APPENDIX P

WATER MANAGEMENT STRATEGY EVALUATION
APPENDIX P

WATER MANAGEMENT STRATEGY EVALUATION

The information contained in this appendix details the Strategy Evaluation for Water Management Strategies in Region C. These strategies are listed below. For additional information on the Marvin Nichols Reservoir (both the recommended configuration for the Sulphur Basin Supplies strategy and the alternative configuration at 328 feet, msl), please see the full reports in Appendix Y.

Strategy Evaluations:

- Carrizo-Wilcox Aquifer
- Conservation - General
- Cypress Basin Supplies
- George Parkhouse North
- George Parkhouse South
- Groundwater – General
- Gulf of Mexico
- Increase Delivery Infrastructure – General
- Integrated Pipeline (TRWD and DWU)
- Irving Lake Hugo
- Irving Reuse
- Lake Columbia
- Lake Palestine
- Lake Ralph Hall and Reuse
- Lake Tehuacana
- Lake Texoma Desal and Blending
- Lower Bois d’Arc Creek Reservoir
- Main Stem Trinity River Pump Station
- Marvin Nichols Reservoir
- Neches Run-of-River Diversions
- Oklahoma
In accordance with TWDB rules and guidelines, the Region C Water Planning Group has adopted a standard procedure for providing an equitable comparison of potential water management strategies. This procedure classifies the strategies using the TWDB’s standard categories developed for regional water planning. The overall strategy evaluations can be found in Tables P.3 and P.4 and a write-up on each strategy can be found beginning on page P.9. Below is a description of the evaluation process.

All strategies are compared based upon the following categories:

- Quantity
- Reliability
- Cost
- Environmental Factors
- Agricultural Resources/Rural Areas
- Other Natural Resources
- Key Water Quality Parameters
- Third Party Social & Economic Factors

Each category is quantitatively assessed. If quantitative values were not available, a ranking from 1 to 5 was assigned. Table P.1 shows the correlation between the category and the ranking of the non-environmental categories where quantitative values were not available. (The Environmental Factors are discussed in the next section.)
Table P.1
Evaluation Matrix Category Ranking Correlation

<table>
<thead>
<tr>
<th>Rank</th>
<th>Reliability</th>
<th>Remaining Strategy Impacts a</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>2</td>
<td>Low to Medium</td>
<td>Medium High</td>
</tr>
<tr>
<td>3</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>Medium to High</td>
<td>Medium Low</td>
</tr>
<tr>
<td>5</td>
<td>High</td>
<td>Low or None</td>
</tr>
</tbody>
</table>

a Includes impacts on agricultural resources, other natural resources, key water quality parameters, and third party impacts.

Impacts to Agricultural Resources are quantified based on the permanent impacts to water supplies to irrigation users or direct impacts to irrigated acreage. Projects with only temporary impacts, such as pipeline projects, would be classified as low impacts. Specific assumptions include:

- If the location of the strategy is known and data is available, actual impacts to agricultural lands will be used.
- If a strategy impacts more than 5,000 acres of agricultural land, the impacts are classified as “high”. If a strategy impacts less than 1,000 acres of agricultural lands, the impacts are classified as “low”.
- If actual impact data was not available for a new reservoir, impacts of medium high were assumed.

More detailed information regarding the scoring for key water quality parameters is included in Chapter 6. Key water quality parameters were scored according to the “remaining strategy impacts” ranking listed in Table P.1.

Environmental Matrix

The Environmental Matrix (Table P.4) is used to determine the score of the ‘Environmental Factors’ category on the Evaluation Matrix (Table P.3).

The Environmental Matrix (Table P.4) takes into consideration the following categories:

- Total Acres Impacted
- Total Wetland Acres Impacted
- Environmental Water Needs
- Habitat
- Threatened and Endangered Species
- Cultural Resources
• Bays & Estuaries

Each category is quantitatively assessed. If quantitative values were not available, a ranking from 1 to 5 was assigned. Table P.2 shows the correlation between the ranking assigned within each category.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Habitat</th>
<th>All Remaining Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Greater than 30,000 Acres</td>
<td>High Impact</td>
</tr>
<tr>
<td>2</td>
<td>20,000-30,000 Acres</td>
<td>Medium High Impact</td>
</tr>
<tr>
<td>3</td>
<td>7,000-20,000 Acres</td>
<td>Medium Impact</td>
</tr>
<tr>
<td>4</td>
<td>5,000-7,000 Acres</td>
<td>Medium Low Impact</td>
</tr>
<tr>
<td>5</td>
<td>0-5,000 Acres (or ‘varies’)</td>
<td>Low Impact or n/a</td>
</tr>
</tbody>
</table>

**Acres Impacted**

Acres Impacted refers to the total amount of area that will be impacted due to the implementation of a strategy.

The following conservative assumptions were made (unless more detailed information was available):

• Each well or storage tank will impact approximately 2 acres of land.
• The acres impacted for pipelines is equivalent to the right of way easements required.
• Reservoirs will impact an area equal to their surface area.
• A conventional water treatment plant will impact 5 acres.
• Conservation strategies will have no impact on acres.

**Wetland Acres Impacted**

Wetland Acres refers to how many acres that are classified as wetlands are impacted by implementation of the strategy.

The following conservative assumptions were made (unless more detailed information was available):

• For pipelines and groundwater wells, it was assumed wetlands would be avoided as feasible and would therefore have low impacts.

**Environmental Water Needs**
Environmental Water Needs refers to how the strategy will impact the area’s overall environmental water needs. Water is vital to the environmental health of a region, and so it is important to take into account how strategies will impact the amount of water that will be available to the environment.

The following conservative assumptions were made (unless more detailed information was available):

- The majority of the strategies will have a low impact on environmental water needs.
- Reuse will have a medium impact if the effluent was previously used for irrigation or discharged back into the water system. This will decrease the overall amount of water that is available to the environment by diverting the effluent and using it for another purpose.

Habitat

Habitat refers to how the strategy will impact the habitat of the local area. The more area that is impacted due to the implementation of the strategy, the more the area’s habitat will be disrupted. The ranges used for this ranking are in Table P.2, unless more detailed information was available.

Threatened and Endangered Species

Threatened and endangered species refers to how the strategy would potentially impact those species in the area once implemented.

The following conservative assumptions were made (unless more detailed information was available):

- Only applicable to strategies implementing infrastructure
- Rankings were based on the amount of threatened and endangered species located within the county. This amount was found using the Texas Parks and Wildlife Database located at http://tpwd.texas.gov/gis/rtest/ and the U.S. Fish and Wildlife Service Database located at http://www.fws.gov/endangered/.
- This ranking only includes threatened and endangered species as defined in the TWDB guidelines and does not include species without official protection such as those proposed for listing or species that are considered rare or otherwise of special concern.

Cultural Resources

Cultural Resources refers to how the strategy will impact cultural resources located within the area. Cultural resources are defined as the collective evidence of the past activities and accomplishments of
people. Locations, buildings and features with scientific, cultural or historic value are considered to be cultural resources.

The following conservative assumptions were made (unless more detailed information was available):

- Only applicable to strategies implementing infrastructure
- All strategies requiring only a pipeline or groundwater wells will have low impacts.
- New reservoirs will have medium high impacts.

**Bays and Estuaries**

Region C is located too far away from any bays or estuaries to have a quantifiable impact. It was assumed that the only strategies that could have potential impacts to bays and estuaries are the Gulf of Mexico and Toledo Bend strategies. These were given a ranking of medium low impacts.
<table>
<thead>
<tr>
<th>Entity</th>
<th>County Used</th>
<th>Basin Used</th>
<th>Strategy</th>
<th>Quantity (Ac/yr/ft)</th>
<th>Reliability</th>
<th>Cost ($/Ac/yr/ft)</th>
<th>Implementation Issues</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTMWD</td>
<td>Multiple</td>
<td>Caro-Vicis Aquifer</td>
<td>63,069</td>
<td>1</td>
<td>$649</td>
<td>Low</td>
<td>Requires contribution with local groundwater districts. Competing costs for water.</td>
<td></td>
</tr>
<tr>
<td>DWU</td>
<td>Dallas-Trinity</td>
<td>Caro-Vicis Aquifer</td>
<td>30,267</td>
<td>1</td>
<td>$670</td>
<td>Low</td>
<td>Requires contribution with local groundwater districts. Competing costs for water.</td>
<td></td>
</tr>
<tr>
<td>MWS</td>
<td>Multiple</td>
<td>Aquifers - General</td>
<td>135,992</td>
<td>1</td>
<td>$994</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NTMWD</td>
<td>Multiple</td>
<td>Cypress Basin Supplies</td>
<td>87,909</td>
<td>1</td>
<td>$154</td>
<td>Low</td>
<td>Requires the development of existing contracts, and contract with NETMWD.</td>
<td></td>
</tr>
<tr>
<td>NTMWD</td>
<td>Multiple</td>
<td>George Parkhouse North</td>
<td>130,984</td>
<td>1</td>
<td>$1,826</td>
<td>Low</td>
<td>Requires new water rights permit and IBT.</td>
<td></td>
</tr>
<tr>
<td>UTWD</td>
<td>Multiple</td>
<td>George Parkhouse North</td>
<td>30,267</td>
<td>1</td>
<td>$354</td>
<td>Low</td>
<td>Requires new water rights permit and IBT.</td>
<td></td>
</tr>
<tr>
<td>NTMWD</td>
<td>Multiple</td>
<td>George Parkhouse South</td>
<td>100,094</td>
<td>1</td>
<td>$748</td>
<td>Low</td>
<td>Requires new water rights permit and IBT.</td>
<td></td>
</tr>
<tr>
<td>UTWD</td>
<td>Multiple</td>
<td>George Parkhouse South</td>
<td>30,000</td>
<td>1</td>
<td>$994</td>
<td>Low</td>
<td>Requires new water rights permit and IBT.</td>
<td></td>
</tr>
<tr>
<td>MWS</td>
<td>Multiple</td>
<td>Carrizo-Wilcox Aquifer</td>
<td>42,000</td>
<td>1</td>
<td>$605</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NTMWD, DWU and UTWD</td>
<td>Multiple</td>
<td>Gulf of Mexico</td>
<td>130,999</td>
<td>1</td>
<td>$2,192</td>
<td>Low</td>
<td>Technology is still developing for this application at this scale. May require some water right permit and IBT. Strategy was related to central location. Capital cost was based on non-supplier. Supply is treated water.</td>
<td></td>
</tr>
<tr>
<td>DWU</td>
<td>Dallas</td>
<td>Trinity-Sulphur Ridge Infrastructure - General</td>
<td>30,000</td>
<td>1</td>
<td>$777</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DWU</td>
<td>Dallas</td>
<td>Trinity-Sulphur Ridge</td>
<td>30,000</td>
<td>1</td>
<td>$777</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DWU</td>
<td>Dallas</td>
<td>Trinity-Johnson Creek</td>
<td>56,032</td>
<td>1</td>
<td>$369</td>
<td>Low</td>
<td>Requires contract with ANRA and IBT.</td>
<td></td>
</tr>
<tr>
<td>DWU</td>
<td>Dallas</td>
<td>Trinity-Jo Palance</td>
<td>130,071</td>
<td>1</td>
<td>$1,279</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UTWD</td>
<td>Multiple</td>
<td>Lake Ralph Hall and Rough</td>
<td>31,499</td>
<td>1</td>
<td>$558</td>
<td>Low</td>
<td>Requires new water right and IBT.</td>
<td></td>
</tr>
<tr>
<td>MWS</td>
<td>Multiple</td>
<td>Lake Texana</td>
<td>41,899</td>
<td>1</td>
<td>$1,385</td>
<td>Medium high</td>
<td>Requires new water rights permit.</td>
<td></td>
</tr>
<tr>
<td>NTMWD, DWU and UTWD</td>
<td>Multiple</td>
<td>Lake-Toucha DeSalination and Blending</td>
<td>160,071</td>
<td>1</td>
<td>$1,329</td>
<td>Low</td>
<td>Requires IBT, state water right, Congressional authorization, and contract with USACE. Deliver's treated water.</td>
<td></td>
</tr>
<tr>
<td>NTMWD</td>
<td>Multiple</td>
<td>Lower Boss of the River Reservoir</td>
<td>120,200</td>
<td>1</td>
<td>$566</td>
<td>Low</td>
<td>Requires new water rights permit and IBT.</td>
<td></td>
</tr>
<tr>
<td>DWU</td>
<td>Dallas</td>
<td>Trinity—Trinity River Pump Station</td>
<td>87,839</td>
<td>1</td>
<td>$2,684</td>
<td>Low</td>
<td>Requires a water right permit amendment.</td>
<td></td>
</tr>
<tr>
<td>NTMWD, TRWD, UTWD</td>
<td>Multiple</td>
<td>Marvin Nichols Reservoir</td>
<td>489,898</td>
<td>1</td>
<td>$773</td>
<td>Low</td>
<td>Requires new water rights permit and IBT. Known public opposition. Marvin Nichols has threatened for export of water out of state.</td>
<td></td>
</tr>
<tr>
<td>DWU</td>
<td>Dallas</td>
<td>Trinity—Anathie Ass of River Communities</td>
<td>47,255</td>
<td>1</td>
<td>$689</td>
<td>Low</td>
<td>Requires new water rights permit and IBT.</td>
<td></td>
</tr>
<tr>
<td>NTMWD, TRWD, and UTWD</td>
<td>Multiple</td>
<td>Shaddox</td>
<td>110,000</td>
<td>1</td>
<td>$689</td>
<td>Low</td>
<td>Marvin Nichols has threatened for export of water out of state.</td>
<td></td>
</tr>
<tr>
<td>NTMWD</td>
<td>Multiple</td>
<td>Trinity—Red River Water Treatment Reservoir</td>
<td>151,514</td>
<td>1</td>
<td>$3,290</td>
<td>Low</td>
<td>Requires state water right permit and IBT.</td>
<td></td>
</tr>
<tr>
<td>DWU</td>
<td>Dallas</td>
<td>Trinity—West Bottoms</td>
<td>191,134</td>
<td>1</td>
<td>$756</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DWU</td>
<td>Dallas</td>
<td>Trinity—Lake Texana</td>
<td>183,267</td>
<td>1</td>
<td>$966</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NTMWD, UTWD, TRWD, Dallas and Irving</td>
<td>Multiple</td>
<td>Sulphur Basin Supplies Strategy</td>
<td>490,898</td>
<td>1</td>
<td>$494</td>
<td>Medium High</td>
<td>Known opposition to Marvin Nichols Reservoir. Known Nichols portion of WWQ. Known DWU portion of WWQ. Average score of Marvin Nichols and Wright Holmes scores.</td>
<td></td>
</tr>
<tr>
<td>DWU</td>
<td>Dallas</td>
<td>Trinity—West Bottoms</td>
<td>118,099</td>
<td>1</td>
<td>$756</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DWU</td>
<td>Dallas</td>
<td>Trinity—Lake Texana</td>
<td>183,267</td>
<td>1</td>
<td>$966</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DWU</td>
<td>Dallas</td>
<td>Trinity—Lake Texana</td>
<td>183,267</td>
<td>1</td>
<td>$966</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MWS</td>
<td>Multiple</td>
<td>Trinity—West Bottoms</td>
<td>191,134</td>
<td>1</td>
<td>$3,290</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MWS</td>
<td>Multiple</td>
<td>Trinity—West Bottoms</td>
<td>191,134</td>
<td>1</td>
<td>$3,290</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MWS</td>
<td>Multiple</td>
<td>Trinity—West Bottoms</td>
<td>191,134</td>
<td>1</td>
<td>$3,290</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MWS</td>
<td>Multiple</td>
<td>Trinity—West Bottoms</td>
<td>191,134</td>
<td>1</td>
<td>$3,290</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MWS</td>
<td>Multiple</td>
<td>Trinity—West Bottoms</td>
<td>191,134</td>
<td>1</td>
<td>$3,290</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table P.3**

**Strategy Evaluation Matrix**

**Table P.4**

**Strategy Evaluation and Quantified Environmental Impact Matrix**
<table>
<thead>
<tr>
<th>Strategy</th>
<th>Entity</th>
<th>County</th>
<th>Basin</th>
<th>Acres Impacted</th>
<th>Wetland Acres Impacted</th>
<th>Water Needs</th>
<th>Environ Water Needs Score</th>
<th>Habitat</th>
<th>Habitat Score</th>
<th>Threat and Endanger Species</th>
<th>Cultural Resources</th>
<th>Cultural Resources Score</th>
<th>Days &amp; Estuaries</th>
<th>Days &amp; Estuaries Score</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NTMWD</td>
<td>Multiple</td>
<td>Multiple</td>
<td>41.96</td>
<td>0.29</td>
<td>Low</td>
<td>0.29</td>
<td>1.0</td>
<td>0.29</td>
<td>None</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td>UTRWD</td>
<td>Multiple</td>
<td>Multiple</td>
<td>11.66</td>
<td>0.29</td>
<td>Low</td>
<td>0.29</td>
<td>1.0</td>
<td>0.29</td>
<td>None</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td>TRWD</td>
<td>Multiple</td>
<td>Multiple</td>
<td>21.67</td>
<td>0.29</td>
<td>Low</td>
<td>0.29</td>
<td>1.0</td>
<td>0.29</td>
<td>None</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
</tr>
</tbody>
</table>

For the purposes of environmental impacts, the same reservoir footprint was assumed for UTRWD despite planning to use less than the total supply made available from this source.

If the supply from both reservoirs is used, the environmental impact would be higher than if only one reservoir was used. However, this is not the case for the strategies provided in this table.

This table includes the impacts of various strategies on environmental factors, including wetland acres impacted, water needs, and habitat scores. The table also considers the threat and endangerment species, cultural resources, and days and estuaries involved.
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Carrizo-Wilcox Groundwater Well Fields
WMS Type: New Groundwater Source
Potential Supply Quantity (Rounded): Varies ac-ft/yr (Varies mgd)
Implementation Decade: Unknown
Strategy Capital Cost: There are multiple strategies for this source. See Appendix Q.
Unit Water Cost (Rounded): There are multiple strategies for this source. See Appendix Q.

STRATEGY DESCRIPTION

The Carrizo-Wilcox aquifer covers a large area of east, central, and south Texas. Organizations and individuals have been studying the development of water supplies from this aquifer for export. Metroplex water suppliers have been approached as possible customers for the water.

Carrizo-Wilcox groundwater is not a recommended strategy for any Region C supplier. It is an alternative strategy for the North Texas Municipal Water District and Dallas Water Utilities.

STRATEGY ANALYSES

The DWU strategy is summarized below from DWU’s Long Range Water Supply Plan.

“The Carrizo-Wilcox Groundwater strategy will provide 27 MGD (30,000 acft/yr) of new supply using new well fields in Wood, Upshur, and Smith counties. Many of the wells will be co-located on the same site to produce groundwater from both the Carrizo-Wilcox and Queen City aquifers.”

“Groundwater from the well fields is pumped through a 58 mile transmission system to the existing intake and pump station at Lake Fork. The Lake Fork and Tawakoni transmission pipelines will be used to convey supplies from this strategy to DWU’s Eastside WTP.”

A detailed analysis of the alternative groundwater strategy for NTMWD has not been completed. NTMWD has been approached by Forestar, an entity with groundwater holdings in East Texas. If NTMWD were to pursue this water at some point, it could be through a partnership with Forestar.

SUPPLY DEVELOPMENT

Supply availability was estimated using the modeled available groundwater (MAG) amounts as estimated by the TWDB.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. A complete list of the
Environmental considerations can be seen in Table P.4. The twenty-six threatened and endangered species potentially impacted by this WMS, based on the species listed in the county(ies) in which this WMS is located, are: American peregrine falcon ST, Bachman’s sparrow ST, bald eagle ST, interior least tern FE and SE, peregrine falcon ST, piping plover FT and ST, Sprague’s pipit C, wood stork ST, creek chubsucker ST, blackside darter ST, bluehead shiner ST, paddlefish ST, black bear ST, Louisiana black bear FT and ST, red wolf FE and SE, Rafineaque’s big-eared bat ST, alligator snapping turtle ST, Louisiana pine snake C and ST, northern scarlet snake ST, Texas horned lizard ST, timber rattlesnake ST, Louisiana pigtoe ST, sandbank pocketbook ST, southern hickorynut ST, Texas heel splitter ST and Texas pigtoe ST.

PERMITTING AND DEVELOPMENT

Development of this source could require pumping permits from local groundwater conservation districts.

COST ANALYSIS

For the Region C cost analysis, planning level opinions of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the Carrizo-Wilcox supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Carrizo-Wilcox Groundwater strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Carrizo-Wilcox Groundwater strategy was evaluated for NTWMD and DWU.
REGION C WATER MANAGEMENT STRATEGY ANALYSIS

CONSERVATION

**WMS Name:** Conservation  
**WMS Type:** Conservation  
**Potential Supply Quantity**  
131,108 ac-ft/yr Municipal  
4,884 ac-ft/yr Non-Municipal  
**Implementation Decade:** Multiple  
**Strategy Capital Cost:** $420,878,859 (Sept. 2013)  
**Unit Water Cost:** $Varies per 1,000 gallons (during loan period)  
See Table Q-10, Q-11, Q-208, Q-209, & Q-212  
$Varies per 1,000 gallons (after loan period)  
See Table Q-10 Q-11, Q-208, Q-209, & Q-212

**STRATEGY DESCRIPTION**

More detailed information on this strategy can be found in Appendix K. This strategy is to proactively reduce water demands through water conservation efforts. In Region C this strategy was assessed for municipal, manufacturing, and irrigation users. This strategy represents a compilation of a myriad of actions that may include but are not limited to, public education and outreach, reducing water waste, conservation oriented rate structures, limiting of outdoor water use, and the increasing efficiency of manufacturing and irrigation processes.

Two Cities (Bedford and Fort Worth) have developed significant water loss control programs with large capital costs. Detailed cost estimates for those programs are in Tables Q-208, Q-209, & Q-212, and a description of those programs are below.

Cost Estimate Q-208 - The City of Bedford is experiencing high levels of water loss and anticipates even higher losses with the addition of a second pressure plane. The city has identified critical line replacements that will provide substantial savings of lost water in the system. It is the city’s intention to replace 150 miles of water distribution main over the next 10 years. In addition the city plans to upgrade their outdated water meters with new state-of-the-art Automatic Meter Readers (AMR) which will alter the city and ultimately the customer, to expedite repairs and curtail water loss.

Cost Estimate Q-209 - The City of Fort Worth plans to develop an Advanced Metering Infrastructure system comprised of state-of-the-art electronic/digital metering hardware and software, which combine interval data measurement with continuously available remote communications. The AMI system will enable measurement of detailed, time-based information and frequent collection and transmittal of such information to various parties. AMI or Advanced Metering Infrastructure typically refers to the full measurement and collection system that includes meters at the customer site, communication networks between the customer and service provider, such as the City’s Water Department, and data reception and management systems that make the information available to the service provider and customer. A major component of this strategy will be automatic leak detection, which will assist the city in identifying leaks in real time both in the distribution system and on the customer side of the meter, allowing for savings of water that would otherwise be lost.
Cost Estimate Q-212 - The City of Fort Worth has completed its first phase of Water Conservation and Condition Assessment Program (WCCAP). This program inventoried the 3,400+ miles of water line in Fort Worth’s distribution system and identified water lines that are a major source of water leakage, particularly those that have had multiple breaks in recent years or that due to age, pipe material, and condition are expected to have major breaks. This is a 10-year program to replace the most critical sources of current water losses and prevent the most likely potential water losses.

SUPPLY DEVELOPMENT

This strategy delays the need for development of other water supplies through demand reductions of users. High levels of conservation have already been achieved in Region C to date.

ENVIRONMENTAL CONSIDERATIONS

This strategy is expected to have no adverse environmental impacts. Rather, it is anticipated to positively impact the environment by delaying the need for other projects that potentially have more impacts.

AGRICULTURAL AND RURAL IMPACTS

No adverse agricultural and rural impacts are expected from the conservation strategy. In some cases, it may make more water available to agricultural and rural users.

COST ANALYSIS

Cost estimates were prepared for each individual WUGs conservation strategy. These cost estimates are contained in Appendix Q, Table Q-10 and Q-11.

WATER MANAGEMENT STRATEGY EVALUATION

Conservation was applied to all municipal water user groups and most irrigation and manufacturing water user groups. Based on the analysis provided above, the conservation strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Cypress Basin Supplies (Lake O’ the Pines)
WMS Type: New Surface Water Source
Potential Supply Quantity (Rounded): 87,900 ac-ft/yr (78 mgd)
Implementation Decade: Unknown
Strategy Capital Cost: $361,876,000 (Sept. 2013) Q-29
Unit Water Cost (Rounded): $1.66 per 1,000 gallons (during loan period)
$0.74 per 1,000 gallons (after loan period)

STRATEGY DESCRIPTION

Lake O’ the Pines is an existing Corps of Engineers reservoir, with Texas water rights held by the Northeast Texas Municipal Water District. The lake is on Cypress Creek in the Cypress Basin in Senate Bill One water planning Region D, the North East Texas Region. Some Metroplex water suppliers have explored the possibility of purchasing supplies in excess of local needs from the Cypress Basin for use in the Metroplex. There could be as much as 89,600 acre-feet per year available from the basin. However, based on information from the 2016 Region D Plan, Lake O’ the Pines may be fully utilized by local demands and may not be available for use in Region C.

Lake O’ the Pines is about 120 miles from the Metroplex, and the distance and limited supply make this a relatively expensive water management strategy. Obtaining water from the Cypress River Basin is not a recommended strategy for any Region C supplier. It is an alternative strategy for the North Texas Municipal Water District.

STRATEGY ANALYSES

A detailed strategy analysis for Cypress Basin Supplies (Lake O’ the Pines) is not included as it is not a recommended strategy for any of the major water providers in Region C. This strategy will be evaluated in detail at later stages.

SUPPLY DEVELOPMENT

Supply Availability was determined using the Cypress Basin WAM.

ENVIRONMENTAL CONSIDERATIONS

Since the Lake O’ the Pines water management strategy obtains water from an existing source, the environmental impacts are expected to be low.

The thirty threatened and endangered species potentially impacted by this WMS, based on the species listed in the county(ies) in which this WMS is located, are: white faced ibis ST, wood stork ST, bald eagle.
ST FR, peregrine falcon ST, American peregrine falcon ST, Arctic peregrine falcon ST, whooping crane SE FE, piping plover ST FT, red knot ST, interior least tern SE, Bachman’s, sparrow ST, paddlefish ST, bluehead shiner ST, creek chubsucker ST, blackside darter ST, rafinesque's big-eared bat ST, red wolf SE, black bear ST, alligator snapping turtle ST, Texas horned lizard ST, Northern scarlet snake ST, Louisiana pine snake ST, timber rattlesnake ST, Texas pigtoe ST, sandbank pocketbook ST, southern hickorynut ST, Louisiana pigtoe ST, Texas heelsplitter ST, Louisiana black bear FT and least tern FE.

PERMITTING AND DEVELOPMENT

Development of this source would require contracts with the Northeast Texas Municipal Water District and other Cypress River Basin suppliers with excess supplies, and an interbasin transfer permit.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the recommended and alternative strategies for Cypress Basin supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Cypress Basin Supplies (Lake O’ the Pines) strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Cypress Basin Supplies (Lake O’ the Pines) strategy was evaluated for NTWMD and customers.
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: George Parkhouse Lake (North)
WMS Type: New Surface Water Source
Potential Supply Quantity (Rounded): Up to 118,960 ac-ft/yr (106 mgd)
Implementation Decade: Unknown
Strategy Capital Cost: There are multiple strategies for this source. See Appendix Q.
Unit Water Cost (Rounded): There are multiple strategies for this source. See Appendix Q.

STRATEGY DESCRIPTION

George Parkhouse Lake (North) is a potential reservoir located in Region D on the North Sulphur River in Lamar and Delta Counties. The yield of the reservoir would be reduced substantially by development of Lake Ralph Hall or Marvin Nichols Reservoir. George Parkhouse Lake (North) would provide an inexpensive source of supply for Region C.

George Parkhouse Lake (North) is not a recommended water management strategy for any Region C water supplier. It is an alternative strategy for the North Texas Municipal Water District and the Upper Trinity Regional Water District.

STRATEGY ANALYSES

If NTMWD were to develop the supply it would be for 118,960 acre-feet per year with a capital cost of $618 million. If UTRWD were to develop the supply it would be for 35,000 acre-feet per year with a capital cost of $230 million. The dam costs were prorated for the UTRWD option to account for the smaller supply needed from this source for that strategy.

SUPPLY DEVELOPMENT

The supply availability was determined using the Sulphur Basin Water Availability Model and assuming that Lake Ralph Hall was in place.

ENVIRONMENTAL CONSIDERATIONS

The George Parkhouse Lake (North) would inundate 15,359 acres. Ninety percent of the land impacted is cropland or pasture. There are no designated bottomland hardwoods located within or adjacent to the site.
The twenty-one threatened and endangered species potentially impacted by this WMS, based on the species listed in the county(ies) in which this WMS is located, are: American burying beetle F, least tern F and S, piping plover F and S, American peregrine falcon S, Bachman’s sparrow S, bald eagle, S, wood stork S, whooping crane S, eskimo curlew S, peregrine falcon S, blackside darter, creek chubsucker S, paddlefish S, blue sucker S, shovel-nosed sturgeon S, black bear S, red wolf S, alligator snapping turtle S, Texas horned lizard S, and Timber rattlesnake S.

PERMITTING AND DEVELOPMENT

Development of the George Parkhouse Lake (North) would require a water right permit and an interbasin transfer permit.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the George Parkhouse Lake (North) supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the George Parkhouse Lake (North) strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.
WATER USER GROUP APPLICATION

The George Parkhouse Lake (North) strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served. George Parkhouse Lake (North) was considered for the large WWPs.
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: George Parkhouse Lake (South)
WMS Type: New Surface Water Source
Potential Supply Quantity (Rounded): Up to 108,480 ac-ft/yr (97 mgd)
Implementation Decade: Unknown
Strategy Capital Cost: There are multiple strategies for this source. See Appendix Q.
Unit Water Cost (Rounded): There are multiple strategies for this source. See Appendix Q.

STRATEGY DESCRIPTION

George Parkhouse Lake (South) is a potential reservoir located in Region D on the South Sulphur River in Hopkins and Delta Counties. It is located downstream from Jim Chapman Lake and would yield 135,600 acre-feet per year (with 108,480 acre-feet per year available for Region C). Its yield would be reduced substantially by the development of Marvin Nichols Reservoir.

George Parkhouse Lake (South) is not a recommended water management strategy for any Region C water supplier. It is an alternative strategy for the North Texas Municipal Water District (NTMWD) and the Upper Trinity Regional Water District (UTRWD).

STRATEGY ANALYSES

If NTMWD were to develop the supply it would be for 108,480 acre-feet per year with a capital cost of $758 million. If UTRWD were to develop the supply it would be for 35,000 acre-feet per year with a capital cost of $309 million. The dam costs were prorated for the UTRWD option to account for the smaller supply needed from this source for that strategy.

SUPPLY DEVELOPMENT

Supply availability was determined using the Sulphur Basin Water Availability Model.

ENVIRONMENTAL CONSIDERATIONS

George Parkhouse Lake (South) would inundate 28,362 acres. Ninety percent of the land impacted is cropland or pasture. There are no designated priority bottomland hardwoods located within or adjacent to the site.
The seventeen threatened and endangered species potentially impacted by this WMS, based on the species listed in the county(ies) in which this WMS is located, are: Least tern F and S, piping plover F and S, American peregrine falcon S, Bachman’s sparrow S, bald eagle S, wood stork S, whooping crane S, peregrine falcon S, blackside darter S, creek chubsucker S, paddlefish S, black bear S, red wolf S, Louisiana pigtoe S, alligator snapping turtle S, Texas horned lizard S, and timber rattlesnake S.

PERMITTING AND DEVELOPMENT

Development of George Parkhouse Lake (South) would require a water right permit and an interbasin transfer permit.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the George Parkhouse Lake (South) supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the George Parkhouse Lake (South) strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.
WATER USER GROUP APPLICATION

The George Parkhouse Lake (South) strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served. George Parkhouse Lake (South) was considered for the large WWPs.
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
GROUNDWATER

WMS Name: Additional Groundwater and New Wells

WMS Type: New Groundwater Source

Potential Supply Quantity (Rounded): 7,422 ac-ft/yr (6.6 mgd)

Implementation Decade: Multiple

Strategy Capital Cost: There are multiple strategies for this source. See Appendix Q.

Unit Water Cost (Rounded): There are multiple strategies for this source. See Appendix Q.

STRATEGY DESCRIPTION

This strategy is to develop groundwater through the drilling of a new well(s). It also includes the construction of all associated transmission and treatment that may be required.

SUPPLY DEVELOPMENT

This strategy was developed in accordance with Modeled Available Groundwater (MAG) values for the appropriate aquifer and county. As such, it is considered to be reliable supply that will not compromise the Desired Future Conditions (DFCs) as established by the Groundwater Management Area (GMA).

ENVIRONMENTAL CONSIDERATIONS

The right of way for the wells and transmission lines may temporarily affect the environment during construction. Additional study and mitigation may be required before construction of the well and transmission pipeline. It may be possible to route the pipeline to avoid environmentally sensitive areas.

AGRICULTURAL AND RURAL IMPACTS

The right of way for the transmission line may temporarily affect a small amount of agricultural acreage during construction. To the extent that this strategy is recommended for a rural user, the increased water supply may enhance the vitality of the community.

PERMITTING AND DEVELOPMENT

All recommended groundwater strategies comply within the Modeled Available Groundwater (MAG) values for their respective counties and aquifers. As such, these strategies should have no adverse effects on the Desired Future Conditions of the aquifers.

Athens MWA’s alternative strategy for new groundwater wells exceeds the MAG (which is why it is an alternative rather than a recommended strategy), but Athens WMA has already received the permits for these wells from the Groundwater Conservation District covering the area.
COST ANALYSIS

Cost estimates were prepared for each individual groundwater strategy. These cost estimates are contained in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Additional Groundwater and New Wells strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Additional Groundwater and New Wells strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served.
The cost of desalination has been decreasing in recent years, and some municipalities in Florida and California have been developing desalinated seawater as a supply source. The State of Texas has sponsored initial studies of potential seawater desalination projects, and this is seen as a potential future supply source for the state. Because the cost of desalination and the distance to the Gulf of Mexico, seawater desalination is not a particularly promising source of supply for Region C. However, seawater desalination has been mentioned through public input during the planning process, and it was evaluated in response to that input.

The supply from seawater desalination is essentially unlimited, but the cost is a great deal higher than the cost of the other water management strategies for Region C. Developing water from the Gulf of Mexico with desalination is not a recommended or alternative strategy for any water supplier in Region C.

The supply from the Gulf of Mexico will be delivered by means of 78-inch or larger pipelines and intake pump stations and multiple booster pump stations. Significant treatment will be required to desalinate the water with water treatment plants retrofitted by reverse osmosis treatment trains. The reject stream from the treatment process will be disposed in a water body.

The potential source of supply is readily available but would require significant treatment and transmission to be usable for the Metroplex customers.

There are several environmental considerations associated with the large quantities of brine water in the reject stream and the potential impact to the water quality of the release streams. There are also potential issues associated with blending highly saline water with other water bodies for the purpose of
PERMITTING AND DEVELOPMENT

Technology for desalination is still developing for this application at this scale. This strategy may require a state water right permit and interbasin transfer (IBT).

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the Gulf of Mexico supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Gulf of Mexico desalination strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Gulf of Mexico desalination strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served. Gulf of Mexico desalination was considered for the large WWPs.

REFERENCES

REGION C WATER MANAGEMENT STRATEGY ANALYSIS
INCREASE DELIVERY INFRASTRUCTURE

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<th>WMS Name:</th>
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<td>Implementation Decade:</td>
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This strategy does not create new supply, but is essential for transporting supplies to end users.

Implementation Decade: Multiple

Strategy Capital Cost: There are multiple strategies for increase delivery infrastructure. See table on following pages.

Unit Water Cost (Rounded): There are multiple strategies for increase delivery infrastructure. See table on following pages.

STRATEGY DESCRIPTION

This strategy is to develop new transmission facilities or increase the size of existing water supply transmission pipelines and pump stations. In many cases this represents the connection of an entity to a wholesale provider or the expansion of an existing transmission system. In other cases, the transmission supply is to connect existing supplies to the end users. This strategy may also include some infrastructure needed to take delivery of water from another provider such as ground storage.

SUPPLY DEVELOPMENT

While this strategy does not create supply, it is vital to making existing and future supplies usable to those with needs. This transmission infrastructure enables the entity to receive the water.

ENVIRONMENTAL CONSIDERATIONS

The right of way for the transmission lines may temporarily affect the environment during construction. Additional study and mitigation may be required before construction of the transmission pipeline. The pipeline may be able to be routed to avoid environmentally sensitive areas.

AGRICULTURAL AND RURAL IMPACTS

The right of way for the transmission line may temporarily affect a small amount of agricultural acreage during construction. To the extent that this strategy is recommended for a rural user, the increased water supply may enhance the vitality of the community.

PERMITTING AND DEVELOPMENT

Construction of the pipeline can likely be done under a nationwide permit. If the pipeline is part of
another larger supply development strategy, there may be additional permitting requirements. Those requirements are considered with the appropriate larger supply development strategy.

COST ANALYSIS

Cost estimates were prepared for each individual water treatment strategy. These cost estimates are contained in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the increase delivery infrastructure strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Increase delivery infrastructure strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the current capacity of delivery infrastructure and the ultimate needed capacity of delivery infrastructure.

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<thead>
<tr>
<th>Entity</th>
<th>Recommended Strategy</th>
<th>Capital Cost</th>
<th>Cost Estimate Number</th>
<th>First Decade of Water Strategy</th>
<th>First Decade Water Supply Volume (acre-feet/year)</th>
<th>First Decade Estimated Annual Average Unit Cost ($/acre-foot/year)</th>
<th>Year 2070 Water Supply Volume (acre-feet/year)</th>
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<td>First Decade Water Supply Volume (acre-feet/year)</td>
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<td>Parallel pipeline and pump station from Fort Worth</td>
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<td>Connect to Weatherford (TRWD)</td>
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<td>2030</td>
<td>25</td>
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<td>Infrastructure improvements at Lake intake</td>
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<td>Q-175</td>
<td>2020</td>
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2016 Region C Water Plan
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<th>Cost Estimate Number</th>
<th>First Decade of Water Strategy</th>
<th>First Decade Water Supply Volume (acre-feet/year)</th>
<th>First Decade Estimated Annual Unit Cost ($/acre-foot/year)</th>
<th>Year 2070 Water Supply Volume (acre-feet/year)</th>
<th>Year 2070 Estimated Annual Average Unit Cost ($/acre-foot/year)</th>
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<td>Expand Capacity of Lake intake and Pump Station</td>
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REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Integrated Pipeline
WMS Type: Existing Surface Water Source
Potential Supply Quantity (Rounded): 270,000 ac-ft/yr (240 mgd)
Implementation Decade: 2020
Strategy Capital Cost: $2,120,666,000 (Sept. 2013) Q-48
Unit Water Cost (Rounded): $2.60 per 1,000 gallons (during loan period)
Note: This is Overall Unit cost. Individual unit costs are different for TRWD and DWU.

STRATEGY DESCRIPTION

The Tarrant Regional Water District (TRWD) and Dallas Water Utilities (DWU) are cooperating to construct the Integrated Pipeline, which will deliver water to Tarrant and Dallas Counties from Lake Palestine, Cedar Creek Lake, and Richland-Chambers Reservoir. The pipeline will have a capacity of about 350 mgd, with about 200 mgd for TRWD and 150 mgd for Dallas. Dallas’s share of the project will deliver water from Lake Palestine. TRWD’s share will deliver about 179,000 acre-feet per year from Cedar Creek Lake and Richland-Chambers Lake (assuming a 1.25 peaking factor). The project is a recommended water management strategy for TRWD and DWU and the total capital cost is $2.7 billion.

SUPPLY DEVELOPMENT

This strategy provides access to current TRWD supplies in Cedar Creek Lake and Richland-Chambers Reservoirs. It also secures access to Dallas’ supplies in Lake Palestine.

ENVIRONMENTAL CONSIDERATIONS

There are no significant environmental considerations associated with the strategy.

PERMITTING AND DEVELOPMENT

There are no permitting issues associated with the strategy.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.
Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the Integrated Pipeline supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the TRWD Integrated Pipeline strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The TRWD Integrated Pipeline strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served. It is expected to serve TRWD and DWU’s customers in the Dallas/Fort Worth area.
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Lake Hugo

WMS Type: Existing Surface Water Source

Potential Supply Quantity (Rounded): 25,000 ac-ft/yr (22.3 mgd)

Implementation Decade: Unknown

Strategy Capital Cost: $177,686,000 (Sept. 2013) Q-91

Unit Water Cost (Rounded): $3.14 per 1,000 gallons (during loan period) $1.31 per 1,000 gallons (after loan period)

STRATEGY DESCRIPTION

This is a strategy to utilize Irving’s existing contract with the city of Hugo, Oklahoma for water from Lake Hugo. Costs include construction of a transmission system as well as a commodity cost per the contract of $0.24/1,000 gallons and treatment costs estimated at $0.58/1,000 gallons. This is an alternative strategy for Irving.

SUPPLY DEVELOPMENT

Supply availability is based on an existing 2008 contract between Irving and Hugo which reserves Irving’s right to purchase an initial increment of 25,000 acre-feet per year from Lake Hugo.

ENVIRONMENTAL CONSIDERATIONS

Water is already impounded and additional environmental impacts at the source would be negligible. Pipeline routing can/will avoid significant resources.

The twenty-four threatened and endangered species potentially impacted by this WMS, based on the species listed in the county(ies) in which this WMS is located, are: wood stork ST, bald eagle ST and FR, peregrine falcon ST, American peregrine falcon ST, whooping crane SE, piping plover ST and FT, eskimo curlew SE, red knot ST, interior least tern SE, Bachman's sparrow ST, shovelnose sturgeon ST, paddlefish ST, blue sucker ST, creek chubsucker ST, blackside darter ST, red wolf SE, black bear ST, alligator snapping turtle ST, Texas horned lizard ST, timber rattlesnake ST, American burying beetle SE and FE, Ouachita rock pocketbook SE, least tern FE and Louisiana black bear FT.

PERMITTING AND DEVELOPMENT

The City of Hugo holds the rights to water from Lake Hugo and has executed a contract with Irving for a portion of those rights. However, the City’s legal right to transport that water to an out of state customer under current Oklahoma law is not clear. Implementation planning allows ten years for the
legal issues to be settled. Once the interstate issues have been clarified/addressed, remaining permitting issues should be minor. It is expected that the pipeline can be permitted under a Nationwide Permit under Section 404 of the Clean Water Act.

**COST ANALYSIS**

Initial costs include a 26.8 MGD pump station and intake structure at Lake Hugo, as well as improvements to the existing Chapman and Princeton pump stations, a new 42” pipeline between Hugo and Lake Chapman, and upgrades to the existing Chapman delivery system. As noted above, Irving’s contract with Hugo specifies a commodity cost for the water of $0.24/1,000 gallons and treatment costs are estimated at $0.58/1,000 gallons.

**WATER MANAGEMENT STRATEGY EVALUATION**

Based on the analysis provided above, the Lake Hugo strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

**WATER USER GROUP APPLICATION**

The Lake Hugo strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served.

**REFERENCES**

REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Irving Reuse Project
WMS Type: Reuse
Potential Supply Quantity (Rounded): 28,000 ac-ft/yr (25 mgd)
Implementation Decade: 2020
Strategy Capital Cost: $39,960,000 (September 2013) Q-90
Unit Water Cost (Rounded): $1.52 per 1,000 gallons (during loan period)

STRATEGY DESCRIPTION

Irving has contracted with TRA for 25 MGD from the TRA Central Plant discharge effluent. This reuse project is a recommended strategy for City of Irving. The recommended strategy consists of infrastructure for pre-treatment of the TRA Central discharge (25 MGD) and transmission to the Dallas Bachman Treatment Plant.

Alternative methods for pretreatment and transmission routes have not been determined. The cost estimate reflects the most expensive form of treatment potentially required. Key variables will be refined as additional studies are performed.

SUPPLY DEVELOPMENT

This strategy allows development of potable supply from currently discharged wastewater effluent.

ENVIRONMENTAL CONSIDERATIONS

The water source for the recommended strategy is reuse water from the TRA Central Plant. No new reservoir or other storage mechanism would be required. It should be noted that the 25 MGD is currently flowing down the Trinity River and will cease to do so when this project is completed. Transmission impacts are limited to the very short distance (approximately 6 miles) between the Central and Bachman Plants. This area is highly disturbed/urbanized and environmental impacts would be minor. The “worst case” analysis for pre-treatment methodology (reverse osmosis) would engender a waste stream requiring disposal.

The seventeen threatened and endangered species potentially impacted by this WMS, based on the species listed in the county(ies) in which this WMS is located, are: white-faced ibis ST, wood stork ST, bald eagle ST, peregrine falcon ST, American peregrine falcon ST, whooping crane FE and SE, piping plover FT and ST, red knot ST, interior least tern FE and SE, black-capped vireo FE and SE, golden-cheeked warbler FE and SE, alligator snapping turtle ST, Texas horned lizard ST, timber rattlesnake ST, Texas pigtoe ST, Louisiana pigtoe ST, and Texas heelsplitter ST.

PERMITTING AND DEVELOPMENT

Depending on the specific approach to transmission between the TRA Central Plant and Bachman...
Treatment Plant, this strategy may require a minor modification to the TRA discharge permit from the Central Plant. This change would include a permit for discharge into water of the State (Fishing Hole Lake), and/or a “bed and banks” permit. A Section 404 permit for the pipeline (most probably a Nationwide Permit rather than an individual permit) and possibly Section 408 approval from the Corps of Engineers may also be required. This project does not require a new State water right.

**COST ANALYSIS**

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

The cost of this strategy is highly dependent on pre-treatment methods (natural wetlands/ultraviolet disinfection/reverse osmoses) required during the permitting process as well as exact transmission route. Costs are also highly dependent on whether or not Irving partners with Dallas in the implementation of their Joe Pool to Bachman water management strategy. These discussions are ongoing. A planning level cost estimate for this strategy is included in Appendix Q.

**WATER MANAGEMENT STRATEGY EVALUATION**

Based on the analysis provided above, the Irving Reuse strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

**WATER USER GROUP APPLICATION**

The Irving Reuse strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served. This strategy was only evaluated for Irving.

**REFERENCES**

Irving Long Range Water Supply Plan (FNI, 2015) interim work product
Dallas Long Range Water Supply Plan (HDR, 2014) interim work product
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Lake Columbia
WMS Type: New Surface Water Source
Potential Supply Quantity (Rounded): 56,050 ac-ft/yr (50 mgd)
Implementation Decade: 2070
Strategy Capital Cost: $327,187,000 (Sept. 2013) Q-39
Unit Water Cost (Rounded): $2.80 per 1,000 gallons (during loan period)

$1.48 per 1,000 gallons (after loan period)

STRATEGY DESCRIPTION

The project description for the Lake Columbia Strategy is based on the information provided by Angelina and Neches River Authority (ANRA) and summarized in the October 2014 Draft Dallas Long Range Water Supply Plan. Angelina Neches River Authority is the sponsor for the Lake Columbia project on Mud Creek in Cherokee and Rusk Counties. Lake Columbia is a recommended strategy in the 2011 East Texas Regional Water Plan (ETRWP). Angelina Neches River Authority has been granted a water right permit (Permit No. 4228) by the TCEQ to impound 195,500 acre feet per year and to divert 85,507 acre feet per year (76.3 MGD) for municipal and industrial purposes. Angelina Neches River Authority currently has contracted with customers for 53 percent of the 85,507 ac-ft per year permit of the proposed Lake Columbia reservoir. Lake Columbia is identified as a recommended WMS for Dallas Water Utilities (DWU). After considering the local needs in the East Texas Region, Dallas’ projected share of the proposed Lake Columbia project is 56,000 ac-ft per year by 2070. This water management strategy for Angelina Neches River Authority was developed to address the total current contracted and potential future customer demand through the construction of Lake Columbia. Angelina Neches River Authority holds the water right for the supply source and will be the project sponsor. It was specified in the 2014 Draft Dallas Long Range Supply Plan that Dallas will be responsible for 70 percent of the dam, reservoir land acquisition, and relocations, and Angelina Neches River Authority will be responsible for the remaining 30 percent of the reservoir construction and land acquisitions costs. This cost split is subject to change during the potential negotiations between Dallas and Angelina Neches River Authority. The Lake Columbia dam site is located two to three miles downstream of Highway 79 on Mud Creek in Cherokee County. The contributing drainage area for the reservoir is approximately 384 square miles. The total conservation pool volume is 195,500 acre feet per year and the top of conservation pool is at the elevation of 315 ft MSL. The conservation pool covers an area of approximately 10,133 acres and the flood pool covers an additional area of 1,367 acres.

STRATEGY ANALYSES

The Lake Columbia strategy is a recommended strategy for DWU. The water would be transported via pipeline to the proposed IPL pump station at Lake Palestine.
SUPPLY DEVELOPMENT

The firm yield for Lake Columbia was determined by means of the water availability analysis using the Neches Basin Water Availability Model (WAM). This model was downloaded from TCEQ website in 2009. The firm yield of the Lake was estimated to be 75,600 acre feet per year in 2020 and reducing to 75,350 acre feet per year in 2070. It should be noted that the water management strategies for the reservoir development and the transmission connections were all based on the firm supplies available from Lake Columbia. The firm yield reported in the October, 2014 Draft Dallas Long Range Water Supply Plan is very similar to the firm yield generated using the WAM models.

ENVIRONMENTAL CONSIDERATIONS

The summary of environmental considerations was developed based on the known environmental factors that have been discussed in the Draft Environmental Impact Study (DEIS).

Habitat – The footprint of Lake Columbia will impact approximately 5,746.5 acres of waters of the U.S., including 3,689 acres of forested wetlands and the remainder comprised of shrub and emergent wetlands (144 and 1,518 acres, respectively), open water, streams and a hillside bog.

Environmental Flows – The current TCEQ Permit No. 4228 allowing the construction and operation of Lake Columbia does not require any instream flow releases. However, if Dallas wants to move water from Lake Columbia in Neches Basin to Trinity River Basin, an amendment to the Permit is required to allow interbasin transfers. Bays and Estuaries – Lake Columbia project is over 280 river miles upstream from the Neches estuary at Sabine Lake and is therefore expected to have no measureable effect on the fresh water inflows into Sabine Lake and Sabine Lake estuary. Recognizing the diminishing effect of upstream distance on bay and estuary inflows, the Texas Water Code (Section 11.147) requires consideration of such effects only if a proposed project is within 200 river miles of the coast.

Threatened and Endangered Species - The Lake Columbia project area includes six federally listed species, five of which are also listed by the state. The state lists fourteen additional species within Smith and Cherokee Counties where the lake would be developed.
Table S-1 Comparison of Environmental Features Impacted by the Toledo Bend Pipeline Alternative and the Proposed Lake Columbia

<table>
<thead>
<tr>
<th>ENVIRONMENTAL FEATURE</th>
<th>TOLEDO BEND ALT. a</th>
<th>L. COLUMBIA b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Miles</td>
<td>Acres</td>
</tr>
<tr>
<td>Upland Forest</td>
<td>41.5</td>
<td>502.4</td>
</tr>
<tr>
<td>Shrub Upland + Grassland (Non-forested Land)</td>
<td>28.8</td>
<td>348.8</td>
</tr>
<tr>
<td>Bottomland Hardwood Forest (Deciduous Forested Wetland)</td>
<td>0.9</td>
<td>10.7</td>
</tr>
<tr>
<td>Herbaceous Wetland</td>
<td>0.5</td>
<td>5.5</td>
</tr>
<tr>
<td>Shrub Wetland</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Hillside Bog</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Minor Streams</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Major Streams</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lacustrine (Pond/Lake)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>New Channel</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>State Parks</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>State Wildlife Management Areas</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>National Forests</td>
<td>13.1</td>
<td>159.2</td>
</tr>
<tr>
<td>Federal Wildlife Management Areas</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number of Federal T/E Species Potentially Occurring c</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Number of State T/E Species Potentially Occurring c</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Urban</td>
<td>7.8</td>
<td>94.6</td>
</tr>
<tr>
<td>High Probability For Cultural Resources Sites d</td>
<td>70.0</td>
<td>843.9</td>
</tr>
</tbody>
</table>

NOTE: For Toledo Bend Pipeline alternative, terminal storage reservoir of several hundred acres not included. Location of such a reservoir has not been determined.

a = Based on USGS Topographic Map review.
b = Data largely taken from FNI, 2003a except for Minor/Major Streams and Lacustrine Habitat taken from USGS Topographic Map review.
c = Acreage calculations assume a 100-foot construction ROW along 86 miles of pipeline.
d = Based on TPWD county records. The potential occurrence of federally listed species in the Permian Area has been ruled out based on either the availability of habitat and/or site-specific surveys of potential habitat (i.e., Red-cockaded woodpecker - FNI, 2003a).
e = High probability areas were assessed as all areas within 400 meters (125 feet) of extant waterways/drainages commonly accepted by the Texas Historical Commission. Because of the presence of waterways and drainages along the entire length, the majority of the proposed pipeline length is considered to be High Probability.
f = Miles of pipeline route traversing indicated feature.
g = For pipeline route, number of streams crossed; for L. Columbia, minor = intermittent, major = perennial jurisdictional streams.
ND = Non-detectable from USGS Topographic Map review.
T/E = Threatened or endangered species.

*Table from Lake Columbia Draft EIS, USACE, January 2010
Table S-2 Impact Summary and Alternatives Comparison

<table>
<thead>
<tr>
<th>Resource/Impact Issue</th>
<th>Lake Columbia Proposed Action Impact</th>
<th>No Action Alternative Impact</th>
<th>Toledo Bend Pipeline Alternative Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physiography and Topography</strong></td>
<td>Topography would be altered by construction of dam and inundation of valley.</td>
<td>No modification of topography.</td>
<td>Construction of intake structure and pump station at Toledo Bend. Construction of several hundred-acre terminal reservoir near proposed reservoir site.</td>
</tr>
<tr>
<td>Geology</td>
<td>10,133 acres would be inundated and sediment would slowly accumulate in the reservoir. Downstream channel scoured near the dam to expose deeper layers.</td>
<td>No changes to geology.</td>
<td>Stills would be altered to depth of pipeline and terminal reservoir construction. Lignite deposits in southern Rock County could not be extracted where pipeline must.</td>
</tr>
<tr>
<td><strong>Soils</strong></td>
<td>135 acres of prime farmland soils would be lost.</td>
<td>No impact on prime farmland soils.</td>
<td>Minimal impacts to prime farmland soils anticipated, except unknown at terminal reservoir site.</td>
</tr>
<tr>
<td>Increase in erosion from disturbance</td>
<td>Erosion would occur during construction activities, but erosion control measures would be used.</td>
<td>Existing soils would not be disturbed.</td>
<td>Erosion would occur during construction activities, but erosion control measures would be used.</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Declining groundwater levels Switch from groundwater to surface water would reduce groundwater drawdown.</td>
<td>Groundwater drawdown would decrease through increasing withdrawal.</td>
<td>Switch from groundwater to surface water would reduce groundwater drawdown.</td>
</tr>
<tr>
<td>Surface Water</td>
<td>Sediment delivery to Mud Creek increased during construction, but reduced during operation.</td>
<td>No impacts on sediment.</td>
<td>Sediment delivery to various streams crossed by the pipeline route and at terminal reservoir site increased during construction.</td>
</tr>
<tr>
<td>Water quality</td>
<td>Water releases would increase base flow, raise dissolved oxygen, reduce turbidity.</td>
<td>Water quality would be unchanged.</td>
<td>Short-term effects at stream crossings. Long-term transfer would cause slight decrease in flows in Sabine Basin and slight increase in Neches Basin.</td>
</tr>
<tr>
<td>Loss of wetlands</td>
<td>5,746.5 acres of wetlands of U.S. would be impacted. To be compensated by mitigation plan.</td>
<td>No change in waters of U.S.</td>
<td>Temporary construction impacts, and loss of wetlands at U.S. at pump station intake at Toledo Bend. Some conversion of forested wetlands along pipeline route. Unknown</td>
</tr>
<tr>
<td><strong>Downstream hydrologic &amp; fluvial geomorphic impacts</strong></td>
<td>Flood peaks reduced. Approximate 16 percent decrease in 100-year floodplain. Some channel scoured below dam site.</td>
<td>No downstream impacts.</td>
<td>No downstream impacts in Mud Creek. Short-term impacts on other streams crossed. Potential impacts associated with terminal reservoir.</td>
</tr>
<tr>
<td>Hydropower</td>
<td>Negligible change in Sam Rayburn hydropower production (0.01%).</td>
<td>No impact on hydropower.</td>
<td>Negligible change in Toledo Bend hydropower production.</td>
</tr>
<tr>
<td>Climatology/Air Quality</td>
<td>Potential exceedance of ambient air quality standards. Climate changes.</td>
<td>Fugitive dust emissions would likely increase particulate concentrations during construction. Slight local increase in relative humidity and moderation of temperatures with lake.</td>
<td>No impact on climatology/air quality.</td>
</tr>
<tr>
<td>Noise</td>
<td>Increase in noise levels Some increase during construction. Boat traffic would generate noise on the lake.</td>
<td>No impact on noise.</td>
<td>Some increase in noise over a larger area during construction of pipeline and terminal reservoir. Pump station noise during operation.</td>
</tr>
<tr>
<td>Vegetation</td>
<td>Impacts to vegetation, including wetland and riparian vegetation 5,351.5 acres of wetlands would be impacted and mostly converted to open water—to be compensated by Mitigation Plan. Development around lake would impact vegetation—to be addressed by Water Quality Regulations. 1,195 acres of wetlands established around water’s edge.</td>
<td>No impact on vegetation.</td>
<td>Wetland vegetation impacted primarily at stream crossings and intake pump station. Other vegetation impacts at several hundred-acre terminal reservoir site and along entire ROW, including approximately 160 acres through Sabine National Forest. Potential conversion of forested wetlands along pipeline route.</td>
</tr>
<tr>
<td>Threatened or endangered (T/E) species</td>
<td>T/E species (Neches River rose-mallow) not known to exist within Permit Area.</td>
<td>No impact on T/E species.</td>
<td>T/E species may exist within counties traversed by pipeline.</td>
</tr>
<tr>
<td>Fish and Wildlife</td>
<td>Threatened or endangered species</td>
<td>T/E species not known to exist within Permit Area.</td>
<td>T/E species may exist within counties traversed by pipeline, particularly red-cockaded woodpeckers in Sabine National Forest.</td>
</tr>
</tbody>
</table>
According to the draft EIS for Lake Columbia, no known threatened or endangered species are known to exist in the Permit Area. Project components such as pipelines are expected to have sufficient design flexibility to avoid any known threatened or endangered species along the route from Lake Columbia to the proposed Lake Palestine pump station.

PERMITTING AND DEVELOPMENT

Lake Columbia would require a contract with ANRA and an interbasin transfer permit.

Angelina Neches River Authority has a water right for Lake Columbia and is currently seeking a 404 permit for construction. A draft environmental impact study (DEIS) has been prepared for Lake Columbia by the USACE. The DEIS was published on January 29, 2010 and public and agency comments were provided on March 30, 2010. Currently, the Lake Columbia project is subject to completion of the EIS and issuance of a 404 permit from the U.S Army Corps of Engineers (USACE).

Lake Columbia is in the permitting phase, and has contracts with several local participants. According to

<table>
<thead>
<tr>
<th>Resource/Impact Issue</th>
<th>Lake Columbia Proposed Action Impact</th>
<th>No Action Alternative Impact</th>
<th>Toledo Bend Pipeline Alternative Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat alteration</td>
<td>Terrestrial and stream habitat converted to open water habitat. All terrestrial and some aquatic species displaced.</td>
<td>No direct impact on habitat. Trend of conversion of forest to pasture and timber plantations likely to continue.</td>
<td>Habitat cleared along pipeline route and terminus reservoir. Timber removal in Sabine National Forest may require EIS.</td>
</tr>
<tr>
<td>Downstream impacts</td>
<td>Floodplain size and flood magnitude decreased. Increased base flows result in increased stream aquatic habitat.</td>
<td>No downstream impacts.</td>
<td>No downstream impacts at Mud Creek. Short-term impacts on other streams temporary.</td>
</tr>
</tbody>
</table>

**Cultural Resources**

- Impacts to cultural resources: 1,272 acres of high probability areas for cultural resources within Permit Area. Implied by 23 known archaeological sites. Many of these sites were located on or adjacent to shoreline. Additional surveys necessary to inventory all sites.
- No impact to cultural resources.
- No surveys conducted, but approximately 70 miles of high probability areas for cultural resources could be impacted, plus several hundred-acre terminal reservoir site.

- Impacts to historic structures: Eight historic structures potentially impacted. NRHP eligibility unknown.
- No impact to historic structures, except site lookup could continue.
- No surveys conducted, but historic structures unlikely, except potentially in cases.

**Socioeconomics**

- Population change: Population increases may exceed projections because of available water and presence of lake.
- Projected population increases may not occur because of insufficient water supply.
- Population increases likely to meet projections.

- Employment and income change: Temporary increase of 2,000 jobs during construction. Permanent increase of 370 jobs from operation. 501 jobs generated from recreational spending prompted by the lake.
- Employment and income would not change.
- Temporary increase of jobs during construction. Permanent increase of jobs from operation. Higher cost of water equivalent to outflow of $450M per year from the local area.

**Land Use and Recreation**

- Conversion of land use: Approximately 11,000 acres of existing agricultural and forested land converted to lake and residential use.
- No impact on land use.
- Approximately 1,000 acres affected along ROW, including timber removal in 13-mile reach through Sabine National Forest, plus several hundred-acre terminal reservoir site.

- Recreation supply and demand: Private land made available for recreation; opportunities for water sports and camping. New demand from new residents and visitors.
- No impact on recreation. Reduced potential for opening private lands for public recreation at Lake Columbia site.
- No impact on recreation. Reduced potential for opening private lands for public recreation at Lake Columbia site.

**Aesthetics**

- Change in landscape character: Forested and agricultural area converted to lake view.
- No impact on aesthetics.
- Loss of timber and other vegetation along pipeline corridor and at terminal reservoir site.

**Environmental Justice**

- Low income or minority population disproportionately affected: No disproportionality identified.
- No disproportionality identified.
- No disproportionality identified.

**Cost**

- Estimated cost of alternatives: $181M capital; $15M annual; $0.53 per 1,000 gallons
- None
- $398M capital; $46M annual; $1.65 per 1,000 gallons

*Table from Lake Columbia Draft EIS, USACE, January 2010*
Angelina Neches River Authority, the participants have the right of first refusal to contract for water in the next phase of the project. The Texas Water Development Board is a 47% participant and has the right of refusal for 35.9 MGD (40,188 acre feet per year) of supply. Process for water contracts will be initiated after the issuance of the Section 404 permit from the USACE.

If Dallas were to participate in the Lake Columbia project, the current permit no. 4228 has to be amended for an interbasin transfer from the Neches to the Trinity basin. There is a potential that the authorized diversions from Lake Columbia project may be subject to some reductions due to the environmental flow standards that may be applied during the amendment process.

<table>
<thead>
<tr>
<th>Permit</th>
<th>Regulatory Entity</th>
<th>Potential Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Right Permit</td>
<td>TCEQ</td>
<td>May require interbasin transfer authorization for Dallas to transfer water from Neches to Trinity basin.</td>
</tr>
<tr>
<td>Amendment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>404</td>
<td>USACE</td>
<td>Required to proceed with construction in waters of the US.</td>
</tr>
</tbody>
</table>

**COST ANALYSIS**

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the Lake Columbia supplies are included in Appendix Q.

**WATER MANAGEMENT STRATEGY EVALUATION**

Based on the analysis provided above, the Lake Columbia strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

**WATER USER GROUP APPLICATION**

The Lake Columbia strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the
WUGs served. This strategy was only evaluated for Dallas.

REFERENCES


Columbia Prospectus, 2012.
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Lake Palestine Pipeline

WMS Type: Existing Surface Water Source

Potential Supply Quantity (Rounded):
- 110,670 ac-ft/yr (100 mgd)

Implementation Decade: 2030

Strategy Capital Cost: $900,817,000 (Sept. 2013) Q-36, Q-37, & Q-48

Unit Water Cost (Rounded):
- $4.68 per 1,000 gallons (during loan period)
- $2.56 per 1,000 gallons (after loan period)

STRATEGY DESCRIPTION

Dallas Water Utilities has a contract with the Upper Neches River Municipal Water Authority for 114,337 acre-feet per year of water from Lake Palestine and an interbasin transfer permit allowing the use of water from the lake in the Trinity River Basin. DWU’s share of the yield of Lake Palestine will provide a supply of 110,670 acre-feet per year in 2020, decreasing to 106,239 acre-feet per year in 2070 due to sedimentation. Lake Palestine is located in East Texas Region on the Neches River. Lake Palestine is a recommended strategy for Dallas Water Utilities.

STRATEGY ANALYSES

Dallas Water Utilities plans to connect Lake Palestine to its water supply system as part of the Integrated Pipeline Project (IPL) being developed jointly with Tarrant Regional Water District. Development of a supply from Lake Palestine provides water at a low cost and with a low environmental impact, and it is a recommended water management strategy for Dallas Water Utilities. The capital cost for the pipeline connecting Lake Palestine to the IPL is $470 million. There are additional costs associated with transporting this water for use by Dallas. Those costs are summarized in the Integrated Pipeline technical memorandum.

SUPPLY DEVELOPMENT

The supply available from Lake Palestine for use by DWU was obtained using the Neches Basin Water Availability Model (WAM Run 3).

ENVIRONMENTAL CONSIDERATIONS

In general, the pipeline corridor does not have any major environmental issues that cannot be avoided. The thirty-three threatened and endangered species that could be potentially impacted by this WMS, based on the species listed in the county(ies) in which this WMS is located, are: American peregrine falcon ST, Bachman’s sparrow ST, bald eagle ST, interior least tern FE and SE, white-faced ibis ST, whooping crane FE and SE, wood stork ST, golden-cheeked warbler FE and SE, black-capped vireo FE and...
PERMITTING AND DEVELOPMENT

Permits have already been obtained.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the Lake Palestine supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Lake Palestine strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Lake Palestine strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served. This was only considered for Dallas and customers.
WMS Name: Lake Ralph Hall and Reuse
WMS Type: New Surface Water Source
Potential Supply Quantity (Rounded): 50,121 ac-ft/yr (45 mgd)
Implementation Decade: 2030
Strategy Capital Cost: $316,160,000 (Sept. 2013) Q-52
Unit Water Cost (Rounded): $1.79 per 1,000 gallons (during loan period)

STRATEGY DESCRIPTION
The Upper Trinity regional Water District has applied for a water right permit for the proposed Lake Ralph Hall, located on the North fork of the Sulphur River in Fannin County in Region C. The yield of the reservoir would be 34,050 acre-feet per year, and Upper Trinity Regional Water District plans to apply for the right to reuse return flows from water originating from the project, providing an additional 16,071 acre-feet per year by 2070 (reuse of return flow is expected to increase after 2070 up to the anticipated permit amount of 18,387 acre-feet per year). Developing Lake Ralph Hall and the related reuse is a recommended strategy for the Upper Trinity Regional Water District.

STRATEGY ANALYSES
The strategy includes construction of the Lake Ralph Hall, a 48-inch, 30-mile transmission pipeline from the reservoir to Upper Trinity Regional Water District’s balancing reservoir, a 2,400 HP pump station, and land acquisition of the reservoir site and transmission system easements.

SUPPLY DEVELOPMENT
The supply available from Lake Ralph Hall was determined using the Sulphur Basin WAM.

ENVIRONMENTAL CONSIDERATIONS
The USFWS lists three endangered or threatened species and the TPWD lists an additional 14 endangered or threatened species as occurring or potentially occurring within Fannin County. The likelihood of the endangered or threatened species to be located within the Lake Ralph Hall area is extremely unlikely. There are no federal listed endangered or threatened plant species within the Lake Ralph Hall project vicinity.

Based on a survey conducted by AR Consultants, Inc. in 2005, the Lake Ralph Hall area has low archaeological potential.

The Lake Ralph Hall reservoir would inundate approximately 7,605 acres at conservation pool.
The seventeen threatened and endangered species potentially impacted in the counties covered by this WMS are: bald eagle FT, interior least tern FE, Louisiana black bear FT, American peregrine falcon SE, Arctic peregrine falcon ST, Bachman’s sparrow ST, eskimo curlew SE, wood stork ST, black bear ST, red wolf SE, alligator snapping turtle ST, Texas horned lizard ST, timber/canebrake rattlesnake ST, blue sucker ST, creek chubsucker ST, paddlefish ST, and shovelnose sturgeon ST.

PERMITTING AND DEVELOPMENT

The Lake Ralph Hall and Reuse strategy would require a new water right and an interbasin transfer permit.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are
included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the Ralph Hall supplies are included in Appendix Q.

**WATER MANAGEMENT STRATEGY EVALUATION**

Based on the analysis provided above, the Lake Ralph Hall and Reuse strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

**WATER USER GROUP APPLICATION**

The Lake Ralph Hall and Reuse strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served. This strategy was only considered for UTRWD and customers.
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Tehuacana Reservoir
WMS Type: New Surface Water Source
Potential Supply Quantity (Rounded): 41,600 ac-ft/yr (37 mgd)
Implementation Decade: 2040
Strategy Capital Cost: $742,730,000 (Sept. 2013) Q-50
Unit Water Cost (Rounded): $4.24 per 1,000 gallons (during loan period)
$0.46 per 1,000 gallons (after loan period)

STRATEGY DESCRIPTION

Lake Tehuacana is a recommended strategy for Tarrant Regional Water District. Lake Tehuacana is a proposed water supply project on Tehuacana Creek within the Trinity River Basin. Tehuacana Creek is a tributary of the Trinity River and lies immediately south and adjacent to Richland Creek on which the existing Richland-Chambers Reservoir is located. Tehuacana Reservoir may/will connect to Richland-Chambers Reservoir by a 9,000-foot channel and be operated as an integrated extension of that reservoir. The project will inundate approximately 15,000 acres. The existing spillway for Richland-Chambers Reservoir was designed to provide enough discharge capacity to accommodate the increased flood flows from Tehuacana Reservoir for the probable maximum flood event. Therefore, the dam for Tehuacana Reservoir can be constructed without a spillway and can function as merely an extension of Richland-Chambers Reservoir. Developing this site will require obtaining a new water right and constructing the dam and reservoir. The estimated safe yield of Lake Tehuacana is 41,600 acre-feet per year, and the estimated firm yield is 81,600 acre-feet per year. This yield analysis was performed with the environmental flows for the Trinity Water Availability Model.

STRATEGY ANALYSES

Tehuacana Reservoir is a proposed reservoir on Tehuacana Creek in Freestone County, a tributary to the Trinity River, immediately south and adjacent to Richland-Chambers Reservoir. Tehuacana Reservoir would inundate approximately 15,000 acres adjacent to Richland-Chambers Reservoir and the two would be hydraulically connected with a small channel. Water from Tehuacana would be transported from Richland-Chambers Reservoir into TRWD transmission facilities.

Tehuacana Reservoir has been part of the TRWD water supply portfolio since the 1950’s, but mineral issues in the reservoir footprint have made the project expensive to develop.

The existing spillway for Richland-Chambers Reservoir has capacity to handle Probable Maximum Flood flows from the additional storage created by Tehuacana Reservoir. The Tehuacana Reservoir dam can be constructed without an additional spillway and can function as an extension of Richland-Chambers Reservoir.
SUPPLY DEVELOPMENT

The supply available for Lake Tehuacana was developed using the Trinity Basin Water Availability Model (WAM). Environmental flow requirements are included in the WAM model and significantly impact the supply available to the Lake Tehuacana water right.

ENVIRONMENTAL CONSIDERATIONS

Tehuacana Reservoir would flood about 15,000 acres adjacent to Richland-Chambers Reservoir and would have a safe yield of 41,600 acre-feet per year. There are no priority bottomland hardwoods within the site.

![Table from Reservoir Site Protection Study, TWDB, July 2008](image)

The thirty-two threatened and endangered species potentially impacted by this WMS, based on the species listed in the county(ies) in which this WMS is located, are: Bald Eagle ST FDM, Least Tern FE, Large-fruited sand-verbena SE FE, Navasota Ladies Tresses SE FE, Whooping Crane SE FE, Alligator Snapping Turtle ST, American Peregrine Falcon ST, Arctic Peregrine Falcon ST, Bachman’s Sparrow ST, Chapman’s Yellow-Eyed Grass SR, Creeper (squawfoot) SR, Fawnsfoot SR, Henslow’s Sparrow SR, Houston toad SE, Interior Least Tern SE , Least Tern FE, Little Spectaclecase SR, Louisiana Pigtoe SR, Peregrine Falcon ST, Plains Spotted Skunk SR, Red Wolf SE, Rough Stem Aster SR, Sandbank Pocketbook SR, Southeastern Myotis Bat SR, Sprague’s Pipit, Texas Garter Snake SR, Texas Heelsplitter SR, Texas Horned Lizard ST, Texas Pigtoe SR, Timber/Canebrake Rattlesnake ST, Wabash Pigtoe SR, and Wood Stork ST.

PERMITTING AND DEVELOPMENT

Development of Tehuacana Reservoir would require a new water right permit, construction of the reservoir, and upsizing TRWD’s third pipeline to deliver that water to Tarrant County.

Environmental flow requirements may have significant impact on yield during the permitting process.

Cost uncertainty is fairly significant due to potential future development of lignite resources in reservoir footprint.
COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the Lake Tehuacana supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Tehuacana Reservoir strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Tehuacana Reservoir strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served. This strategy was only evaluated for TRWD and customers.

REFERENCES


WMS Name: Lake Texoma
WMS Type: Existing Surface Water Source
Potential Supply Quantity (Rounded): 220,000 ac-ft/yr (Costs for 113,000 ac-ft/yr) (196 mgd (Costs for 101 mgd))
Implementation Decade: 2040
Strategy Capital Cost: Multiple Strategies, Costs Listed in the Text Below
Unit Water Cost (Rounded): Multiple Strategies, Costs Listed in the Text Below

STRATEGY DESCRIPTION

Lake Texoma is an existing Corps of Engineers reservoir on the Red River on the border between Texas and Oklahoma. Under the terms of the Red River Compact, the yield of Lake Texoma is divided equally between Texas and Oklahoma. Lake Texoma is used for water supply, hydropower generation, flood control, and recreation. In Texas, the North Texas Municipal Water District, the Greater Texoma Utility Authority, the City of Denison, TXU, and the Red River Authority have contracts with the Corps of Engineers and Texas water rights allowing them to use water from Lake Texoma.

The U.S. Congress has passed a law allowing the Corps to reallocate an additional 300,000 acre-feet storage in Lake Texoma from hydropower use to water supply, 150,000 acre-feet for Texas and 150,000 acre-feet for Oklahoma. The North Texas Municipal Water District is purchasing 100,000 of the 150,000 acre-feet of storage for Texas and has received a Texas water right to divert an additional 113,000 acre-feet per year from Lake Texoma. The remaining 50,000 acre-feet storage was reserved by Congress for the Greater Texoma Utility Authority, which is purchasing storage and has received a Texas water right for the supply.

Further reallocation of hydropower storage to water supply in Lake Texoma would provide additional yield. According to the Corps of Engineers, the firm yield of Lake Texoma with all hydropower storage reallocated to water supply would be 1,088,500 acre-feet per year. Texas’ share would be 544,250 acre-feet per year, leaving about 220,000 acre-feet per year of additional supply available to Texas by the reallocation of more hydropower storage to municipal use (beyond the supplies already contracted for the currently authorized reallocation). Further reallocation would require a new authorization by Congress.

Lake Texoma is only about 50 miles from the Metroplex. The lake has elevated levels of dissolved solids, and the water must be blended with higher quality water or desalinated for municipal use. The elevated dissolved solids in Lake Texoma would have some environmental impacts whether the water is used by blending or desalination. Use for most Region C needs will require an interbasin transfer permit. Blending water from Lake Texoma with water from other sources provides an inexpensive supply for Region C. Desalination provides treated water but is a more expensive strategy, and there are uncertainties in the long-term costs.
The estimated costs for desalination of water from Lake Texoma are based on current cost information for large desalination facilities. However, they are more uncertain than other cost estimates in this plan of a couple of reasons. There is not an established track record of success in the development of large brackish water desalination facilities. Most of the large desalination facilities built to date are located on or near the coast. If a 100 million gallon per day or larger plant were to be developed for Lake Texoma water, it would be the largest inland desalination facility in the world. In addition, the method and cost of brine disposal for such a facility are uncertain. Brine disposal has the potential to significantly increase the estimated cost for desalination. Detailed studies to solidify the cost estimates will be required if this strategy is pursued.

Lake Texoma is a recommended source of additional water supply for the North Texas Municipal Water District (113,000 acre-feet per year) and the Greater Texoma Utility Authority (56,500 acre-feet per year). It is an alternative source of supply for Dallas Water Utilities, Upper Trinity Regional Water District, and North Texas Municipal Water District (desalination).

**STRATEGY ANALYSES**

The strategy analyses for Lake Texoma

The following strategies are included in the 2016 Region C Water Plan.

1) **Blending of Texoma Supplies with Lower Bois d’Arc supplies**
   b. Capital Cost - $174,179,000 (Q-25)
   c. Unit Cost before Amortization - $1.59
   d. Unit Cost after Amortization - $0.46
   e. Authorized Supply

2) **Blending of Texoma Supplies with potential Sulphur Basin Supplies**
   a. Recommended Strategy for NTMWD – 58,267 acre-feet per year.
   b. Capital Cost - $347,596,000 (Q-26)
   c. Unit Cost before Amortization - $1.97
   d. Unit Cost after Amortization - $0.44
   e. Authorized Supply

3) **Desalination of Texoma Supplies at Sherman WTP**
   b. Capital Cost - $622,592,000 (Q-30)
   c. Unit Cost before Amortization - $7.20
   d. Unit Cost after Amortization - $2.96
   e. Authorized Supply

4) **Desalination of Texoma Supplies for Dallas Water Utilities**
b. Capital Cost - $1,517,474,000 (Q-46)
c. Unit Cost before Amortization - $4.57
d. Unit Cost after Amortization - $1.91
e. Not yet Authorized

5) Blending of Texoma Supplies with Sulphur Basin Supplies
   a. Alternative Strategy for Upper Trinity Regional Water District—25,000 acre-feet per year.
   b. Capital Cost - $197,198,000 (Q-26A)
c. Unit Cost before Amortization - $2.76
d. Unit Cost after Amortization - $0.74
e. Not yet Authorized

6) Desalination of Texoma Supplies for municipal supply
   a. Recommended Strategy for Greater Texoma Utility Authority—25,528 acre-feet per year.
   b. Capital Cost - $92,840,000 (Q-64)
c. Unit Cost before Amortization - $2.58
d. Unit Cost after Amortization - $1.64
e. Authorized

7) Lake Texoma Supplies for steam electric power (raw water)
   a. Recommended Strategy for Greater Texoma Utility Authority—15,548 acre-feet per year.
   b. Capital Cost - $49,382,000 (Q-63 and Q-128)
c. Unit Cost before Amortization - $2.07
d. Unit Cost after Amortization - $0.40
e. Authorized

SUPPLY DEVELOPMENT

All the recommended and alternative strategies for North Texas Municipal Water District represent the authorized amounts of the Lake Texoma supplies. The strategies for Dallas Water Utilities and Upper Trinity Regional Water District are yet to be authorized.

ENVIRONMENTAL CONSIDERATIONS

Transference of zebra mussels from Lake Texoma to the water body where it is blended is a significant environmental issue. The recommended Lake Texoma strategy proposes the transfer Lake Texoma water directly to the water treatment plant for blending to avoid the transfer of zebra mussels from one water body to another. The total dissolved solids of the wastewater are an environmental consideration with this method. When considering desalination, disposal of the brine and the potential high costs of
treatment should be taken into account.

The twentyfour threatened and endangered species potentially impacted by this WMS, based on the species listed in the county(ies) in which this WMS is located, are: American peregrine falcon ST, bald eagle ST, black-capped vireo FE and SE, eskimo curlew FE and SE, golden-cheeked warbler FE and SE, interior least tern LE and SE, peregrine falcon ST, piping plover FT and ST, Sprague’s pipit C, whooping crane FE and SE, white-faced ibis ST, wood stork ST, Texas heelsplitter ST, Louisiana pigtoe ST, Texas pigtoe ST, alligator snapping turtle ST, Texas horned lizard ST, timber rattlesnake ST, blue sucker ST, creek chubsucker ST, paddlefish ST, shovelnose sturgeon ST, red wolf FE and SE, and gray wolf FE and SE.

PERMITTING AND DEVELOPMENT

The Lake Texoma strategy would require an interbasin transfer (IBT), state water right, Congressional authorization, and contract with USACE.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the recommended and alternative strategies for Texoma supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Lake Texoma strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Lake Texoma strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served. This strategy was evaluated for NTWMD, GTUA, and Dallas (and customers of all of these
REFERENCES


REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Lower Bois d’Arc Creek Reservoir

WMS Type: New Surface Water Source

Potential Supply Quantity (Rounded): 120,200 ac-ft/yr (107 mgd)

Implementation Decade: 2020

Strategy Capital Cost: $625,610,000 (Sept. 2013) Q-23

Unit Water Cost (Rounded): $1.55 per 1,000 gallons (during loan period)

$0.22 per 1,000 gallons (after loan period)

STRATEGY DESCRIPTION

The proposed Lower Bois d’Arc Creek Reservoir was a recommended strategy for the North Texas Municipal Water District (NTMWD) in the 2001, 2006, 2011 Region C Water Plans. The project is located in Region C on Bois d’Arc Creek in Fannin County, northeast of the City of Bonham.

Lower Bois d’Arc Creek Reservoir is a recommended water management strategy for the North Texas Municipal Water District (NTMWD) and would have a capital cost of $625,610,000, including water transmission facilities.

STRATEGY ANALYSES

This strategy includes construction of Lower Bois d’Arc Creek Reservoir, transmission facilities to NTMWD’s North Water Treatment Plant, and terminal storage facilities.

SUPPLY DEVELOPMENT

The supply available from the Lower Bois d’Arc Creek Reservoir was obtained using the Red River Water Availability Model with the instream flow requirements specified in the water right.

ENVIRONMENTAL CONSIDERATIONS

The Lower Bois d’Arc Creek Reservoir (LBCR) project would inundate 16,358 acres. A jurisdictional determination was conducted for the LBCR in 2007. Based on this study, there are 5,874 acres of wetlands and 651,024 linear feet of streams within the project site. For the forested wetlands, the Habitat Suitability Index was calculated at 0.25 on a scale of 0 to 1. Habitat evaluation studies confirmed the poor quality of these wetlands. The 1984 Fish and Wildlife Service Texas Bottomland Hardwood Preservation Program report classified the Bois d’Arc Creek bottoms in the reservoir area as Priority 4 bottomland hardwoods, which are “moderate quality bottomlands with minor waterfowl benefits.”

There are no federally listed threatened and endangered species potentially impacted by the LBCR. Of the state listed species potentially located in Fannin County, five species could potentially be impacted by construction of LBCR.
NTMWD had developed a mitigation plan to mitigate for impacts associated with the LBCR. This plan has been accepted by the state and is under review by the USACE.

PERMITTING AND DEVELOPMENT

NTMWD has been granted a water right permit and an interbasin transfer permit. NTMWD has applied for a Federal Section 404 permit for the project and a Draft Environmental Impact Statement has been prepared.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.
Cost estimates for the Lower Bois d’Arc Creek Reservoir supplies are included in Appendix Q.

**WATER MANAGEMENT STRATEGY EVALUATION**

Based on the analysis provided above, the Lower Bois d’Arc Creek Reservoir strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

**WATER USER GROUP APPLICATION**

The Lower Bois d’Arc strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to where the water can be used based on the IBT permit. No customers outside of the Red and Trinity Basins, and Sulphur Basin within Fannin County, were assigned supply from this strategy. Water from LBCR will be used as part of NTMWD’s system and will meet the needs of NTMWD customers.

**REFERENCES**


REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Main Stem Trinity River Pump Station
WMS Type: Existing Surface Water Source
Potential Supply Quantity (Rounded): 87,886 ac-ft/yr (90 mgd)
Implementation Decade: 2020
Strategy Capital Cost: $116,224,000 (Sept. 2013) (Q-22 & Q-34)
Unit Water Cost (Rounded): $0.47 per 1,000 gallons (during loan period)

STRATEGY DESCRIPTION
The Main Stem Trinity River Pump Station will divert water from the Trinity River for delivery to the North Texas Municipal Water District (NTMWD) East Fork Wetlands. NTMWD is developing an agreement with the Trinity River Authority to purchase up to 56,050 acre-feet per year of return flows from the main stem of the Trinity River that originate from TRA’s Central Regional Wastewater System. Initially this pump station will deliver up to 56,050 acre-feet per year, but use of this pump station will diminish over time as more of NTWMD’s own return flow is available from their wastewater plants located on the East Fork of the Trinity River. This is a recommended strategy for NTMWD. The capital cost of a 90 MGD plant that will supply to both NTMWD and DWU is approximately $116 million.

STRATEGY ANALYSES
“In December 2008, Dallas and the North Texas Municipal Water District (NTMWD) entered into an agreement (swap agreement) for the exchange of return flows. The swap agreement allows Dallas to use NTMWD return flows discharged into Lake Ray Hubbard in exchange for NTMWD utilizing a portion of Dallas’ return flows from the main stem of the Trinity River. Under the swap agreement Dallas and NTMWD will cooperate in the construction of a pump station (Main Stem Pump Station) and transmission pipeline to deliver return flows (from Dallas and other entities) from a location on the main stem of the Trinity River to an agreed “point of delivery” near the NTMWD wetlands located near the East Fork of the Trinity River and Hwy 175 near Seagoville.” When the swap agreement is implemented, Dallas will have the right to utilize all NTMWD water discharged into Lake Ray Hubbard. Until the swap agreement is implemented, Dallas has agreed to pass NTMWD’s discharges from Lake Ray Hubbard. The project to be constructed under the swap agreement includes the construction of a Main Stem Pump Station and a pipeline to transport water to the NTMWD wetlands. The Main Stem Pump Station provides access to 50 MGD or (56,050 acre-feet per year) of supplies for North Texas Municipal Water District and 31 MGD (or 34,751 acre-feet per year) for Dallas Water Utilities.

SUPPLY DEVELOPMENT
This strategy restores access to existing supplies. No new supplies are accessed with this strategy.
ENVIRONMENTAL CONSIDERATIONS

There are no significant environmental considerations associated with this strategy.

The seventeen threatened and endangered species potentially impacted by this strategy, based on the species listed in the county(ies) in which this WMS is located, are: American peregrine falcon ST, bald eagle ST, interior least tern FE and SE, peregrine falcon ST, piping plover FT and ST, Sprague’s pipit C, white-faced ibis ST, red wolf FE and SE, alligator snapping turtle ST, Texas horned lizard ST, timber rattlesnake ST, Louisiana pigtoe ST, sandbank pocketbook ST, Texas heelsplitter ST, and Texas pigtoe ST.

PERMITTING AND DEVELOPMENT

The Main Stem Trinity River Pump Station would require a water right permit amendment.

COST ANALYSIS

For the Region C cost analysis, Planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the Main Stem supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Main Stem Trinity River Pump Station strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Main Stem Trinity River Pump Station strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served. This strategy was developed to meet the needs of existing and future customers of NTMWD and DWU.
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM*

*A detailed report analyzing and quantifying impacts of the Marvin Nichols Reservoir at elevation 328 feet, msl is included in Appendix Y of this report.

WMS Name: Marvin Nichols Reservoir (elevation 328 feet, msl)
WMS Type: New Surface Water Source
Potential Supply Quantity (Rounded): 489,800 ac-ft/yr (Region C portion) (437 mgd)
Implementation Decade: Unknown
Strategy Capital Cost: $4,321,909,000 (Sept. 2013)
Unit Water Cost (Rounded): $2.98 per 1,000 gallons (during loan period) $0.74 per 1,000 gallons (after loan period)

STRATEGY DESCRIPTION

The configuration of the Marvin Nichols Reservoir described in this technical memorandum is at elevation 328 msl and is an alternative strategy for TRWD, NTWMD, UTRWD, and Irving. It is not a recommended water management strategy for any wholesale providers. (See Sulphur Basin Supplies technical memorandum for the recommended strategy involving a different configuration of this reservoir).

Region C is retaining the original configuration of Marvin Nichols Reservoir (at elevation 328 msl, as detailed in Appendix Y) as an alternative water management strategy for the 2016 Region C Water Plan. The proposed Marvin Nichols Reservoir is located on the Sulphur River in the Sulphur River Basin in Senate Bill One Planning Region D, the North East Texas Region. The proposed reservoir is about 115 miles from the Metroplex. Development of Marvin Nichols Reservoir was a recommended strategy for Region C in the 2001 and 2006 Region C Water Plans. Using the Sulphur River Basin Water Availability Model and assuming that the proposed Lake Ralph Hall is in place as a senior water right, the estimated yield of Marvin Nichols Reservoir is 590,000 acre-feet per year after allowing for downstream water rights and environmental releases as required by the Texas Water Development Board’s environmental flow criteria.

This original configuration of Marvin Nichols at 328 msl is being retained as an alternative strategy because Region C recognizes that there are inherent risks and impacts associated with the Sulphur Basin Supplies strategy (combination of Marvin Nichols at 313.5 msl and reallocation of Wright Patman), particularly the reallocation of flood storage at Wright Patman Lake. Reallocation of storage at Wright Patman Lake at the scale envisioned for the Sulphur Basin Supplies strategy will require a recommendation by the Corps of Engineers/Department of the Army and approval by the United States Congress. Wright Patman reallocation may also be constrained by Dam Safety considerations. As more detailed studies seek to develop an understanding of the tradeoffs between the environmental impacts at Wright Patman in comparison with the predicted impacts of new storage at the Marvin Nichols site, the risk exists that the Wright Patman reallocation alternative may be constrained by either policy or
environmental issues, or both. Should the reallocation of Wright Patman not be achieved, Region C could choose to substitute the alternative Marvin Nichols Reservoir strategy (elevation 328 msl) in place of the Sulphur Basin Supplies recommended strategy.

Assuming that 20 percent of the yield is used to provide water in Region D and 80 percent is made available to Region C, Marvin Nichols Reservoir will provide 489,000 acre-feet per year of additional water supply for Region C.

STRATEGY ANALYSES

The Marvin Nichols strategy is an alternative strategy for TRWD, NTMWD, UTRWD, and Irving. This strategy could replace any recommended strategy for these entities that is unable to be implemented in the timeframe it is needed.

SUPPLY DEVELOPMENT

The supply is not yet developed and the project sponsor will have to go through the permitting process and construction of the reservoir to develop this supply. The supply availability reported in the 2016 Region C Water Plan is based on the yield estimated from the Sulphur Basin Water Availability Model.

ENVIRONMENTAL CONSIDERATIONS

As a major reservoir project, Marvin Nichols Reservoir will have significant environmental impacts. The reservoir would inundate about 66,000 acres. The 1984 U.S. Fish and Wildlife Service Bottomland Hardwood Preservation Program classified some of the land that would be flooded as a Priority 1 bottomland hardwood site, which is “excellent quality bottomlands of high value to key waterfowl species.” The proposed new location of the dam will reduce but not eliminate the impact on bottomland hardwoods and will slightly increase the acreage required for the reservoir. Permitting the project and developing appropriate mitigation for the unavoidable impacts will require years, and it is important that water suppliers start that process in advance of the need for water from the project. Development of the Marvin Nichols Reservoir will require an interbasin transfer permit to bring the water from the Sulphur River Basin to the Trinity River Basin. The project will include a major water transmission system to bring the new supply to the Metroplex. The project will make a substantial water supply available to the Metroplex, and the unit cost is less than that of most other major water management strategies.

<table>
<thead>
<tr>
<th>Landcover Classification</th>
<th>Acreage</th>
<th>Percent</th>
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</thead>
<tbody>
<tr>
<td>Bottomland hardwood forest</td>
<td>26,309</td>
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<tr>
<td>Marsh</td>
<td>6,259</td>
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<td>Seasonally flooded shrubland</td>
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<td>Swamp</td>
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<td>Upland deciduous forest</td>
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<td>Grassland</td>
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</table>

*Table from Reservoir Site Protection Study, TWDB, July 2008*
The twenty-three threatened and endangered species potentially impacted by this WMS, based on the species listed in the county(ies) in which this WMS is located, are: American burying beetle F, least tern F and S, piping plover F and S, American peregrine falcon S, Bachman’s sparrow S, bald eagle S, wood stork S, whooping crane S, peregrine falcon S, blackside darter S, creek chubsucker S, paddlefish S, shovelnose sturgeon S, black bear, S, Rafinesque’s big-eared bat, red wolf S, Louisiana pigtoe S, southern hickorynut S, Texas pigtoe S, alligator snapping turtle S, northern scarlet snake S, Texas horned lizard S, and timber rattlesnake S.

PERMITTING AND DEVELOPMENT

The Marvin Nichols Reservoir would require new water rights permit and interbasin transfer (IBT). It should be noted that there is known public opposition to this strategy.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Planning level cost estimates for the Marvin Nichols strategy is included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Marvin Nichols Reservoir strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Marvin Nichols Reservoir strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served.
REFERENCES


REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Neches River Run-of-River Diversion
WMS Type: New Surface Water Source
Potential Supply Quantity (Rounded): 47,250 ac-ft/yr (42 mgd)
Implementation Decade: 2060 (2060)
Strategy Capital Cost: $226,790,000 (Sept. 2013)
Unit Water Cost (Rounded): $2.14 per 1,000 gallons (during loan period)

$0.91 per 1,000 gallons (after loan period)

STRATEGY DESCRIPTION

Lake Fastrill was a recommended water management strategy in the approved 2006 Region C Water Plan and the 2007 State Water Plan and was designated by the Texas Legislature as a unique site for reservoir development. The lake was intended to meet projected water supply needs for the Dallas and water user groups in Anderson, Cherokee, Henderson, and Smith counties in Region I. A decision of the United States Supreme Court on February 22, 2010 not to hear the appeals of the State of Texas and Dallas has effectively supported the creation of the Neches River National Wildlife Refuge (NRNWR) and rendered the development of Lake Fastrill extremely unlikely. The Neches Run-of-the-River Diversion strategy is one potential alternative to Lake Fastrill. It would involve run-of-the-river diversions from the Neches River downstream of Lake Palestine and the Neches River National Wildlife Refuge and upstream of the Weches Dam site.

Dallas and UNRMWA are long-term partners on Lake Palestine with their initial water sale contract being in place since 1972.

STRATEGY ANALYSES

“The selected Upper Neches Project strategy includes a new river intake and pump station for a run-of-river diversion from the Neches River near the SH 21 crossing. Water would be delivered through a 42-mile, 72-inch diameter pipeline to Dallas’ pump station at Lake Palestine for delivery to Dallas through the IPL. Facilities include a small diversion dam on the Neches River, a river intake and pump station, and a transmission pipeline and booster pump station with delivery to the IPL pump station site near Lake Palestine.” It is anticipated that this project will be online by 2060.

Using the run-of-river diversions operated as a system with Lake Palestine is the recommended strategy. However, run-of-river diversions operated as a system with off-channel tributary storage and as conjunctive use along with groundwater are proposed as alternative strategies in the 2014 feasibility study. These are not considered as strategies in the 2016 Region C Water Plan. All the potentially feasible WMSs for UNRMWA and City of Dallas are discussed in the 2014 Report Upper Neches River Water Supply Project Feasibility Study.
SUPPLY DEVELOPMENT

“The Upper Neches Project includes a run-of-river diversion from Neches River backed up by storage in Lake Palestine when streamflows are not available due to drought conditions, senior water rights calls, and/or TCEQ environmental flow restrictions. Water available at this diversion point was computed based on a maximum diversion rate of 141 cfs (91 MGD). The firm yield of this strategy is about 42 MGD (47,250 acft/yr), assuming conjunctive system operations with Lake Palestine. This firm yield was calculated using the TCEQ’s Neches River Basin Water Availability Model...”

“Implementation and operation of the Upper Neches Project will comply with TCEQ environmental flow standards and will leave adequate flows in the Neches River to sustain a healthy eco-system.”

ENVIRONMENTAL CONSIDERATIONS

Relating to habitat, there is no presence of critical or unique habitat in the project area. The impacts to environmental water needs, bays and estuaries and wetlands are expected to be minimal.

The twenty-six threatened and endangered species potentially impacted by the WMS, based on the species listed in the county(ies) in which this WMS is located, are: American peregrine falcon ST, bald eagle ST, Bachman’s sparrow ST, interior least tern FE and SE, peregrine falcon ST, piping plover ST and ST, Sprague’s pipit C, white-faced ibis ST, whooping crane LE and SE, wood stork ST, creek chubsucker ST, paddlefish ST, black bear ST, Louisiana black bear FT and ST, red wolf FE and SE, alligator snapping turtle ST, Texas horned lizard ST, timber rattlesnake ST, Louisiana pine snake C and ST, northern scarlet snake ST, Neches River rose-mallow FT, Louisiana pigtoe ST, sandbank pocketbook ST, southern hickorynut ST, Texas heelsplitter ST, and Texas pigtoe ST.

PERMITTING AND DEVELOPMENT

The Neches River Run-of-the-River Diversion would require a new water rights permit and an interbasin transfer permit.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. Cost estimates for the Neches Run-of-River supplies are included in Appendix Q.
WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Neches River Run-of-the-River Diversion strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Neches River Run-of-the-River Diversion strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served.

REFERENCES


REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Water from Oklahoma
WMS Type: New Surface Water Source
Potential Supply Quantity (Rounded): Up to 50,000 ac-ft/yr (45 mgd)
Implementation Decade: Varies
Strategy Capital Cost: There are multiple strategies for this source. See Appendix Q.
Unit Water Cost (Rounded): There are multiple strategies for this source. See Appendix Q.

STRATEGY DESCRIPTION

Several wholesale water providers in the Metroplex have been pursuing the purchase of water from Oklahoma. At the present time, the Oklahoma Legislature has established a moratorium on the export of water from the state. Since the 2011 Plan, the Tarrant Regional Water District pursued a case in Federal Court to determine whether this moratorium could be overturned, and the Supreme Court subsequently ruled in favor of Oklahoma. For the long term, Oklahoma remains a potential source of water supply for Region C.

STRATEGY ANALYSES

Water from Oklahoma is a recommended strategy for North Texas Municipal Water District (50,000 acre-feet per year). This recommended strategy is expected to be online beginning in 2070. It is identified as an alternative strategy for the Tarrant Regional Water District (50,000 acre-feet per year) and the Upper Trinity Regional Water District (15,000 acre-feet per year).

SUPPLY DEVELOPMENT

Supply availability is based on the evaluation of the supplies available in Lake Hugo.

ENVIRONMENTAL CONSIDERATIONS

Raw water from Oklahoma would have a relatively low environmental impact because of the use of existing sources. A complete list of the environmental considerations can be seen in Table P.4.

The twenty-four threatened and endangered species potentially impacted by this WMS, based on the species listed in the county(ies) in which this WMS is located, are: wood stork ST, bald eagle ST and FR, peregrine falcon ST, American peregrine falcon ST, whooping crane SE, piping plover ST and FT, eskimo curlew SE, red knot ST, interior least tern SE, Bachman's sparrow ST, shovelnose sturgeon ST, paddlefish ST, blue sucker ST, creek chubsucker ST, blackside darter ST, red wolf SE, black bear ST, alligator snapping turtle ST, Texas horned lizard ST, timber rattlesnake ST, American burying beetle SE and FE, Ouachita rock pocketbook SE, least tern FE and Louisiana black bear FT.
PERMITTING AND DEVELOPMENT

Oklahoma has moratorium for export of water out of state.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the Oklahoma supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the water from Oklahoma strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The water from Oklahoma strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served.

REFERENCES


REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Red River Off-Channel Reservoir (OCR)
WMS Type: New Surface Water Source
Potential Supply Quantity (Rounded): 114,342 acre/feet per year (127.5 MGD)
Implementation Decade: 2060
Strategy Capital Cost: $852,987,000 (Sept. 2013)
Unit Water Cost (Rounded): $2.53 per 1,000 gallons (during loan period)

STRATEGY DESCRIPTION

The project description for the Red River OCR strategy is based on the information summarized in the October 2015 Draft Dallas Long Range Water Supply Plan (LRWSP). According to the LRWSP, “The Red River OCR project includes a 162 MGD (250 cfs) intake and pump station on the Red River at Arthur City, TX immediately downstream of Highway 271 bridge...This location allows for streamflow from the Blue River and Muddy Boggy River watersheds to contribute to flow released from Lake Texoma resulting in improved water quality.”

“Diversions from the Red River would be pumped approximately 2 miles via an 84-in pipeline to three OCRs in series. The first OCR consists of a 2,500 acft basin for purposes of initial sediment settling and subsequent removal. The next OCR would consist of a 5,300 acft basin for water quality improvement and additional sediment removal. Finally, a third OCR would consist of a 32,000 acft storage basin to allow for extended pumping during those times when flow in the Red River is extremely low or water quality is impaired.”

“Water would then be diverted from the third OCR by a 129 MGD (200 cfs) intake and pump station and would transport, on average, about 102 MGD (114,000 acft/yr) via an 84-in transmission pipeline to Lake Ray Roberts for subsequent blending and use by Dallas. The delivery system was designed with a 1.25 peaking factor to allow for over pumping to compensate for delivery shortages during periods when diversions from the OCR are not available.”

SUPPLY DEVELOPMENT

“A yield analysis was completed using monthly available flow at Arthur City extracted from the TCEQ Red River WAM.” The flows were adjusted to account for instream flow requirements in the Red River Compact (RRC). The available yield from this supply, as an alternative strategy for Dallas, is limited by the proposed infrastructure to approximately 102 MGD.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. The twenty-three threatened and endangered species potentially impacted by this WMS, based on the species listed in the county(ies) in
which this WMS is located, are: American peregrine falcon ST, bald eagle ST, bachman's sparrow ST, Eskimo curlew FE and SE, interior least tern FE and SE, peregrine falcon ST, piping plover FT and ST, sprague's pipit C, whopping crane FE and SE, wood stork ST, blackside darter ST, blue sucker ST, creek chub sucker ST, paddlefish ST, shovelnose sturgeon ST, American burying beetle FE, black bear ST, red wolf FE and SE, Ouachita rock pocketbook FE, Texas heelsplitter ST, alligator snapping turtle ST, Texas horned lizard ST, and timber rattlesnake ST.

PERMITTING AND DEVELOPMENT

“Dallas would need to obtain a water rights permit for the river diversion from the TCEQ including an interbasin transfer authorization. In addition to the water rights permit, Dallas would need to obtain a 404 permit from the USACE for impacts to a waterway from construction activities.”

“Diversions from the Red River would potentially need to comply with provisions of the Lacey Act…” depending on where the intake and pump station facilities are constructed. Diversions would also need to comply with the RRC.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP (a more detailed cost was provided by Dallas as part of their LRWSP). In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for alternative strategy for Red River supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Red River OCR strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Region Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Red River OCR strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to
identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served. This strategy is included as an alternative strategy for Dallas in the *2016 Region C Water Plan*.

**REFERENCES**

REGION C WATER MANAGEMENT STRATEGY ANALYSIS
REUSE

WMS Name: Reuse
WMS Type: Reuse
Potential Supply Quantity (Rounded): 355,118 ac-ft/yr in 2070 (317 mgd)
Implementation Decade: Multiple
Strategy Capital Cost: $1,312,165,948 (Sept. 2013)
Unit Water Cost (Rounded): Varies per 1,000 gallons (during loan period) See table below

STRATEGY DESCRIPTION

This strategy is to develop projects that reuse treated wastewater effluent, either directly or indirectly. It includes the construction of all associated transmission that may be required. Further description of individual reuse projects is in the tables that follow.

SUPPLY DEVELOPMENT

The supply amounts for this strategy were developed based on estimates of water use and related return flows to specific wastewater treatment plants. Where applicable, consideration was given for specific minimum by-pass flow requirements where required by water rights.

ENVIRONMENTAL CONSIDERATIONS

Direct reuse projects will reduce the volume of treated wastewater effluent that is returned to natural waterways. The right of way for transmission lines may temporarily affect the environment during construction, for which there would be mitigation. Additional studies and mitigation may be required before the construction of transmission pipelines. Pipelines may be able to be routed to avoid environmentally sensitive areas.

Indirect reuse projects will reduce the volume of flow in natural waterways in certain areas, but only to the extent that they remove flows returned by upstream wastewater treatment plants. No naturalized stream flow (naturally occurring runoff from precipitation) will be removed from waterways as part of any reuse projects. It should be noted that some return flow water rights dictate the allowable use of return flow and minimum by-pass requirements in order to protect the environment.

AGRICULTURAL AND RURAL IMPACTS

The right of way for the transmission line may temporarily affect a small amount of agricultural acreage during construction.
PERMITTING AND DEVELOPMENT

All recommended indirect reuse strategies that are currently permitted have been structured to comply with the terms of the associated water right. All recommended reuse strategies (both direct and indirect) that are not currently permitted are anticipated to apply for and obtain any necessary permits from TCEQ including but not limited to reuse water right permits and Section 210 permits.

COST ANALYSIS

Cost estimates were prepared for each reuse strategy (except the five projects listed below). These cost estimates are contained in Appendix Q. There are five reuse projects that do not have associated capital costs. Those projects are below along with the explanation of why they do not have capital costs:

Athens Fish Hatchery – The Texas Freshwater Fisheries Center in Athens (“Fish Hatchery”) has a contract with Athens MWA for 3,023 acre-feet per year from Lake Athens. After using the water in its facility, the Fish Hatchery discharges almost all of that water back into Lake Athens. Athens MWA has an agreement that allows them to use this return flow. Since Athens MWA already has existing pumping and treatment facilities on the lake, there are no additional facilities needed and thus no capital costs.

Cooke County Mining Reuse – On-site recycling – Currently mining operations discharge their process water. The strategy presented in this plan is to recirculate process water within the facility rather than discharging. No capital costs were included since any infrastructure needed would be internal to the mining operation site, similar to distribution system costs, which are not allowed to be included in regional planning.

Jacksboro/Jack County Mining – Currently mining (mostly oil and gas) companies obtain water from the City of Jacksboro. Currently oil/gas water tanker trucks get water from a water tank located at Jacksboro’s water treatment plant. Jacksboro has recently obtained a permit to allow reuse of some of its wastewater. This strategy will now involve oil/gas water tanker trucks getting water from a non-potable water tank located at Jacksboro’s wastewater treatment plant.

UTRWD Indirect Reuse of Lake Ralph Hall Water – UTRWD has a water right permit for Lake Ralph Hall which also grants the right to reuse a portion of this water. Once Lake Ralph Hall is constructed and water is being used by UTRWD customers, this water is returned to UTRWD wastewater plants which then discharge into Lake Lewisville. UTRWD already has water treatment plant facilities on Lake Lewisville which can make use of this returned Ralph Hall water. There are no additional transmission facilities needed to utilize this Ralph Hall reuse.

Wise County Mining Reuse – Currently mining operations discharge their process water. The strategy presented in this plan is to recirculate process water within the facility rather than discharging. No capital costs were included since any infrastructure needed would be internal to the mining operation site, similar to distribution system costs, which are not allowed to be included in regional planning.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the reuse strategies were evaluated across eleven different criteria to facilitate a quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.
WATER USER GROUP APPLICATION

The reuse strategy was evaluated on several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served.
## Recommended Reuse Projects in Region C*

*Values in Acre-Feet per Year*

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<tr>
<td>Cooke County Mining</td>
<td>Cooke County Mining</td>
<td>Mining Reuse – On-site recycling</td>
<td>direct</td>
<td>Cooke</td>
<td>99</td>
<td>67</td>
<td>71</td>
<td>74</td>
<td>77</td>
<td>80</td>
<td>None</td>
<td>$163</td>
<td>$163</td>
<td>0</td>
<td>0</td>
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<tr>
<td>DWU</td>
<td>DWU &amp; Customers</td>
<td>DWU Main Stem Pump Station</td>
<td>indirect</td>
<td>Dallas</td>
<td>34,751</td>
<td>34,751</td>
<td>34,751</td>
<td>34,751</td>
<td>34,751</td>
<td>$44,481,000</td>
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<td>$153</td>
<td>$46</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>DWU</td>
<td>DWU &amp; Customers</td>
<td>DWU Main Stem Balancing Reservoir (Ellis County Off-Channel)</td>
<td>indirect</td>
<td>Ellis</td>
<td>0</td>
<td>0</td>
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<td>Ennis</td>
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<td>2,034</td>
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<td>3,696</td>
<td>3,696</td>
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<td>$1,374</td>
<td>$481</td>
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<tr>
<td>Fort Worth</td>
<td>Fort Worth (non-potable irrigation &amp; industrial demand included in Fort Worth Municipal Use)</td>
<td>Fort Worth Future Direct Reuse</td>
<td>direct</td>
<td>Tarrant</td>
<td>2,688</td>
<td>8,936</td>
<td>8,166</td>
<td>8,166</td>
<td>8,166</td>
<td>$129,976,000</td>
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<td>$1,363</td>
<td>$268</td>
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<td>Frisco (non-potable irrigation demand included in Frisco Municipal Use)</td>
<td>Collin/Denton County Direct Reuse</td>
<td>direct</td>
<td>Collin/Denton</td>
<td>2,240</td>
<td>3,360</td>
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<td>Jacksboro</td>
<td>Jack Co Mining</td>
<td>Indirect Reuse (Jack County mining)</td>
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<td>Jack</td>
<td>330</td>
<td>342</td>
<td>348</td>
<td>351</td>
<td>356</td>
<td>359</td>
<td>None</td>
<td>$34</td>
<td>$3</td>
<td>0</td>
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</tr>
<tr>
<td>Irving/TRA</td>
<td>Irving</td>
<td>Irving Direct for Municipal Use</td>
<td>indirect</td>
<td>Dallas</td>
<td>28,025</td>
<td>28,025</td>
<td>28,025</td>
<td>28,025</td>
<td>28,025</td>
<td>$39,960,000</td>
<td>Q-90</td>
<td>$497</td>
<td>$377</td>
<td>17</td>
<td>0</td>
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<tr>
<td>NTMWD/TRA</td>
<td>NTMWD customers</td>
<td>Central Reuse for East Fork Wetlands</td>
<td>indirect</td>
<td>Dallas/Kaufman</td>
<td>53,088</td>
<td>37,913</td>
<td>25,366</td>
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<td>WWTP in Tarrant Co</td>
<td>Tarrant County SEP</td>
<td>Tarrant County SEP</td>
<td>direct</td>
<td>Tarrant</td>
<td>0</td>
<td>1,528</td>
<td>2,360</td>
<td>2,360</td>
<td>2,360</td>
<td>$13,080,000</td>
<td>Q-196</td>
<td>$560</td>
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<td>25</td>
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<tr>
<td>TRA/Fort Worth</td>
<td>Fort Worth (non-potable irrigation &amp; industrial demand included in Fort Worth Municipal Use)</td>
<td>Alliance Corridor Direct Reuse</td>
<td>direct</td>
<td>Tarrant/Denton</td>
<td>3,921</td>
<td>3,921</td>
<td>11,537</td>
<td>11,537</td>
<td>11,537</td>
<td>11,537</td>
<td>$16,083,000</td>
<td>Q-68</td>
<td>$161</td>
<td>$20</td>
<td>20</td>
<td>0</td>
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<tr>
<td>TRA</td>
<td>Dallas County SEP (2,000 afy) &amp; future undefined customer</td>
<td>Dallas County Indirect Reuse</td>
<td>indirect</td>
<td>Dallas</td>
<td>0</td>
<td>5,000</td>
<td>6,750</td>
<td>6,750</td>
<td>6,750</td>
<td>$8,661,000</td>
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<td>$590</td>
<td>$228</td>
<td>20</td>
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<td>TRA</td>
<td>Unspecified future customers</td>
<td>Joe Pool Lake Indirect Reuse</td>
<td>indirect</td>
<td>Dallas</td>
<td>1,914</td>
<td>2,835</td>
<td>4,041</td>
<td>4,368</td>
<td>4,368</td>
<td>4,368</td>
<td>N/A**</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
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<td>0</td>
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<tr>
<td>TRA</td>
<td>Ellis Co SEP</td>
<td>Ellis County Direct Reuse</td>
<td>direct</td>
<td>Ellis</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2,200</td>
<td>4,700</td>
<td>$17,958,000</td>
<td>Q-60</td>
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<td>$235</td>
<td>25</td>
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</tr>
<tr>
<td>TRA</td>
<td>Freestone Co SEP</td>
<td>Freestone County Indirect Reuse</td>
<td>indirect</td>
<td>Freestone</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6,760</td>
<td>6,760</td>
<td>6,760</td>
<td>$30,593,000</td>
<td>Q-61</td>
<td>$613</td>
<td>$235</td>
<td>37</td>
<td>0</td>
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<td>TRA</td>
<td>Kaufman Co SEP</td>
<td>Kaufman County Indirect Reuse</td>
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<td>Kaufman</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>$8,763,000</td>
<td>Q-62</td>
<td>$935</td>
<td>$283</td>
<td>37</td>
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<td>TRA</td>
<td>Dallas Co Irrigation</td>
<td>Additional Las Colinas Direct Reuse</td>
<td>direct</td>
<td>Dallas</td>
<td>7,000</td>
<td>7,000</td>
<td>7,000</td>
<td>7,000</td>
<td>7,000</td>
<td>$15,017,000</td>
<td>Q-58</td>
<td>$392</td>
<td>$212</td>
<td>20</td>
<td>0</td>
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</table>

2016 Region C Water Plan
<table>
<thead>
<tr>
<th>TRWD</th>
<th>TRWD customers</th>
<th>Test Reuse - Cedar Creek</th>
<th>indirect</th>
<th>Henderson/ Kaufman</th>
<th>0</th>
<th>37,163</th>
<th>63,204</th>
<th>82,860</th>
<th>88,059</th>
<th>88,059</th>
<th>$139,078,000</th>
<th>Q-49</th>
<th>$182</th>
<th>$50</th>
<th>243</th>
<th>wetlands will be created</th>
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</thead>
<tbody>
<tr>
<td>UTRWD</td>
<td>UTRWD customers</td>
<td>Indirect Reuse of Lake Ralph Hall Water</td>
<td>indirect</td>
<td>Fannin</td>
<td>4,744</td>
<td>9,733</td>
<td>14,967</td>
<td>15,335</td>
<td>15,703</td>
<td>16,071</td>
<td>$0</td>
<td>None</td>
<td>$0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>UTRWD</td>
<td>Denton Co Irrigation</td>
<td>Direct Reuse</td>
<td>direct</td>
<td>Denton</td>
<td>0</td>
<td>560</td>
<td>1,121</td>
<td>2,240</td>
<td>2,240</td>
<td>2,240</td>
<td>$13,213,000</td>
<td>Q-53</td>
<td>$590</td>
<td>$94</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Weatherford</td>
<td>Weatherford &amp; customers</td>
<td>Lake Weatherford Indirect Reuse</td>
<td>indirect</td>
<td>Parker</td>
<td>2,240</td>
<td>2,240</td>
<td>2,240</td>
<td>2,240</td>
<td>2,240</td>
<td>2,240</td>
<td>$13,089,000</td>
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<td>$580</td>
<td>$91</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Wise County Mining Reuse</td>
<td>Wise Co Mining</td>
<td>Wise County Mining Reuse</td>
<td>direct</td>
<td>Wise</td>
<td>0</td>
<td>0</td>
<td>87</td>
<td>1,234</td>
<td>2,401</td>
<td>4,022</td>
<td>$0</td>
<td>None</td>
<td>$316</td>
<td>$316</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

| Total         |                |                          |          |                    | 144,982 | 185,314 | 211,660 | 324,286 | 341,527 | 355,118 | $1,312,165,948 | 5,198 | <10 |

a) County reflects location of reuse project.

* NOTE: Lists recommended reuse strategies for Region C and does not include existing reuse projects.

** Cost estimate is only for the portion of this project that Fort Worth will develop, which will be 7,841 acre-feet per year. The remainder of the volume available from this project has not been assigned to a specific user.

*** There is no cost to get return flow water into Lake Joe Pool (effluent is currently returned to the lake). This supply is available but it not currently assigned to a specific WUG as a recommended strategy. Capital costs and purchase costs to utilize this return flow will be determined as specific WUGs develop this supply.
### Description of Recommended Reuse Projects in Region C

<table>
<thead>
<tr>
<th>DB17 Project ID</th>
<th>Project Name</th>
<th>DB17 Source ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>See Region I Plan</td>
<td>Athens Fish Hatchery</td>
<td>See Region I Plan</td>
<td>Source will be existing return flow from Athens Fish Hatchery into Lake Athens. City of Athens already has facilities in place to be able to utilize this flow so there are no capital costs.</td>
</tr>
<tr>
<td>1011</td>
<td>Direct Reuse</td>
<td>1922</td>
<td>Source is City of Gainesville WWTP. End-user is Cooke County Irrigation for direct reuse.</td>
</tr>
<tr>
<td>None</td>
<td>Mining Reuse</td>
<td>1962</td>
<td>Source will be City of Gainesville's WWTP to be used for Cooke County MINING WUG. Project will provide water through direct reuse. There is no infrastructure related to this strategy since Mining operations fill tanker trucks with treated effluent directly from WWTP. (This is separate from the potable water that the City of Gainesville as a WWP provides to Cooke County MINING WUG.)</td>
</tr>
<tr>
<td>833</td>
<td>DWU Main Stem Pump Station</td>
<td>2235</td>
<td>See detailed information in Appendix L. <em>(Source will be some of NTMWD WWTP's discharges to the Lake Ray Hubbard watershed to be used by DWU from Lake Ray Hubbard diversion point. This will be in exchange for some of DWU's return flows in Main Stem of Trinity River which would be diverted to NTMWD's East Fork Wetlands and used by NTMWD from Lake Lavon diversion point.)</em></td>
</tr>
<tr>
<td>834</td>
<td>DWU Main Stem Balancing Reservoir</td>
<td>277</td>
<td>See detailed information in Appendix L. Source is return flows from the City of Dallas' Central and Southside WWTPs. A 300,000 acre-foot off channel reservoir in Ellis County would store return flows. Stored flows would be pumped back to DWU's system to augment DWU supply through indirect reuse.</td>
</tr>
<tr>
<td>1038</td>
<td>Indirect Reuse</td>
<td>1965</td>
<td>Source will be City of Ennis' WWTP (located in Ellis County) return flows. Current return flows go into the stream downstream of Lake Bardwell. Infrastructure would be built to route return flow directly into Lake Bardwell, augmenting the city's supply in Lake Bardwell through indirect reuse. Water right already allows for use of return flow.</td>
</tr>
<tr>
<td>997</td>
<td>Fort Worth Future Direct Reuse</td>
<td>1966</td>
<td>Source will be the City of Fort Worth's Village Creek WRP for future City of Fort Worth direct reuse opportunities.</td>
</tr>
<tr>
<td>1004</td>
<td>Collin/Denton County Direct Reuse</td>
<td>1920</td>
<td>Source is NTMWD's Stewart Creek West WWTP to be used by City of Frisco to irrigate parks and schools for direct reuse.</td>
</tr>
<tr>
<td>None</td>
<td>Indirect Reuse (Jackson County Mining)</td>
<td>1967</td>
<td>Source will be Jacksboro WWTP return flows to replace existing City of Jacksboro potable water supply sales to Jack County MINING WUG. There is no infrastructure related to this strategy since Mining operations fill tanker trucks with treated effluent directly from WWTP.</td>
</tr>
<tr>
<td>1020</td>
<td>Irving Direct for Municipal Use</td>
<td>1980</td>
<td>Source will be TRA's Central RWS for direct reuse by the City of Irving. Irving plans to develop a project to use this reuse source within five years.</td>
</tr>
<tr>
<td>DB17 Project ID</td>
<td>Project Name</td>
<td>DB17 Source ID</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------------------</td>
<td>----------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>954</td>
<td>NTMWD Main Stem Pump Station</td>
<td>277</td>
<td>Reuse for East Fork Wetlands. There will be 2 sources of reuse supply: water purchased from TRA from TRA’s Central Regional WWTP and water traded with DWU from DWU’s Central and Southside WWTPs. Water from these 2 sources will flow down the Main Stem of the Trinity River to a location near NTMWD’s existing East Fork Wetlands system. This effluent will be diverted via the Main Stem Pump Station into the East Fork Wetlands and subsequently pumped back to Lake Lavon for use by NTMWD.</td>
</tr>
<tr>
<td>1127</td>
<td>Tarrant County SEP</td>
<td>1968</td>
<td>Source is a WWTP in Tarrant County (unspecified at this time due to uncertainty in location of future SEP facility). END-USER is an unknown FUTURE TARRANT COUNTY SEP facility for use as cooling water. The direct reuse project(s) may be located anywhere in Tarrant County, depending on the development of SEP generation facilities and/or the occurrence of other opportunities to meet SEP water needs with reuse water.</td>
</tr>
<tr>
<td>998</td>
<td>Alliance Corridor Direct Reuse</td>
<td>1982</td>
<td>Source will be TRA’s Denton Creek RWS. TRA has been in discussions with potential water users (TRA customers) in the area for irrigation and municipal use in Denton and Tarrant counties. It would most likely be a joint project between TRA; City of Fort Worth; and large land developer, Hillwood Corporation.</td>
</tr>
<tr>
<td>989</td>
<td>Dallas County Indirect Reuse</td>
<td>1970</td>
<td>Source will be TRA’s Central RWS return flows to augment TRA Mountain Creek Lake supplies. (To be used by Dallas Co SEP as cooling water (&amp; other possible Dallas Co. WUGs)). The indirect reuse project(s) may be located anywhere in Dallas County, depending on the development of SEP generation facilities and/or the occurrence of other opportunities to meet SEP water needs with reuse water.</td>
</tr>
<tr>
<td>None</td>
<td>Joe Pool Lake Indirect Reuse</td>
<td>1971</td>
<td>Source will be TRA’s Mountain Creek RWS, to augment TRA’s supply in Joe Pool Lake for indirect reuse. This supply is available but it not currently assigned to a specific WUG as a recommended strategy. Capital costs and purchase costs to utilize this return flow will be determined as specific WUGs develop this supply.</td>
</tr>
<tr>
<td>990</td>
<td>Ellis County Direct Reuse</td>
<td>1972</td>
<td>Sources will be TRA’s Red Oak, Mountain Creek, &amp; Ten Mile Creek RWS return flows diverted from the Trinity River to Ellis County SEP for use as cooling water (&amp; other possible Ellis Co WUGs). The direct reuse project(s) may be located anywhere in Ellis County, depending on the development of SEP generation facilities and/or the occurrence of other opportunities to meet SEP water needs with reuse water.</td>
</tr>
</tbody>
</table>

2016 Region C Water Plan P.80
<table>
<thead>
<tr>
<th>DB17 Project ID</th>
<th>Project Name</th>
<th>DB17 Source ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>991</td>
<td>Freestone County Indirect Reuse</td>
<td>1973</td>
<td>Source will be TRA’s return flows diverted from the Trinity River to Freestone Co. SEP for use as cooling water. The indirect reuse project(s) may be located anywhere in Freestone County, depending on the development of SEP generation facilities and/or the occurrence of other opportunities to meet SEP water needs with reuse water.</td>
</tr>
<tr>
<td>992</td>
<td>Kaufman County Indirect Reuse</td>
<td>1974</td>
<td>Source will be return flows from TRA’s RWSs diverted from the Trinity River to Kaufman Co. SEP for use as cooling water. The indirect reuse project(s) may be located anywhere in Kaufman County, depending on the development of SEP generation facilities and/or the occurrence of other opportunities to meet SEP water needs with reuse water.</td>
</tr>
<tr>
<td>988</td>
<td>Additional Las Colinas Direct Reuse</td>
<td>1975</td>
<td>Source will be the TRA Central RWS for additional direct reuse by Las Colinas, including irrigation and augmentation of water features (canals, etc.) within the development. TRA sells the water to Dallas County Utility and Reclamation District (DCURD), who then distributes the water to the Las Colinas development.</td>
</tr>
<tr>
<td>979</td>
<td>Trinity River Indirect Reuse – Cedar Creek</td>
<td>1976</td>
<td>Source will be return flows from TRA's Central RWS &amp; Denton RWS; as well as the Fort Worth Village Creek WRP, which will be diverted to new TRWD Cedar Creek wetlands, then diverted to Cedar Creek Reservoir to augment TRWD supplies through indirect reuse.</td>
</tr>
<tr>
<td>992</td>
<td>Indirect Reuse of Lake Ralph Hall Water</td>
<td>1977</td>
<td>Source will be UTRWD WWTPs' return flows, which will augment UTRWD's Lake Ralph Hall supplies through indirect reuse. Lake Ralph Hall is a recommended WMS for UTRWD. There is no real cost for the reuse as all cost is associated with Lake Ralph Hall which provides water to users which is then discharged by UTRWD’s WWTPs.</td>
</tr>
<tr>
<td>983</td>
<td>Direct Reuse</td>
<td>1978</td>
<td>Source will be various UTRWD WWTPs to provide direct reuse water for this project. Recipient is Denton County Irrigation WUG.</td>
</tr>
<tr>
<td>1107</td>
<td>Lake Weatherford Indirect Reuse</td>
<td>2209</td>
<td>Source will be City of Weatherford’s WWTP return flows conveyed to a tributary of Lake Weatherford, which will augment the city’s lake supplies through indirect reuse.</td>
</tr>
<tr>
<td>None</td>
<td>Wise County Mining Reuse</td>
<td>1958</td>
<td>Source is recycling of mining operations wastewater. Available reclaimed water supply based on estimated available for Wise Co. oil/gas mining and sand/gravel mining as reported in Bureau of Economic Geology: Oil &amp; Gas Water Use in Texas: Update to the 2011 Mining Water Use Report, prepared for the Texas Oil &amp; Gas Association, Austin, September 2012. Project will utilize direct reuse for reclaimed water. No cost has been included for this on-site recycling</td>
</tr>
</tbody>
</table>
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM*

*A detailed report analyzing and quantifying impacts of the Marvin Nichols (313.5 msl) portion of the Sulphur Basin Supplies is included in Appendix Y.

WMS Name: Sulphur Basin Supplies
WMS Type: New Surface Water Source

Yield of the Sulphur Basin Supplies is detailed below

<table>
<thead>
<tr>
<th>Potential Supply Quantity (Rounded):</th>
<th>Total Available Yield</th>
<th>Region C Portion (80%)</th>
<th>Region D Portion (20%)</th>
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</thead>
<tbody>
<tr>
<td>Wright Patman pool raise (232.5)</td>
<td>158,900</td>
<td>127,120</td>
<td>31,780</td>
</tr>
<tr>
<td>Marvin Nichols (313.5)</td>
<td>469,050</td>
<td>375,240</td>
<td>93,810</td>
</tr>
<tr>
<td>Total</td>
<td>627,950</td>
<td>502,360</td>
<td>125,590</td>
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</table>

Implementation Decade: 2050 for Wright Patman portion; 2070 for Marvin Nichols portion

Strategy Capital Cost: $4,516,545,000 (September 2013) Q-18

Unit Water Cost (Rounded): $2.96 per 1,000 gallons (during loan period) $0.73 per 1,000 gallons (after loan period)

STRATEGY DESCRIPTION

The Sulphur Basin Supplies strategy involves development of new surface water supplies from the Sulphur River Basin through a reallocation of storage at Wright Patman Lake from its current purpose, flood control, to water conservation storage, in combination with new storage at the Marvin Nichols IA site. The supply quantity and cost identified above are for a specific to reallocation of Wright Patman at elevation 232.5’ NGVD and conservation storage at the Marvin Nichols site at elevation 313.5’ NGVD. At those conservation pool elevations, the Marvin Nichols component would inundate an estimated 41,722 acres, while the pool raise at Wright Patman Lake would inundate an additional 9,429 acres over and above the current “average” conservation pool elevation. Of that additional acreage at Wright Patman, the Corps of Engineers has estimated that 7,126 acres are not currently owned by the U.S. Government in a fee title interest and would require purchase.

Studies are currently underway to optimize the specific combination of Wright Patman and Marvin Nichols in terms of cost, environmental, and social impacts, and the final strategy may differ somewhat in terms of specific elevation at either or both components of the project.

The Sulphur Basin Supplies strategy is a recommended water management strategy for NTMWD, UTRWD, and TRWD. It is also an alternative strategy for Dallas and the City of Irving. Approximately 80 percent of the water supplied from the Sulphur Basin Supplies strategy is expected to serve customers
of wholesale water providers in Region C and approximately 20 percent would serve water needs in Region D.

STRATEGY ANALYSES

Previously recommended or alternative Water Management Strategies from the Sulphur River Basin in past Region C Plans include: Marvin Nichols Reservoir, Wright Patman Lake (including reallocation of flood storage), Lake George Parkhouse North, and Lake George Parkhouse South. All of these reservoirs are located in the Region D (North East Texas) Regional Water Planning Area. Marvin Nichols Reservoir would be located on the Sulphur River upstream from its confluence with White Oak Creek. The dam would be in Titus and Red River counties and would also impound water in Franklin County. Wright Patman Lake is an existing reservoir on the Sulphur River, about 150 miles from the Metroplex. It is owned and operated by the U.S. Army Corps of Engineers, and the City of Texarkana has contracted with the Corps of Engineers for storage in the lake and holds a Texas water right to use up to 180,000 acre-feet per year from the lake.

The Region C entities that are interested in development of Sulphur Basin Supplies (NTMWD, TRWD, Dallas, UTRWD, and Irving) have formed a Joint Committee on Program Development (JCPD). Since 2001, the JCPD has provided more than $5 million to the Sulphur River Basin Authority (SRBA) to further investigate the development of potential water supply sources in the Sulphur River Basin. Ongoing Sulphur Basin Feasibility studies are being conducted by the U.S. Army Corps of Engineers, SRBA and the JCPD. At the direction of SRBA and the JCPD, these ongoing studies are seeking to address concerns from Region D entities regarding the protection of natural resources, environmental impacts, and the socio-economic impacts of developing water supply within Region D and the Sulphur Basin. As a result, these ongoing studies have identified additional options for water supply in the Sulphur Basin that may address concerns from Region D and would also develop supply needed for Region C and Region D entities.

As identified in the 2014 Sulphur River Basin studies, this 2016 Region C Plan recommends a combined strategy of Marvin Nichols Reservoir with the reallocation of flood storage to conservation storage in Wright Patman Lake. This combination is referred to in the report as the Sulphur Basin Supplies strategy. The combination strategy may enable the Marvin Nichols Reservoir to be developed with a smaller footprint. The proposed Sulphur Basin Supplies strategy would yield around 600,000 acre-feet per year (calculated using TCEQ WAM models, assuming Lake Ralph Hall is senior, and accounting for environmental flows).

These 2014 Sulphur River Basin studies evaluated a total of sixty combinations of alternative scales and locations of new surface water development in the Sulphur Basin. Based on these analyses, ongoing strategy optimization is focused on reallocated storage at Wright Patman between elevation 232.5 and elevation 242.5 in combination with new storage at the Nichols site ranging between conservation pool elevations of 296.5 and 313.5. For the purpose of the 2016 Region C Plan, the Sulphur Basin Supplies Strategy assumes the reallocation of Wright Patman to 232.5 and new storage at Marvin Nichols site for a conservation pool elevation of 313.5.

As discussed in Section 5C, the Sulphur Basin Supplies is a recommended strategy for the North Texas Municipal Water District (174,800 acre-feet per year), the Tarrant Regional Water District (280,000 acre-feet per year), and Upper Trinity Regional Water District (35,000 acre-feet per year). It is an alternative strategy for Dallas Water Utilities and the city of Irving. The Region C capital cost for the recommended strategy is $4.5 billion. The capital cost for the alternative strategy is approximately $4.8 billion. Studies conducted by SRBA, the Corps of Engineers, and Region C providers between 2011 and 2014 evaluated a
total of sixty combinations of alternative scales and locations of new surface water development in the Sulphur Basin. Based on these analyses, strategy optimization is focused on reallocated storage at Wright Patman between elevation 232.5 and elevation 242.5 in combination with new storage at the Nichols site ranging between conservation pool elevations of 296.5 and 313.5. The anticipated division of yield of the Sulphur Supplies between the three WWP s for which this is a recommended strategy is shown below. NOTE: This division is shown for the purpose of this regional plan and DB17 ONLY and is not intended to be used as a constraint in permitting or operation of these supply reservoirs.

<table>
<thead>
<tr>
<th>(Values in Acre-feet per year)</th>
<th>TOTAL Region C Portion (80% of total yield)</th>
<th>Tarrant Regional WD</th>
<th>North Texas Municipal WD</th>
<th>Upper Trinity Regional WD</th>
<th>Unassigned Region C Portion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wright Patman pool raise</td>
<td>127,120</td>
<td>72,670</td>
<td>45,367</td>
<td>9,083</td>
<td>0</td>
</tr>
<tr>
<td>(available in 2050)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marvin Nichols (313.5)</td>
<td>375,240</td>
<td>207,330</td>
<td>129,433</td>
<td>25,917</td>
<td>12,560</td>
</tr>
<tr>
<td>(available in 2070)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>502,360</td>
<td>280,000</td>
<td>174,800</td>
<td>35,000</td>
<td>12,560</td>
</tr>
</tbody>
</table>

* NOTE: The division between supplies shown in this table is for the purpose of this regional plan and DB17 only and is not intended to be used as a constraint in permitting or operation of these supply reservoirs.

SUPPLY DEVELOPMENT

The amount of supply available from Marvin Nichols Reservoir and Wright Patman was developed using the Sulphur Basin Water Availability Model, assuming that Lake Ralph Hall was in place and senior to Sulphur Basin Supplies, and accounting for environmental flows).

ENVIRONMENTAL CONSIDERATIONS

Both reallocated storage and new storage would permanently inundate agricultural, silvicultural, and natural resources. Based on a “desktop” analysis using remotely-sensed data, approximately 32,601 acres potentially subject to Section 404 jurisdiction would be affected within the footprint of the combined project. The unit costs shown above reflect the yield reduction predicted after application of anticipated environmental flow requirements, imposed to mitigate downstream impacts.

As with most major reservoir projects, the Sulphur Basin Supplies strategy will have significant environmental impacts. At the conservation pool elevations mentioned above, the Marvin Nichols component would inundate an estimated 41,722 acres, while the pool raise at Wright Patman Lake would inundate an additional 9,459 acres over and above the current “average” conservation pool elevation. Of that additional acreage, the Corps of Engineers has estimated that 7,126 acres are not currently owned by the U.S. Government in a fee title interest and would require purchase. Studies are currently underway to optimize the combination in terms of cost, environmental, and social impacts, and the final strategy may differ somewhat in terms of specific elevation at either or both components of the project.
The twenty-six threatened and endangered species potentially impacted by this WMS, based on the species listed in the county(ies) in which this WMS is located, are: American peregrine falcon ST, Bachman’s sparrow ST, bald eagle ST, interior least tern FE and SE, peregrine falcon ST, piping plover FT and ST, Sprague’s pipit C, wood stork ST, blackside darter ST, bluehead shiner ST, creek chubsucker ST, paddlefish ST, shovel-nosed sturgeon ST, American burying beetle FE, black bear ST, Louisiana black bear FT and ST, Rafinesque’s big-eared bat ST, red wolf FE and SE, Louisiana pigtoe ST, Ouachita rock pocketbook FE, southern hickorynut ST, Texas pigtoe ST, alligator snapping turtle ST, northern scarlet snake ST, Texas horned lizard ST, and timber rattlesnake ST.

PERMITTING AND DEVELOPMENT

Reallocation at Wright Patman Lake on the scale envisioned in this strategy would require approval of the U.S. Congress. The new storage impoundment would require an individual Section 404 permit, as would the transmission system. A new State water right and inter-basin transfer approval would be required from TCEQ in order to implement the strategy.

The 1984 U.S. Fish and Wildlife Service Bottomland Hardwood Preservation Program classified some of the land that would be flooded as a Priority 1 bottomland hardwood site, which is “excellent quality bottomlands of high value to key waterfowl species.” The proposed location/size of the Marvin Nichols Reservoir will reduce but not eliminate the impact on bottomland hardwoods compared to the location originally proposed. Permitting the project and developing appropriate mitigation for the unavoidable impacts will require years, and it is important that water suppliers start that process well in advance of the need for water from the project. Development of the Sulphur Basin Supplies will require interbasin transfer permits to bring the water from the Sulphur River Basin to the Trinity River Basin. The project will include a major water transmission system to bring the new supply to the Metroplex.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the Sulphur Basin Supplies are included in Appendix Q.

The project will make a substantial water supply available to the Metroplex, and the unit cost is less than that of most other major water management strategies. Cost shown are for the specific alternative identified above and are likely to change somewhat as the project is optimized. The estimated capital cost includes the storage component, which includes the embankment and spillway at the Marvin.
Nichols site, updated storage costs and required dam safety modifications at Wright Patman Lake, as well as conflicts, real estate, mitigation, and permitting at both sites. The remaining first costs account for the extensive transmission system required for this strategy.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Sulphur Basin Supply strategy was evaluated across a number of different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Sulphur River Basin strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served.

This strategy was considered for Dallas Water Utilities, Tarrant Regional Water District, City of Irving, Upper Trinity Regional Water District, North Texas Municipal Water District, and various Region D WUG’s.

REFERENCES


Sulphur River Basin Comparative Assessment – Environmental Evaluation Interim Report, FNI, June 2013
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: Toledo Bend Reservoir
WMS Type: Existing Surface Water Source
Potential Supply Quantity (Rounded): Varies
Recommended WMS for NTWMD of 100,000 ac-ft/yr
Implementation Decade: Varies (2060 for NTWMD)
Strategy Capital Cost: $Varies (Sept. 2013)
Recommended WMS for NTWMD $1,248,461,000 (Q-57)
Unit Water Cost (Rounded): $Varies per 1,000 gallons (during loan period)
Recommended WMS for NTWMD $4.07 per 1,000 gallons
$Varies per 1,000 gallons (after loan period)
Recommended WMS for NTWMD $0.95 per 1,000 gallons

STRATEGY DESCRIPTION

Toledo Bend Reservoir is an existing impoundment located in the Sabine River Basin on the border between Texas and Louisiana. It was built in the 1960s by the Sabine River Authority of Texas (SRA) and the Sabine River Authority of Louisiana. The yield of the project is split equally between the two states, and Texas' share of the yield is slightly over 1,000,000 acre-feet per year. The SRA holds a Texas water right to divert 750,000 acre-feet per year from Toledo Bend and is seeking the right to divert an additional 293,000 acre-feet per year.

The Metroplex water suppliers have been investigating the possibility of developing substantial water supplies from Toledo Bend Reservoir, with up to 400,000 acre-feet per year delivered to Region C. (Toledo Bend Reservoir is located in Region I, the East Texas Region.) The development of this supply will require an agreement among the SRA and Metroplex suppliers, an interbasin transfer permit from the Sabine River Basin to the Trinity River Basin, and development of water transmission facilities. Because Toledo Bend Reservoir is so far from Region C (about 200 miles), this is a relatively expensive source of supply for the Region. However, it does offer a substantial water supply, and environmental impacts will be limited because it is an existing source.

STRATEGY ANALYSES

Supply from Toledo Bend is identified as a recommended and alternative strategy for North Texas Municipal Water District (NTMWD) and as an alternative strategy for Dallas, Tarrant Regional Water District (TRWD), and Upper Trinity Regional Water District (UTRWD). The recommended strategy for the North Texas Municipal Water District is for 100,000 acre-feet per year. The entity hopes to connect to Toledo Bend Reservoir by 2070. The alternative strategies for Dallas, Tarrant Regional Water District,
North Texas Municipal Water District, and the Upper Trinity Regional Water District is to develop a total supply of approximately 548,660 acre-feet per year.

This strategy would require a contract between Metroplex water providers and SRA for the potential supply quantity. The purchase rate for the raw water will be determined based on the negotiations between SRA and the Metroplex providers. Because of the prohibitive distance and terrain involved in transferring water from Toledo Bend, this strategy is expensive with respect to the capital investment and annual maintenance.

SUPPLY DEVELOPMENT

SRA is currently authorized for 750,000 acre-feet per year of supplies from Toledo Bend Reservoir and 147,000 acre-feet per year from Sabine run-of-river supplies. There are some current customers using these sources of supply but most of this supply amount is available as a surplus for other potential customers. The supply is already developed by SRA and this strategy would require a voluntary transfer between SRA in Region I and Region C water providers. The amount required for the recommended strategy can be met with the current authorizations available from Toledo Bend. However, if the entire potential quantity proposed for the alternative water management strategies is sought, then SRA will have to secure the water right amendment to access the additional 293,300 acre-feet per year supplies from Toledo Bend Reservoir. The application of this water right permit is already administratively complete and SRA is working with TCEQ to secure this permit.

ENVIRONMENTAL CONSIDERATIONS

There are minimal environmental issues associated with the supplies currently available at SRA’s Toledo Bend Reservoir location and the run-of-river diversion points. However, SRA’s permit application for additional supplies from Toledo Bend may potentially be subject to environmental flow requirements established for the Sabine basin, when the permit application is considered for approval.

The forty-one threatened and endangered species potentially impacted by the WMS, based on the species listed in the county(ies) in which this WMS is located, are: Swallow-tailed kite ST, American peregrine falcon ST, Bachman’s sparrow ST, blad eagle ST, interior least tern FE and SE, peregrine falcon ST, piping plover FT and ST, Sprague’s pipit C, red-cockaded woodpecker FE and SE, white-faced ibis ST, whooping crane FE and SE, black-capped vireo FE and SE, sharptail shinerFE, smalleye shiner FE, gray wolf FE and SE, black bear ST, Louisiana black bear FT and ST, red wolf FE and SE, alligator snapping turtle ST, Texas horned lizard ST, timber rattlesnake ST, earth fruit FT and ST, creek chubsucker ST, paddlefish ST, Rafinesque’s big eared bat ST, Louisiana pine snake C and ST, northern scarlet snake ST, Neches River rose mallow FT, Brazos water snake ST, Texas golden gladecress FE, white bladderpod FE and SE, Texas fawnsfoot C and ST, Louisiana pigtoe ST, sandbank pocketbook ST, southern hickorynut ST, Texas heelsplitter ST, Texas pigtoe ST and triangle pigtoe ST.

PERMITTING AND DEVELOPMENT

The Toledo Bend Reservoir strategy will require an interbasin transfer permit (IBT) and agreements with multiple users.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In
accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the recommended and alternative strategies for Toledo Bend supplies are included in Appendix Q.

**WATER MANAGEMENT STRATEGY EVALUATION**

Based on the analysis provided above, the Toledo Bend Reservoir strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

**WATER USER GROUP APPLICATION**

The Toledo Bend Reservoir strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served.

Currently this source of supply can be used to meet local needs in East Texas Regional Water Planning Area (ETRWPA) region along with the needs of other regions such as Region C and Region H. Toledo Bend Reservoir is a reliable source of supply for WUGs in all the regions and the quality of the water is superior. However, the unit cost could be prohibitive for WUGs located in other regions because of the distance from the source location.

**REFERENCES**


REGION C WATER MANAGEMENT STRATEGY ANALYSIS
TECHNICAL MEMORANDUM

WMS Name: TRWD Wetlands
WMS Type: Reuse
Potential Supply Quantity (Rounded): 88,059 ac-ft/yr (79 mgd)
Implementation Decade: 2030
Strategy Capital Cost: $139,078,000 (Sept. 2013) (Q-49)
Unit Water Cost (Rounded): $0.56 per 1,000 gallons (during loan period)

STRATEGY DESCRIPTION

The Tarrant Regional Water District has water rights allowing the diversion of return flows of treated wastewater from the Trinity River. TRWD has already developed a reuse project at Richland-Chambers Reservoir, and a portion of the supply from this project is included in the currently available supply. The water is pumped from the Trinity River into the constructed George W. Shannon Wetlands for treatment and then pumped into Richland-Chambers Reservoir. TRWD will be developing a similar reuse project at Cedar Creek Reservoir in the near future. In November 2014, TRWD’s certificates of adjudication for these reuse projects were amended to increase the total permitted reuse diversion to 188,524 acre-feet per year, including 100,465 acre-feet per year at Richland-Chambers and 88,059 acre-feet per year at Cedar Creek Reservoir. The available supply for the Cedar Creek reuse project as calculated by Region C is 88,059 acre-feet per year by 2070.

This is a relatively inexpensive source of new supply for the Tarrant Regional Water District, and the environmental impacts are low. It is a recommended strategy for the Tarrant Regional Water District.

SUPPLY DEVELOPMENT

Supply availability was evaluated by the Region C Consultants and summarized in the 2015 Draft Memorandum “Region C Reuse Calculations”.

ENVIRONMENTAL CONSIDERATIONS

There are no significant environmental considerations associated with this strategy. The quality of the effluent and the impact on the wetlands will be evaluated and the wetlands will be designed to treat the return flows appropriately.

There are no federally listed threatened and endangered species at the proposed Cedar Creek wetlands site. The state listed species that could potentially be impacted are the Texas Pigtoe, Sandbank Pocketbook, Southern Hickorynut, Louisiana Pigtoe, and Texas Heelsplitter. A survey would need to be conducted to confirm the presence of any of these species at the site.
PERMITTING AND DEVELOPMENT

Tarrant Regional Water District has already secured permits to develop the wetlands on Cedar Creek and Richland-Chambers.

COST ANALYSIS

For the Region C cost analysis, planning level opinion of costs have been developed using the TWDB’s costing tool, except where more detailed cost analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance, the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included. It should be noted that the purchase water costs are planning level estimates and actual purchase costs will be finalized based on negotiations between the suppliers.

Cost estimates for the TRWD Cedar Creek Wetlands supplies are included in Appendix Q.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the TRWD Wetlands strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The TRWD Wetlands strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served.
REGION C WATER MANAGEMENT STRATEGY ANALYSIS
WATER TREATMENT PLANTS

WMS Name: Water Treatment Plants
WMS Type: Various
Potential Supply Quantity (Rounded): 0 ac-ft/yr. This strategy does not create new supply, but it is necessary to utilize the supplies created by other strategies.
Implementation Decade: Multiple
Strategy Capital Cost: See tables Q-12 and Q-13
Unit Water Cost (Rounded): See tables Q-12 and Q-13

STRATEGY DESCRIPTION

This strategy is to develop required water treatment capacity to use raw water supplies developed as part of other strategies. In some cases, this strategy involves the construction of a new facility and in other instances it is an expansion of existing facilities.

SUPPLY DEVELOPMENT

This strategy is to develop required water treatment capacity to use raw water supplies developed as part of other strategies. While this strategy does not explicitly create supply, it is necessary to utilize the supplies as drinking water.

ENVIRONMENTAL CONSIDERATIONS

The construction of the treatment plant may temporarily impact the environment during construction. Additional study and mitigation may be required before construction of the water treatment plant. The plant may be able to be located to avoid environmentally sensitive areas.

AGRICULTURAL AND RURAL IMPACTS

No agricultural and rural impacts are expected from the construction of the treatment facilities.

PERMITTING AND DEVELOPMENT

Wastewater discharge permits may be necessary for new facilities. Further evaluation and study will be needed to determine the impact of discharges on receiving water bodies. This will be performed as part of the permitting process.

COST ANALYSIS

Cost estimates were prepared using the TWDB Costing Tool.
WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the water from water treatment plants strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The evaluation results can be found in Tables P.3 and P.4.

WATER USER GROUP APPLICATION

The Water Treatment Plant strategy was evaluated on the basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the quality of the water from another strategy to the WUGs served.

ENTITIES WITH WATER TREAMENT PLANT STRATEGIES

See Tables Q-12 and Q-13.