforts to conduct a comprehensive feasibility study of the Sulphur River Basin have been undertaken. Such a study would be invaluable in further evaluating impacts to Lake Wright Patman and Lake O' the Pines and could provide much needed source data for the conduct of future socioeconomic impact studies. The Project Team recommends that all stakeholders work together to ensure this study is completed.

2. Develop guidelines and recommendations for conducting future socioeconomic impact studies

   As previously discussed, the socioeconomic impact studies conducted to date on the water supply alternatives considered by the Study Commission utilize inconsistent methodologies which can lead to differing conclusions regarding the same supply alternative. The Project Team recommends that guidelines and recommendations be developed to help guide analysts when conducting such studies.

   Further, once such guidelines and recommendations are developed, it may be of assistance to the Study Commission to update the previously conducted analyses concerning the Marvin Nichols reservoir. The studies conducted to-date on this supply alternative utilized preliminary information regarding the location and size of the reservoir. Since that time, the proposed site of the dam for this reservoir has been refined which could change some of the assumptions utilized in the previous studies. Given this change, an updated analysis may be warranted
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8.0 CONCLUSIONS

The objective of this Phase II study was to evaluate water supply alternatives to determine if Lake Wright Patman and/or Lake O' the Pines were reasonably equivalent alternatives to the Marvin Nichols project. As a result, Espey Consultants, Inc. (EC) performed extensive research and data analysis leading to the following conclusions:

- The City of Texarkana (Texarkana) is the majority owner of water rights from Lake Wright Patman. Texarkana un-contracted water, plus a possible redistribution of an estimated 60,000 afpy of un-used water from International Paper Corporation, could provide an estimated 117,500 afpy of available water for Lake Wright Patman. This additional water would require the activation of the USACE contract with Texarkana for use of the storage in Lake Wright Patman.
- Modifications to the upper and lower conservation pool elevations of Lake Wright Patman, including the varying effects of inundation to the White Oak Creek Wildlife Management Area (WOCWMA) and other areas, were evaluated to determine reasonable options to increase the yield of available water from Lake Wright Patman. Although a constant water surface elevation of 230 feet msl was found to have minimal effects on the WOCWMA, EC believes reallocation of flood pool resources, including an increase in the water surface elevation up to 240 feet msl, should be given serious consideration. Due to the complexity and magnitude of the federally mandated reallocation requirements, a Sulphur River basin-wide study is recommended.
- Operating Lake Wright Patman at a constant water surface elevation of 230 feet msl would provide a total estimated firm yield of about 514,500 afpy while inundating an estimated 521 acres (about 2 percent) of the WOCWMA.
- Operating Lake Wright Patman at a constant water surface elevation of 240 feet msl would provide a total estimated firm yield of about 790,800 afpy while inundating an estimated 3,596 acres (about 14 percent) of the WOCWMA.
- Within the scope of this study, varying degrees of alternatives to the Marvin Nichols Reservoir project include: Voluntary redistribution of existing un-used permitted water rights; Modification of Lake Wright Patman's reservoir operating curve; System Operations of Lakes Wright Patman and Jim Chapman; and, Reallocation of Lake Wright Patman and Lake O' the Pines flood conservation pool.
- The total cost to convey 500,000 afpy of water from Lake Wright Patman to Eagle Mountain Reservoir was estimated to be about $885 per acre foot before amortization and $303 per acre foot after amortization. These cost estimates are more detailed than those provided in the 2011 IPP. Additional information of cost estimate details from the IPP have been requested and should be performed as part of the comparison of reasonable alternatives to Marvin Nichols. Additional information regarding costing has been requested from the USACE.
- The Northeast Texas Municipal Water District (NETMWD) is the owner of water rights from Lake O' the Pines (LOP) totaling 241,800 afpy. Based on the availability of 34,000 afpy of un-contracted water plus the purchase of un-used water rights from existing contract holders US Steel Corporation and the NETMWD member cities (estimated at 67,000 afpy) the total available water from Lake O' the Pines is estimated to be approximately 100,000 afpy under the current operating scenario.
- Increasing the conservation pool elevation of LOP from 228.5 to 231 or 235 feet msl produces additional estimated yields of 13,500 and 34,100 afpy respectively. A conservation pool elevation above 231 feet msl is estimated to trigger Federal Reallocation requirements and approval of the US Congress would be necessary.
- The total cost to convey 100,000 afpy of water from Lake O' the Pines to the Dallas Water Utility East Side WTP was estimated to be about $723 per acre foot before amortization and $298 per

acre foot after amortization. The total project cost was estimated to be about $590 million not including annual operating costs.

- The reservoir reallocation process is governed by the Federal Water supply Act of 1958 as well as the State of Texas. Reallocation of flood storage greater than 50,000 ac-ft for both Lakes Wright Patman and Lake O' the Pines would trigger Federal and State of Texas reallocation guideline requirements as well as the need to obtain approval of the US Congress. The details of these guidelines are outlined in 11 of the main report.
- Given the variations in water supply alternatives and the varying degrees of economic impact that can be experienced, it is important that when quantifying the anticipated economic impact, each alternative must be studied carefully to determine the total net impact on landowners, agricultural and natural resources, businesses and industries, and taxing entities. The steps needed to quantify these impacts were defined in this report.
- The Sulphur River basin wide study is recommended to obtain additional information for the development and understanding of reallocation of the water resources of Lake Wright Patman and Lake O' the Pines.

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