Water Supply
Potential Source Study

Montgomery County
Alternative Water Supply Program

Ronald D. Kelling

Ronald D. Kelling, P.E.

January 26, 2009

Date

January 2009

Table of Contents

Table of Contents (Continued)

Executive Summary

ES.1 Background and Purpose

The Lone Star Groundwater Conservation District (LSGCD) established a regulatory target in its District Regulatory Plan (DRP) Phase I to reduce groundwater withdrawals from the aquifer in Montgomery County to 64,000 acre-feet per year by January 2015. The LSGCD DRP Phase II (A) requires certain large volume groundwater users (LVGU) to submit a Water Resources Assessment Plan (WRAP) which includes identification of new water supply sources to meet projected water demands. The purpose of this study is to identify potential alternative water sources available to Montgomery County to reduce groundwater use and meet projected water demands, evaluate those potential sources, and select a source to be used as the basis for the SJRA Joint WRAP Part II.

The identification and evaluation of potential alternative water sources began in 2007 and was completed in 2008. Data was collected throughout the study period. A baseline was established based on that data for which all alternatives were equitably evaluated for the purpose of this study.

ES.2 Water Sources

For purposes of this Potential Source Study, a broad range of water supply sources were considered. Available water sources include groundwater and surface water in both the San Jacinto and Trinity River Basins.

ES.3 Water Demands

Projected countywide water demand based on long-term water planning conducted by Region H and the Texas Water Development Board is as follows.

Table ES-1. Water Demands

Year	Demand (afpy)
2015	90,000
2025	114,000
2035	137,000
2045	165,000
2055	201,000
2060	220,000

ES.4 Alternatives

Various alternatives identified and screened include the following.

1. SJRA trade its Trinity River Basin water rights for the City of Houston's Lake Conroe water rights
2. SJRA trade its San Jacinto Basin water rights for the City of Houston's Lake Conroe water rights
3. SJRA purchase the City of Houston's Lake Conroe water rights
4. SJRA participate in Luce Bayou project in exchange for use of the City of Houston's Lake Conroe water rights
5. SJRA enters into a Long-Term Contract with the NHCRWA for treated surface water
6. SJRA enters into a Long-Term Contract with the City of Houston for Lake Conroe raw surface water
7. SJRA enters into a Long-Term Contract with the Trinity River Authority for raw surface water diverted from the Trinity River near Huntsville
8. SJRA enters into a Long-Term Contract with the City of Houston for Lake Conroe raw surface water plus a Long-Term Contract with the Trinity River Authority for raw surface "replacement" water diverted from the Trinity River near Huntsville
9. SJRA enters into a Long-Term Contract for imported groundwater

ES.5 Comparison of Alternatives

Initial screening of alternatives resulted in four scenarios carried forth for further evaluation. These four scenarios included the long-term water supply contracts for surface water with the City of Houston and Trinity River Authority and for imported groundwater (Alternative Nos. 6, 7, 8, and 9). For the purpose of comparing water sources, preliminary diversion locations, water treatment, finished water storage and pumping, and transmission size and routing were identified. Costs related to the implementation of each alternative were developed and are shown in Table ES-2. These costs were spread over the projected countywide water demands (excluding exempt demands), resulting in equivalent unit costs as shown in Exhibit ES-1.

Table ES-2. Costs

	Current SJRA Conroe Rights (Beginning 2015) + Contract COH Water In Conroe (Beginning 2025)+ SJRA's Trinity River Rights Via Luce Bayou (2055)	Current SJRA Conroe Rights (Beginning 2015) + Contract TRA Water From Trinty U/S of Livingston (Beginning 2025) + SJRA's Trinity River Rights Via Luce Bayou (2055)	Current SJRA Conroe Rights (Beginning 2015) + Contract COH Water In Lake Conroe and TRA Water From Trinty U/S of Livingston (Beginning 2025) + SJRA's Trinity River Rights Via Luce Bayou (2055)	Contract Imported Groundwater (Beginning 2015) + Current SJRA Conroe Rights (Beginning 2045) + SJRA's Trinity River Rights Via Luce Bayou (2055)
	Capital Costs (2008 Dollars)	Capital Costs (2008 Dollars)	Capital Costs (2008 Dollars)	Capital Costs (2008 Dollars)
Phase				
2009-2014 Planning	$100,088,000	$100,088,000	$100,088,000	$80,510,000
2015	$313,002,000	$313,002,000	$313,002,000	$246,547,000
2025	$63,690,900	$321,172,950	$346,192,350	$68,652,150
2035	$252,913,500	$252,913,500	$252,913,500	$269,415,300
2045	$154,747,950	$154,747,950	$154,747,950	$209,321,700
2055	$594,922,650	$594,922,650	$594,922,650	$594,922,650
Total	$1,479,365,000	$1,736,847,050	$1,761,866,450	$1,469,368,800
	Capital Costs (Dollars in Year Constructed)	Capital Costs (Dollars in Year Constructed)	Capital Costs (Dollars in Year Constructed)	Capital Costs (Dollars in Year Constructed)
Phase				
2009-2014 Planning	$110,347,000	$110,347,000	$110,347,000	$88,762,000
2015	$399,479,000	$399,479,000	$399,479,000	$314,664,000
2025	$132,409,000	$667,696,000	$719,709,000	$142,723,000
2035	$856,455,000	$856,455,000	$856,455,000	$912,336,000
2045	$853,592,000	$853,592,000	$853,592,000	$1,154,622,000
2055	$5,345,385,000	$5,345,385,000	$5,345,385,000	$5,345,385,000
	Present Worth Value (2015 thru 2060) (2008 Dollars)	Present Worth Value (2015 thru 2060) (2008 Dollars)	Present Worth Value (2015 thru 2060) (2008 Dollars)	Present Worth Value (2015 thru 2060) (2007 Dollars)
	$2,996,691,827	$3,461,237,563	$3,900,374,038	$5,481,265,502

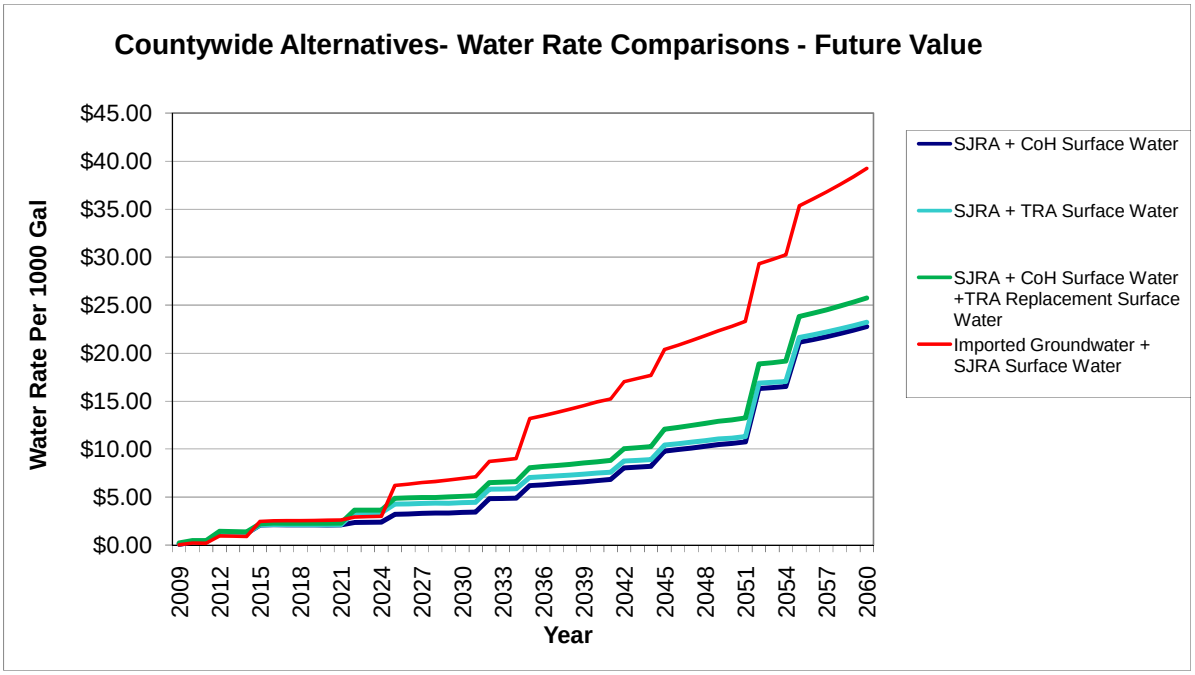

Exhibit ES-1. Unit Cost Comparisons

ES.6 Recommendation and Conclusion

The most cost-effective source-water supply alternative is the use of SJRA water rights in Lake Conroe plus a long-term water supply contract with the City of Houston for its water in Lake Conroe. While it is anticipated that the final diversion locations and amounts, and infrastructure size and location will vary from the baseline developed in this study, the final conclusion will remain the same. Therefore it is recommended that all of the permitted yield of Lake Conroe be utilized to supply treated surface water in Montgomery County prior to the conveyance of water from additional sources into the county and that a long-term water supply contract with the City of Houston be executed in a timely manner.

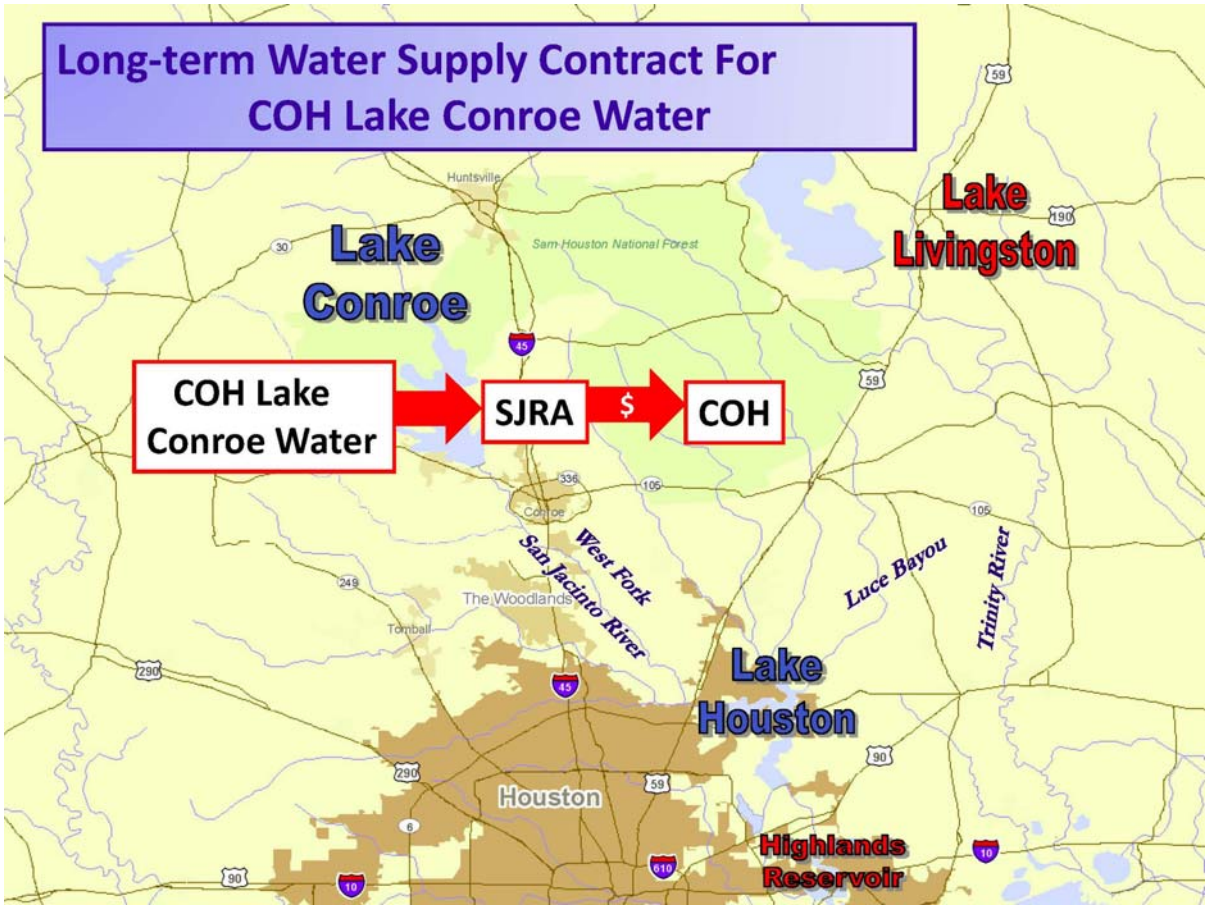

Exhibit ES-2. Recommended Water Supply

Section 1 Introduction

1.1 Background

The Lone Star Groundwater Conservation District (LSGCD) was created by the Texas Legislature in 2001 to conserve, protect, and enhance the groundwater resources of Montgomery County. Scientific studies conducted by the LSGCD quickly confirmed what many water suppliers in Montgomery County were already seeing, which is that the demand for groundwater in many places within the county was exceeding what the aquifers could sustainably yield, and water levels were declining at an alarming rate. Modeling of future population and water demand showed that the projected impacts of continued reliance on groundwater would soon create significant water-level declines and severe problems for water suppliers in every area of Montgomery County.

In an effort to begin reducing groundwater demands and encourage the conjunctive use of surface water and groundwater supplies, the LSGCD recently adopted regulations that require certain groundwater users to conduct long-term planning to assess their future water needs and describe how they will obtain alternative water supplies to meet their future demands in light of the reduction requirements adopted by the LSGCD. The specific requirements for this planning are set forth in the LSGCD's District Regulatory Plan (DRP) Phase II (A) and are based on the regulatory target established in the DRP Phase I to reduce groundwater withdrawals in Montgomery County to 64,000 acre-feet per year by January 2015.

The LSGCD DRP Phase II (A) requires certain large volume groundwater users (LVGU) to submit a Water Resources Assessment Plan (WRAP), which is divided into two major parts. Part I includes information about current and projected water demands; identification of current water supplies; and description of current well capacities. Part II includes identification of new water supply sources to meet projected water demands; description of infrastructure needed to deliver new supplies; timeline and cost estimate for development of new supplies; and a letter from the supplier confirming the availability of the new supplies.

The SJRA submitted a Joint WRAP Part I to the LSGCD in August 2008. The Joint WRAP included 198 of the LVGUs in Montgomery County.

1.2 Purpose

The purpose of this study is to identify potential alternative water sources available to Montgomery County to reduce groundwater use and meet projected water demands, evaluate those potential sources, and select a source to be used as the basis for the SJRA Joint WRAP Part II study.

Section 2 Water Sources

2.1 Groundwater

The Northern Gulf Coast Aquifer System consists of the Chicot and Evangeline aquifers, the Burkeville confining layer, and the Jasper aquifer. In Montgomery County, the Chicot aquifer is shallow and is used primarily by single family and agricultural interests on individual wells. The primary groundwater sources for public water supply systems in Montgomery County are the Evangeline and Jasper aquifers.

The sustainable yield from the Evangeline and Jasper aquifers is based on the recharge rate of the aquifer. The amount of recharge varies with the amount of rainfall that infiltrates into each aquifer. The recharge zones are shown in Exhibit 2-1 below.

Exhibit 2-1. North Gulf Coast Aquifer System

The LSGCD Groundwater Management Plan (GMP), adopted in 2003, assumed the sustainable groundwater yield for Montgomery County is 64,000 acre-feet per year (afpy) based on an annual deep recharge to the Northern Gulf Coast Aquifer System of approximately 1.1 inches per year applied to the entire surface area of the county in acres (697,600 acres). As seen in Exhibit 2-1, the outcropping of the three aquifers, and particularly the Evangeline and Jasper aquifers do not coincide with the county boundary.

The Texas Water Development Board (TWDB) has recently released preliminary results of the Northern Gulf Coast Aquifer Groundwater Availability Model (GAM) which indicate the recharge rate could be considerably less than 64,000 afpy. The LSGCD has contracted with the US Geological Survey (USGS) to conduct a three-year study of the recharge rate. Preliminary results of that study will not be available until late 2009 and final results will not be available until 2010. The LSGCD has chosen not to adopt the TWDB GAM data at this time, but rather wait until the USGS study results are available. Regardless of the results of these studies, it is clear that the existing groundwater supply cannot meet the growing water demands of Montgomery County.

2.2 Imported Groundwater

LSGCD DRP Phase II (A) does not allow consideration of groundwater imported from adjacent counties as an alternative water supply source. Therefore any groundwater imported into Montgomery County must be conveyed across at least one county. The major aquifers of Texas are shown in Exhibit 2-2 below.

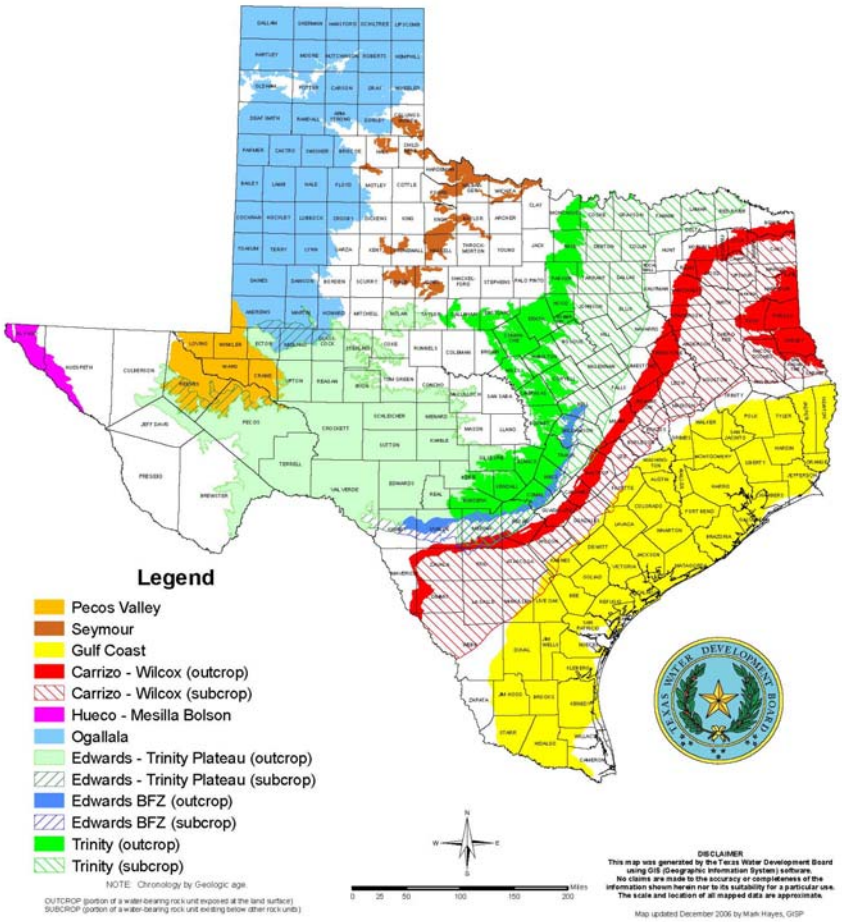

Exhibit 2-2. Major Aquifers (TWDB, Dec. 2006)

It should be noted, however, that the option of importing groundwater from other nearby counties triggers additional legal and policy issues. The state of Texas has been divided into groundwater management areas (GMAs), which are essentially regional planning areas established over common aquifers. Montgomery County is within GMA 14. The various groundwater conservation districts (GCDs) in each GMA are responsible for defining a desired future condition for each aquifer within their planning area. Each GCD then develops a groundwater management plan and regulations that are intended to meet the desired future condition for the aquifer within its GMA. It is anticipated that some GCDs may not allow the exportation of groundwater from their district, therefore limiting or eliminating the option to import groundwater from that GCD into Montgomery County.

2.3 Surface Water

As shown in Exhibit 2-3, Montgomery County is located in the San Jacinto River basin. The Trinity River is located to the north and east of Montgomery County. The Brazos River is located to the west of Montgomery County.

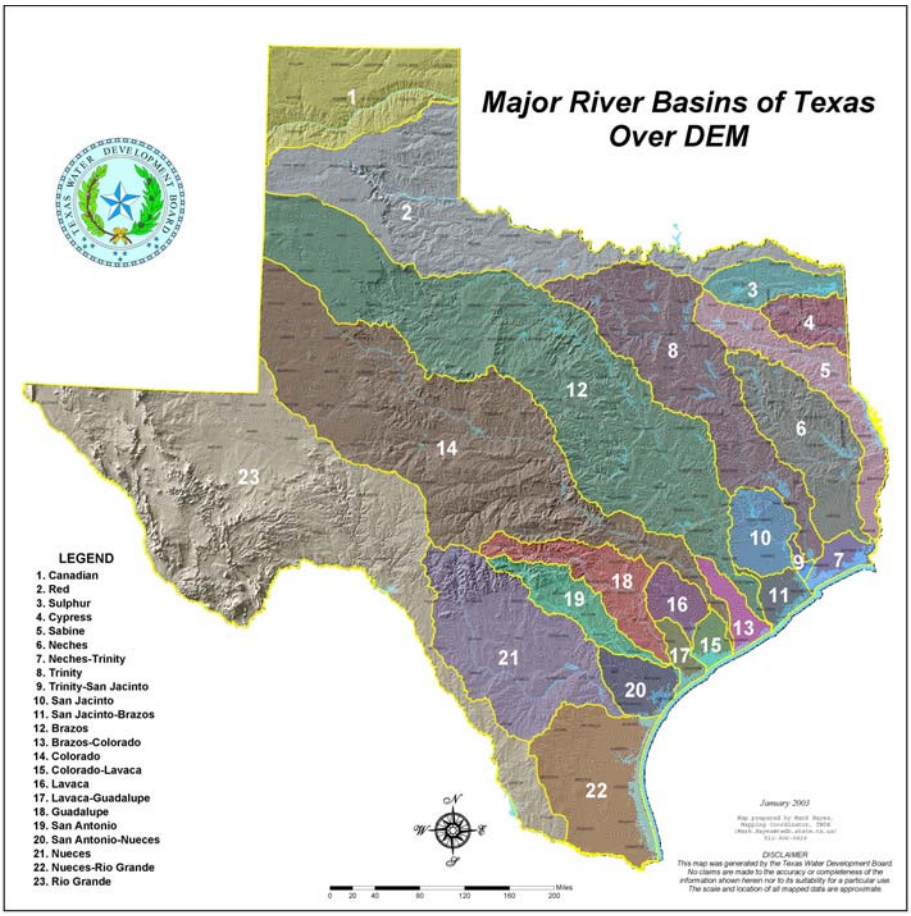

Exhibit 2-3. Major River Basins of Texas (TWDB, Jan. 2003)

2.4 SJRA Surface Water Rights

Surface water in Texas lakes and rivers is owned by the State of Texas. Entities and individuals who want to divert and use surface water are required to hold a water right granted by the state to do so. Each right is based on a priority system as reflected by a date attached to each water right. The SJRA holds surface water rights granted by the State of Texas shown in Table 2-1 and Exhibit 2-4.

Table 2-1. SJRA Surface Water Rights

Location	Permitted Diversion (afpy)	Permitted Use	Priority
Lake Conroe	22,000	Municipal	1959, 1965
	9,500	Industrial	1959, 1965
	1,833	Mining	1959, 1965
Run-of-River at Lake Houston	55,000	Municipal, Industrial, Irrigation	1942
Run-of-River at CWA Pump Station on Trinity River	56,000	Multiple Use	1917 thru 1936
Run-of-River at CWA Pump Station on Trinity River	30,000	Multiple Use	1914, 2004
Reuse at Lake Houston from Wastewater Effluent from SJRA's three Woodlands WWTPs	14,944	Multiple Use	2004
Lake Houston	14,000	Multiple Use	2003
Run-of-River at Lake Houston (Pending)	40,000	Multiple Use	2003

In addition to data provided in the table, the water rights are also defined by diversion location, diversion rate, reliability, and other permit provisions. Some water rights in the Trinity River basin and San Jacinto River basin also contain environmental flow restrictions which may limit diversions under specified flow conditions in the respective rivers.

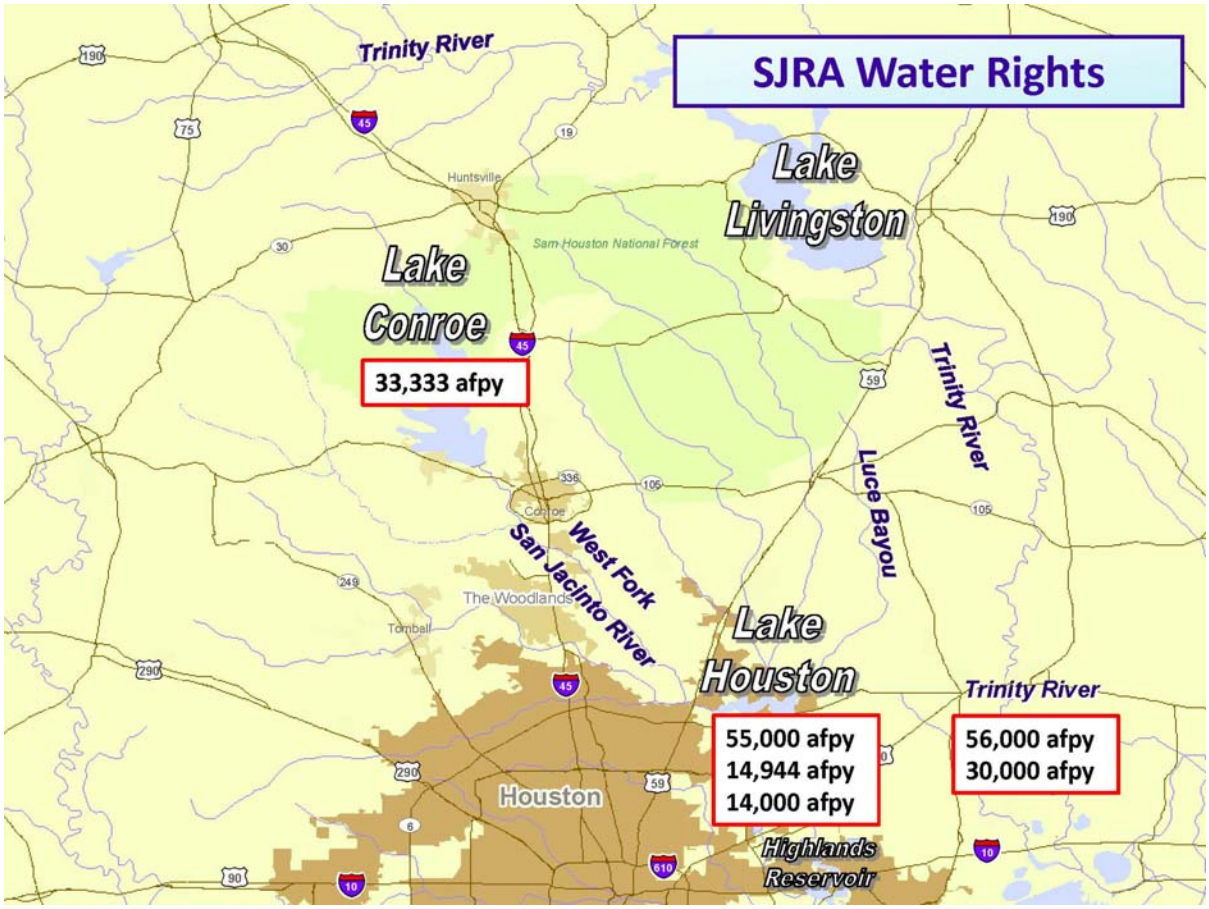

Exhibit 2-4. SJRA Existing Water Rights

2.5 Other Surface Water Sources

City of Houston

The City of Houston holds considerable water rights in the Trinity River Basin, including Lake Livingston, and the San Jacinto River basin, including Lake Houston. The City of Houston's water rights in Lake Conroe total 66,667 afpy and are shown in Table 2-2 below.

Table 2-2. City of Houston Water Rights in Lake Conroe

Permitted Diversion Amount (afpy)	Permitted Use	Priority
44,000	Municipal	1959, 1965
19,000	Industrial	1959, 1965
3,667	Mining	1959, 1965

Trinity River

Various entities hold water rights in the Trinity River, including the Trinity River Authority.

Brazos River

Various entities hold water rights in the Brazos River, including the Brazos River Authority.

2.6 Treated Surface Water

The North Harris County Regional Water Authority (NHCRWA) is located in Harris County immediately south of Montgomery County. The NHCRWA purchases treated surface water from the City of Houston which diverts the water from Lake Houston, treats it at the City's Northeast Water Purification Plant, and conveys it to NHCRWA through a pipeline. The NHCRWA is in the process of constructing a treated surface water transmission system within its boundaries as shown in Exhibit 2-5.

Exhibit 2-5. NHCRWA Surface Water Supply System

2.7 Treated Wastewater Effluent

As cheap, sustainable groundwater is limited and readily available surface water is expensive to treat and transmit, treated wastewater effluent becomes a viable source of water for some uses. Many public entities are permitted by the State of Texas to collect, treat and discharge

wastewater throughout Montgomery County. Effluent reuse is considered a water supply management strategy and will be addressed further in the SJRA Joint WRAP Part II.

2.8 Water Conservation

Water conservation is recognized as one of the most efficient methods to address future water supply issues. Simply reducing the overall water demand delays the need for the development of future water supplies. Water conservation is considered a demand management strategy and will be addressed further in the SJRA Joint WRAP Part II.

2.9 Drought Management

Management strategies implemented during periods of drought or other historically high water demand periods, reduces the peak demands thereby potentially reducing the amount of additional water supplies and size of water infrastructure required. Drought management is also considered a demand management strategy and will be considered further in the SJRA Joint WRAP Part II.

Section 3 Water Demands

3.1 Highlands

The SJRA currently provides raw surface water to various customers in the Highlands. Some of these customers have depended on and paid for this reliable water supply since the 1940s. The water is primarily used for industrial purposes with relatively minor amounts for irrigation and municipal purposes. The projected surface water demands for the Highlands is approximately 80,000 afpy as shown in Exhibit 3-1.

3.2 Montgomery County

Based on data provided by the Texas Water Development Board and utilized in the development of the 2006 Region H Plan and the 2007 State Water Plan, projected water demands for Montgomery County are as shown in Table 3-1.

Table 3-1. Water Demand

Year	Demand (afpy)
2015	90,000
2025	114,000
2035	137,000
2045	165,000
2055	201,000
2060	220,000

The LSGCD DRP Phase II (A) requires the development of a Water Resources Assessment Plan (WRAP) through the planning period ending 2045. The SJRA chose to initially review water supply requirements to 2060. This coincides with statewide water planning efforts coordinated by the Texas Water Development Board.

Planning out this far into the future also forces the identification of potential water supplies in addition to Lake Conroe. The total surface water demand for Montgomery County is projected to be approximately 165,000 afpy in 2045. Since the combined sustainable groundwater available is 64,000 afpy and the permitted yield of Lake Conroe is 100,000 afpy, additional water supplies will be required to meet the needs beyond 2045. The projected surface water demands for Montgomery County are shown on Exhibit 3-1. Identifying water supplies to meet Montgomery County water demands greater than those

available from Lake Conroe and the aquifers provides a different perspective for long range planning.

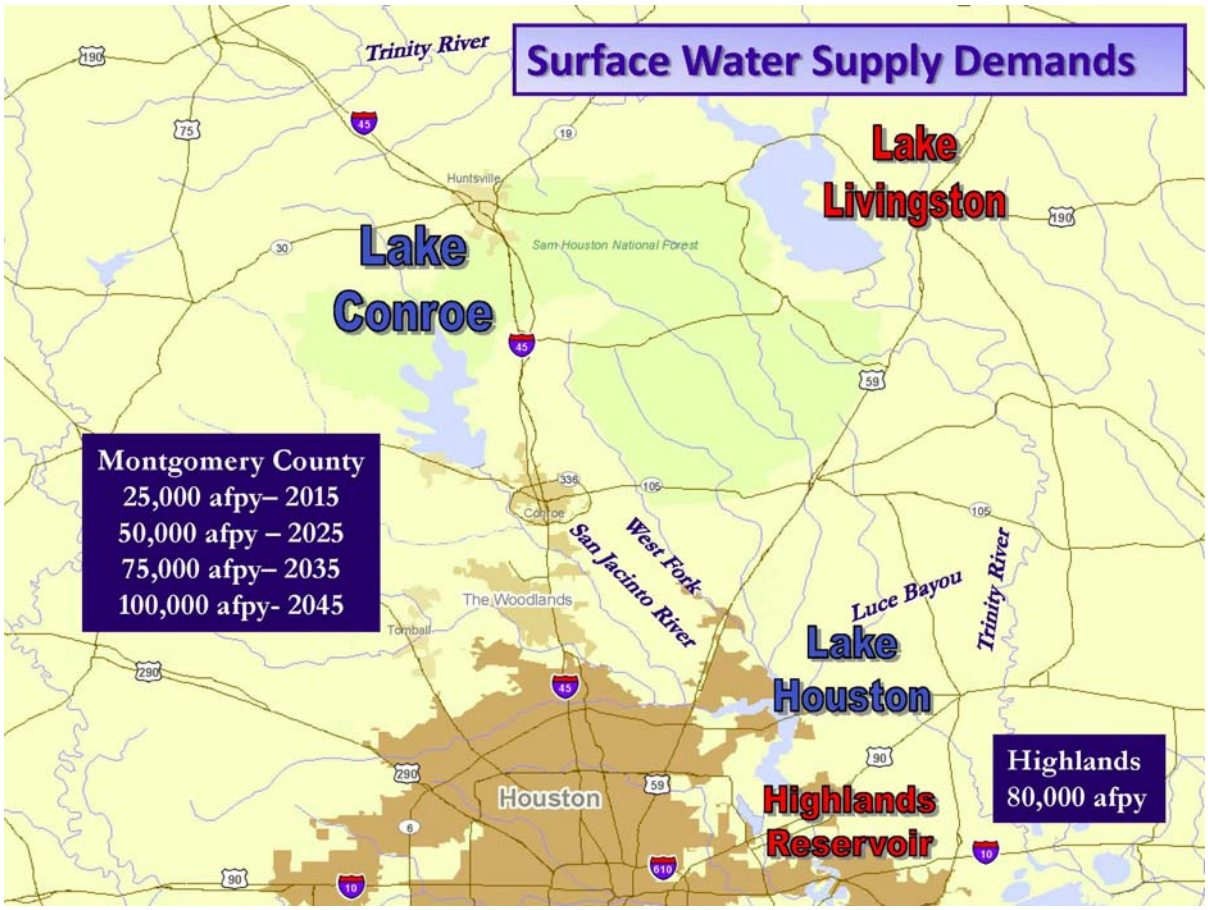

Exhibit 3-1. Surface Water Supply Demands

Section 4 Alternatives

4.1 Water Rights Trade

The SJRA initiated and has pursued a potential water rights trade with the City of Houston for several years. The discussions included various scenarios offered by the SJRA including the following:

- trade SJRA's surface water rights in the Trinity River for the City's surface water rights in Lake Conroe (Exhibit 4-1)
- trade SJRA's surface water rights in the San Jacinto River Basin (including Lake Houston) for the City's surface water rights in Lake Conroe (Exhibit 4-2)

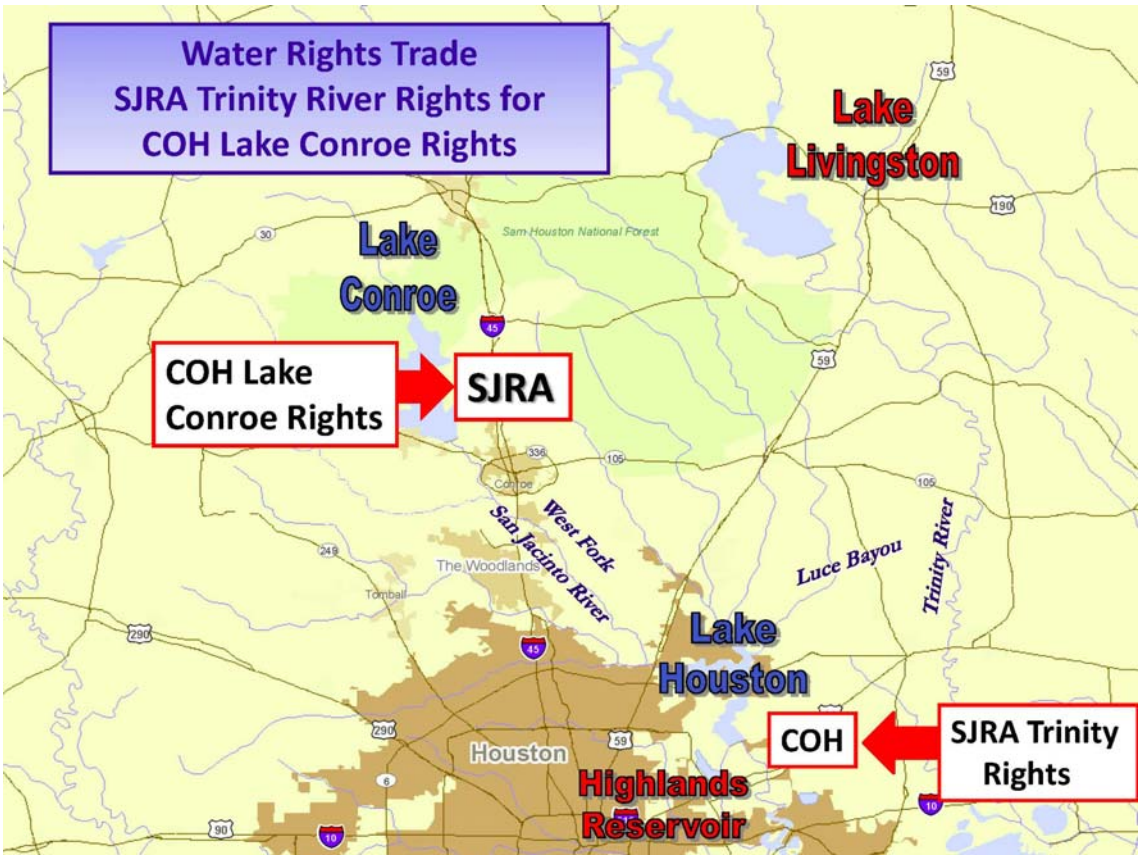

Exhibit 4-1. SJRA Trinity Rights for COH Lake Conroe Rights

Currently the SJRA serves its Highlands customers with surface water in Lake Houston and the Trinity River. Therefore a trade of a portion of these rights would require a reapportionment of surface water to assure the water demands of these long-term customers are met. A significant investment in infrastructure would be required to meet the reapportionment of surface water.

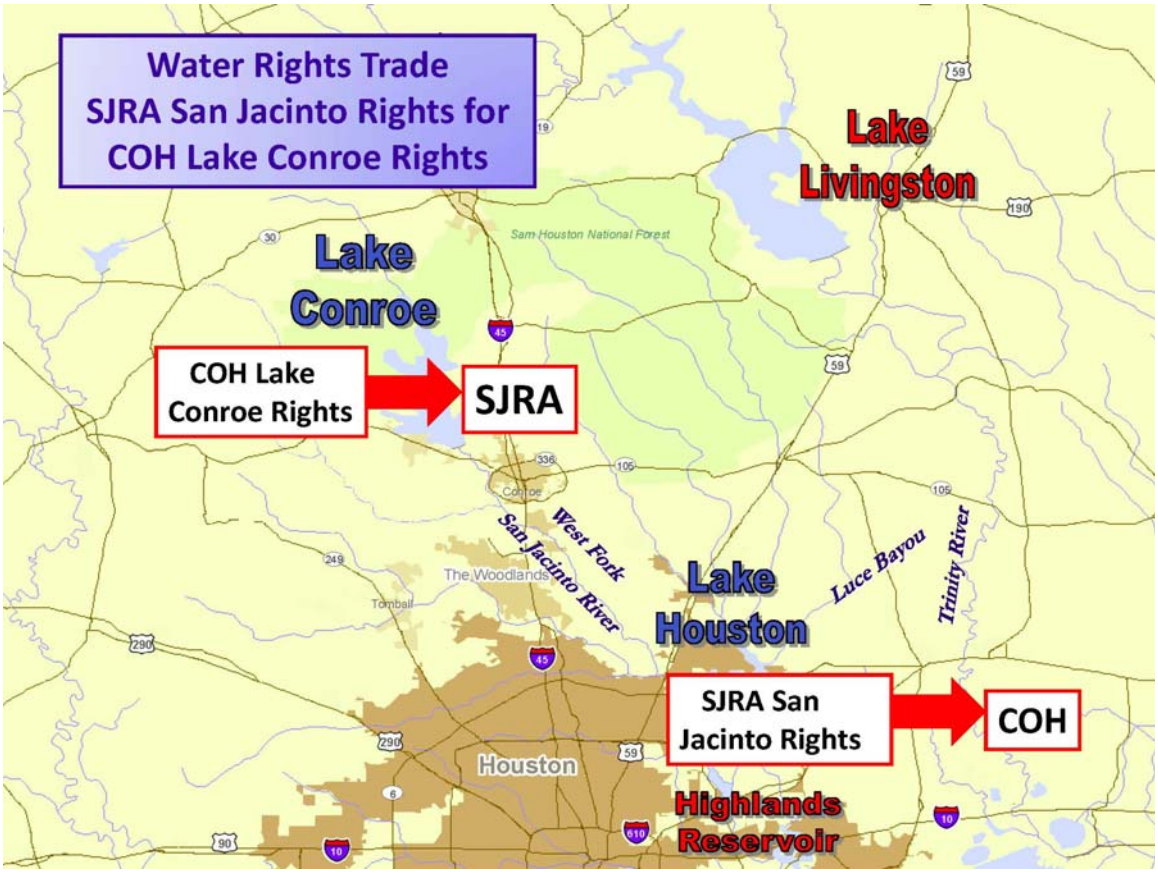

Exhibit 4-2. SJRA San Jacinto Rights for COH Lake Conroe Rights

Each surface water right is defined by limits and restrictions placed in the permit such as the following:

- diversion location, amount and rate
- type of use
- priority
- environmental flow restrictions

For each potential combination of surface water rights included in a potential trade, each component of the trade was evaluated based on the criteria noted above, along with the impact on the SJRA's ability to continue to meet its current customer needs. Results from Water Availability Models (WAMs) -- including reliability analysis, consideration for conveyance losses, and infrastructure required in the Highlands to convey alternative sources of water to existing customers -- were also included in the analysis of each combination.

After considerable effort directed toward this effort, including numerous meetings and proposals, *the City of Houston ultimately informed the SJRA that it was not interested in furthering discussions regarding a water rights trade and this alternative was eliminated from further review.*

4.2 Water Rights Purchase

The SJRA has discussed an outright purchase of the City of Houston's surface water rights in Lake Conroe as shown in Exhibit 4-3. A purchase of this size is not common in the state of Texas and therefore there is no market pricing available. Instead, the value of a surface water right is strictly limited to a common value placed on it by a willing seller and a willing buyer. The sale would require the SJRA to issue a bond to purchase the water rights.

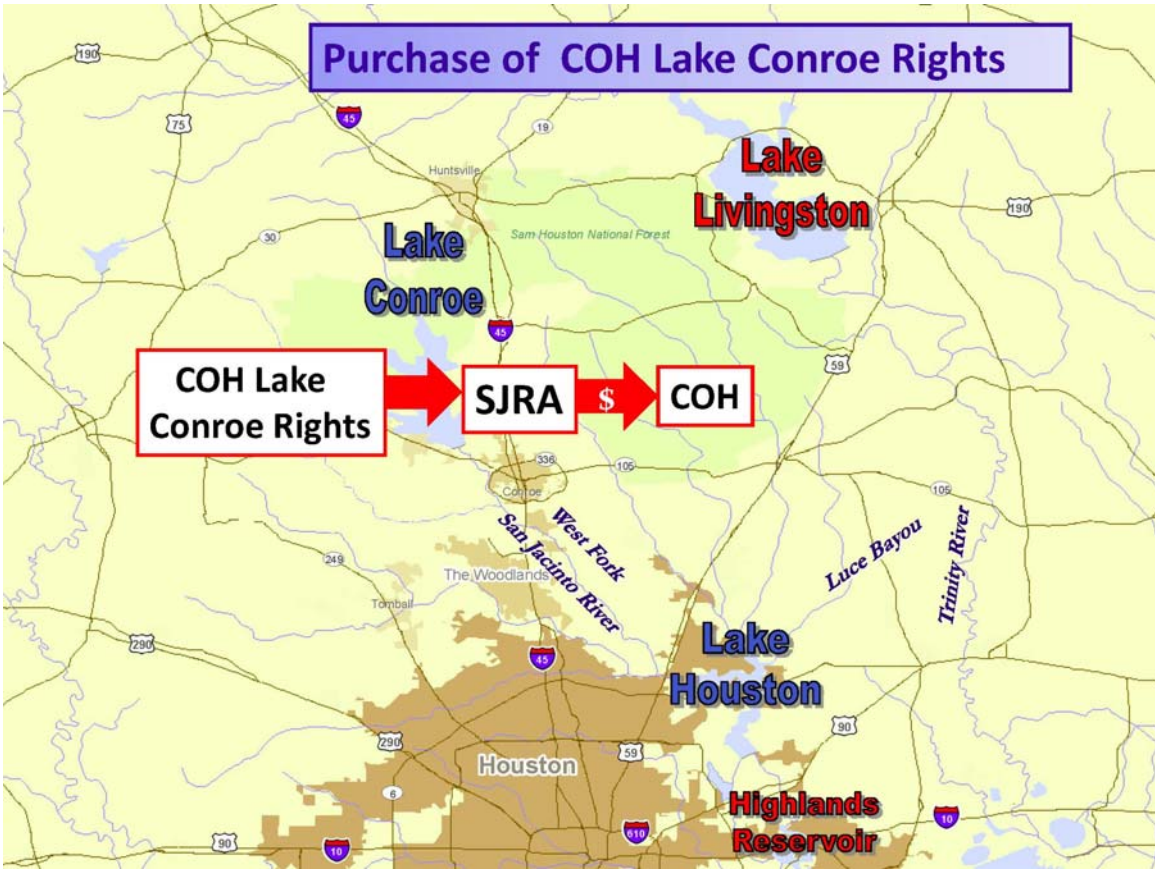

Exhibit 4-3. Purchase of COH Lake Conroe Rights

The City of Houston initially considered the idea; however it *ultimately informed the SJRA that it was not interested in further discussions regarding a sale of its water rights*. Therefore this alternative was eliminated from further review.

4.3 Participation in Luce Bayou

The City of Houston is participating in an agreement with the North Harris County Regional Water Authority (NHCRWA), West Harris County Regional Water Authority (WHCRWA), North Fort Bend Water Authority (NFBWA) and Central Harris County Regional Water Authority (CHCRWA) to construct the Luce Bayou Interbasin Transfer Project which would

convey raw surface water from the Trinity River near Capers Ridge to Lake Houston. The raw water will ultimately be diverted from Lake Houston and treated at the City of Houston Northeast Water Purification Plant and the East Water Purification Plant. The Coastal Water Authority (CWA) is responsible for implementing the project with a target completion date of 2020.

Participation in the Luce Bayou Interbasin Transfer Project was offered by the City of Houston as a method for the SJRA to utilize the City of Houston's surface water in Lake Conroe as represented in Exhibit 4-4. Participation would require a substantial initial payment to the City of Houston plus monthly payments as surface water is diverted. The City of Houston would retain ownership of the surface water rights.

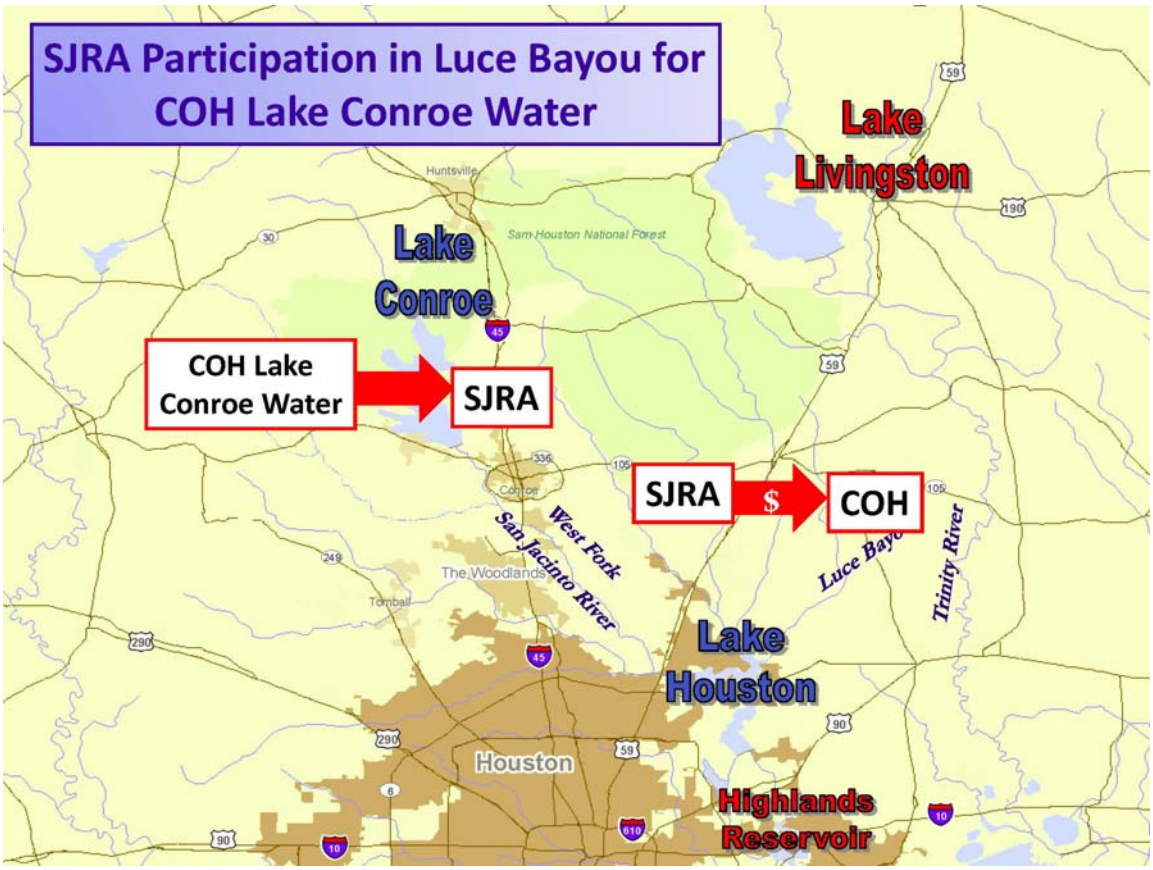

Exhibit 4-4. Participation in Luce Bayou For COH Lake Conroe Water

The SJRA evaluated the contractual arrangement and financial conditions of participation in the Luce Bayou Interbasin Transfer Project. *After review, the SJRA determined participation was not fiscally prudent and this alternative was eliminated from further review.*

4.4 North Harris County Regional Water Authority Long-Term Water Contract

The surface water supply pipeline from the Northeast Water Purification Plant to portions of northwest Harris County constructed by the City of Houston with participation by the NHCRWA contains approximately 10 MGD of additional capacity that has not been allocated. Potentially this surface water could be transmitted through the existing NHCRWA surface water supply system to southern Montgomery County as represented in Exhibit 4-5. The existing pipeline does not have adequate capacity to meet the entire needs of Montgomery County, therefore participation in additional treatment and transmission capacity with the NHCRWA and/or City of Houston would be required. In addition, a water transmission system would be required from the NHCRWA system to Montgomery County. *The anticipated cost of the water at the NHCRWA system delivery point plus the costs to convey to Montgomery County were not considered to be cost-effective and therefore this alternative was eliminated from further study.*

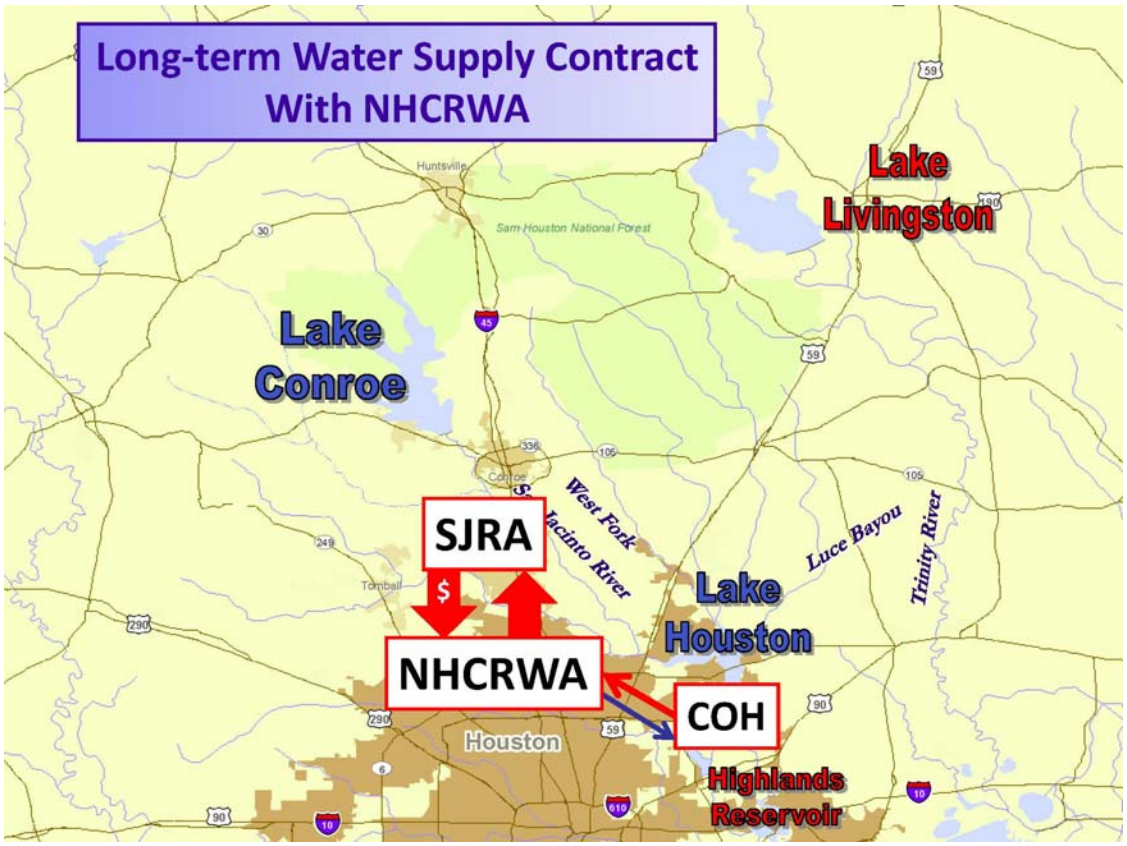

Exhibit 4-5. Long-Term Water Supply Contract with NHCRWA

4.5 City of Houston Long-Term Water Supply Contract

After the City of Houston indicated it was no longer interested in further discussions of either a water rights trade or sale, the SJRA initiated discussions regarding a long-term water

supply contract with the City of Houston to supplement the surface water in Lake Conroe currently owned by the SJRA as represented in Exhibit 4-6. The contract would include terms by which the SJRA would reserve and purchase surface water in Lake Conroe from the City's portion of water in the lake. The City of Houston would retain its surface water rights in Lake Conroe.

Typically long-term raw water supply contracts include a provision termed a "reservation fee" or a "ready to serve fee". The seller of the water places the amount of water desired by the purchaser in reserve. Once the purchaser begins use of the water, it must pay an agreed-upon volumetric rate for the water used. The reservation assures the purchaser that the seller will not sell the reserved water to any other entity. The purchaser usually pays a "reservation fee" or "ready to serve fee" for this provision. Once the contract is executed, the purchaser begins paying the reservation fee. *This alternative remains viable and since negotiations with the City of Houston remain ongoing, potential terms of such a contract are not presented.*

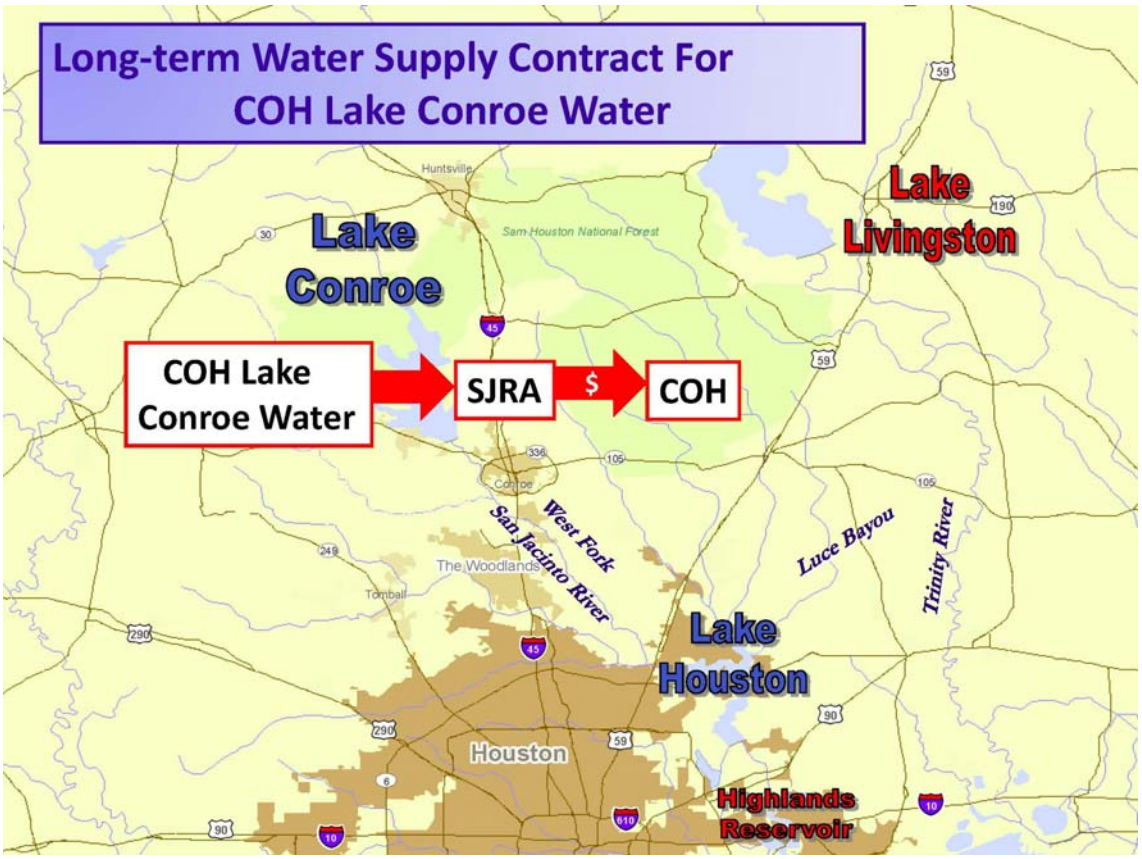

Exhibit 4-6. Long-Term Water Supply Contract for COH Lake Conroe Water

4.6 Trinity River Authority Long-Term Water Supply Contract

The SJRA has also discussed a long-term water contract with the Trinity River Authority (TRA) to purchase water from the TRA on a long-term contract basis to supplement the surface water in Lake Conroe currently owned by the SJRA. The TRA proposes to divert surface water from the Trinity River at the same diversion point used to supply raw surface water to the water treatment plant serving the City of Huntsville. A raw water transmission system would be required to convey the water from this discharge point to the upper reaches of Lake Conroe.

Preliminary planning included identification of potential delivery points at Lake Conroe, alternative corridors, potential transmission line sizing, environmental issues and project costs.

Exhibit 4-7. Long-Term Water Supply Contract for TRA Water

Discussions were conducted and remain open with the Trinity River Authority regarding potential contractual requirements for a long-term water contract including amount of surface water available, reservation fees, contract water rates and other requirements.

4.7 City of Houston Long-Term Water Supply Contract and Trinity River Authority Long-Term Replacement Water Supply Contract

Some residents, primarily owners of property adjacent to or very near Lake Conroe, have raised a concern about varying lake levels due to diversions of surface water from the lake. Therefore a combination of the two previously identified alternatives was considered to supplement the volume of surface water in Lake Conroe currently owned by the SJRA. This alternative included a long-term water supply contract with the City of Houston to purchase water in Lake Conroe, and a long-term water contract with the Trinity River Authority to purchase "replacement" water in the Trinity River. The concept would include conveying water from the Trinity River via the Huntsville transmission system described above solely to replace water diverted from Lake Conroe that is either water currently held by the SJRA and/or water purchased from the City of Houston.

Under this approach lake level would not vary due to diversions to meet the demands within Montgomery County, but would fluctuate as it does now with varying rainfall, required releases, watershed drainage, seepage, evaporation, etc.

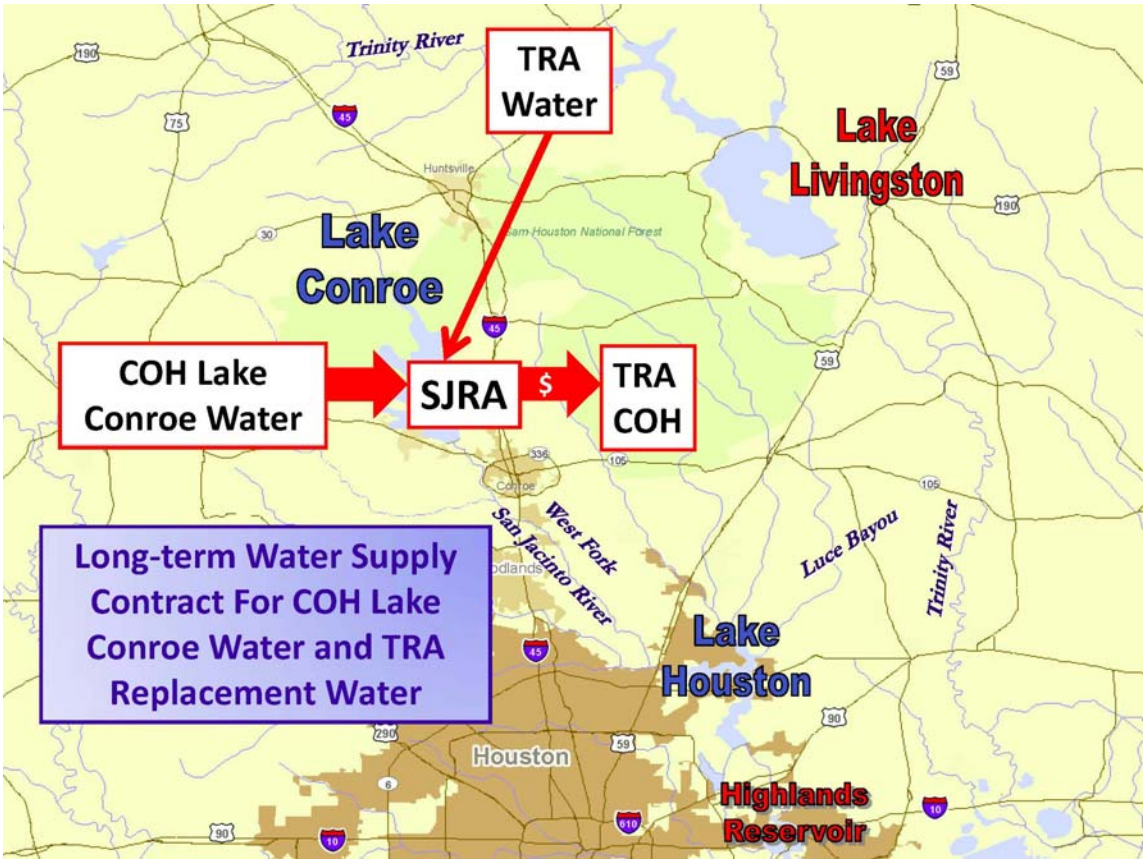

Exhibit 4-8. Long-Term Water Supply Contract for COH Lake Conroe Water and TRA Replacement Water

This alternative offers the same challenges contained with the two previous alternatives in addition to the following. Typically water supply reservoirs are developed for supplying water for municipal, industrial and agricultural needs thus resulting in varying water levels. *Importing water from another river basin solely to reduce the impact on reservoir levels is unusual and does not comply with the current 2007 State Water Plan.*

However, as previously noted, at some point in the future all of the available water in Lake Conroe will be allocated and additional water will be required to meet water demands greater than the aquifer and Lake Conroe can meet. At that time additional surface water will be required and this alternative could be reconsidered to increase the yield of Lake Conroe to meet the larger water demands, but not as "replacement" water to reduce impacts of varying water levels.

4.8 Imported Groundwater from Burleson County

The SJRA has discussed importing groundwater from Burleson County with a private water purveyor. The plan reviewed included importation of groundwater with a potential delivery system from west of Montgomery County generally parallel to Highway 105 to Conroe and generally from Dobbin to the west side of The Woodlands. Discussions included the amount of groundwater available, contract water rates and other requirements. *Due to the projected cost and potential regulatory issues related to exportation of groundwater this alternative was eliminated from further consideration for the WRAP.*

4.9 Bedias Reservoir

The SJRA reviewed the potential to develop additional water supplies at Bedias Reservoir in Madison County. An analysis of the Bedias Reservoir was included in the 2001 Region H Water Plan. *Due to the projected cost, time, property rights, and environmental issues to overcome, this alternative was eliminated from further consideration for the WRAP.*

4.10 SJRA Trinity River Water Rights

The diversion point of SJRA's water rights in the Trinity River is located in Liberty County. The water would be conveyed to Montgomery County via Luce Bayou or another large conveyance system.

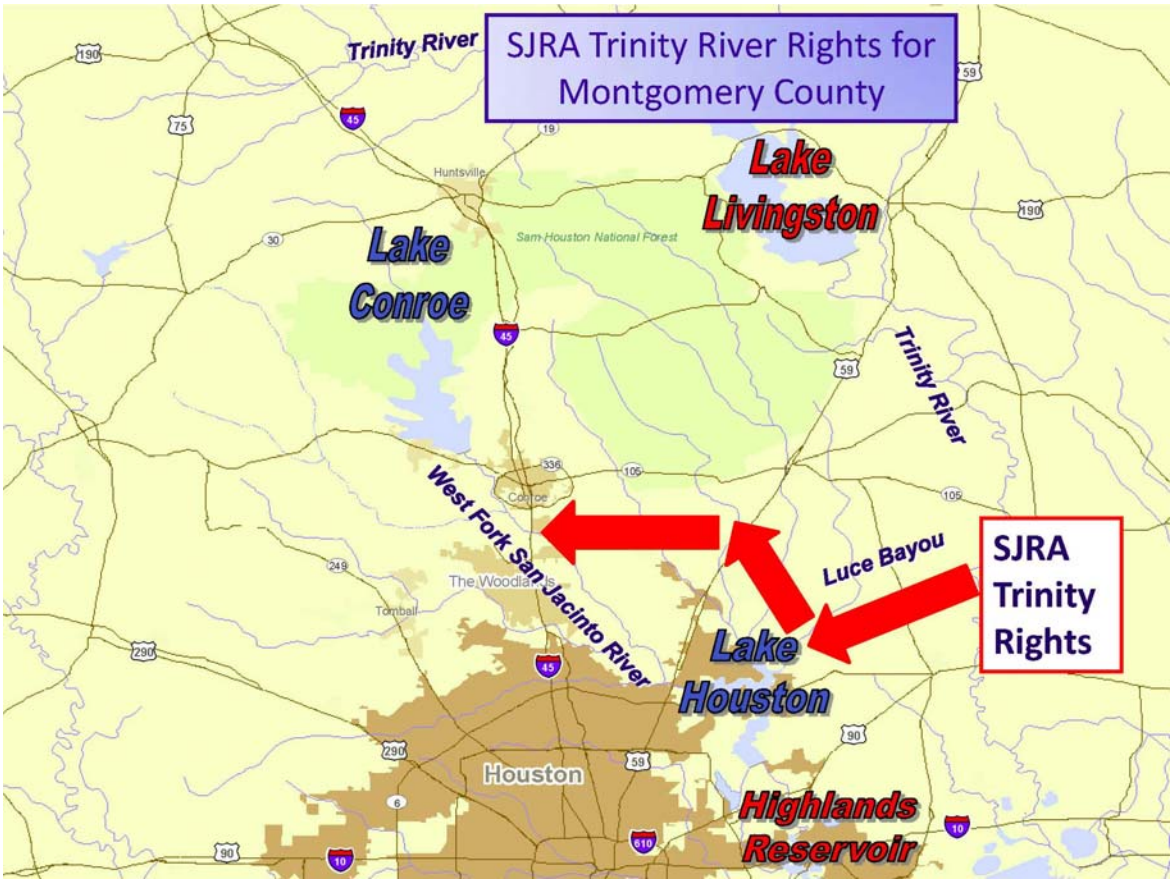

Exhibit 4-9. SJRA Trinity River Water Rights

Section 5 Evaluation of Alternatives

5.1 Comparison of Alternatives Countywide

A quantitative evaluation of water supply alternatives requires the identification of preliminary conveyance, treatment, storage, pumping and transmission system for which costs can be identified. Assumptions are required for the following:

- Diversion locations
- Treatment process and location
- Finished water storage location and size
- Finished water pumping location and size
- Pipeline routes and sizes
- Utility Conflict Resolution
- Surface Disruption Mitigation
- Environmental Mitigation
- Land/Easement Acquisition
- Inflation
- Bond Term and Interest Rate
- Initial $21.5M in Planning Costs via TWDB WIF Differed Funds
- Planning Costs Financing Method

Preliminary infrastructure location used for the purpose of this study was identified as shown in Exhibit 5-1. Many of these assumptions will change as the program develops. Since these preliminary routes were identified over a year ago, numerous issues identified in the WRAP will impact the route locations. Since the routes shown in Exhibit 5-1 were used in the evaluation of all alternatives, any changes to these routes will not impact the ranking/rating of one alternative against another. Various alternatives were analyzed and evaluated in further detail.

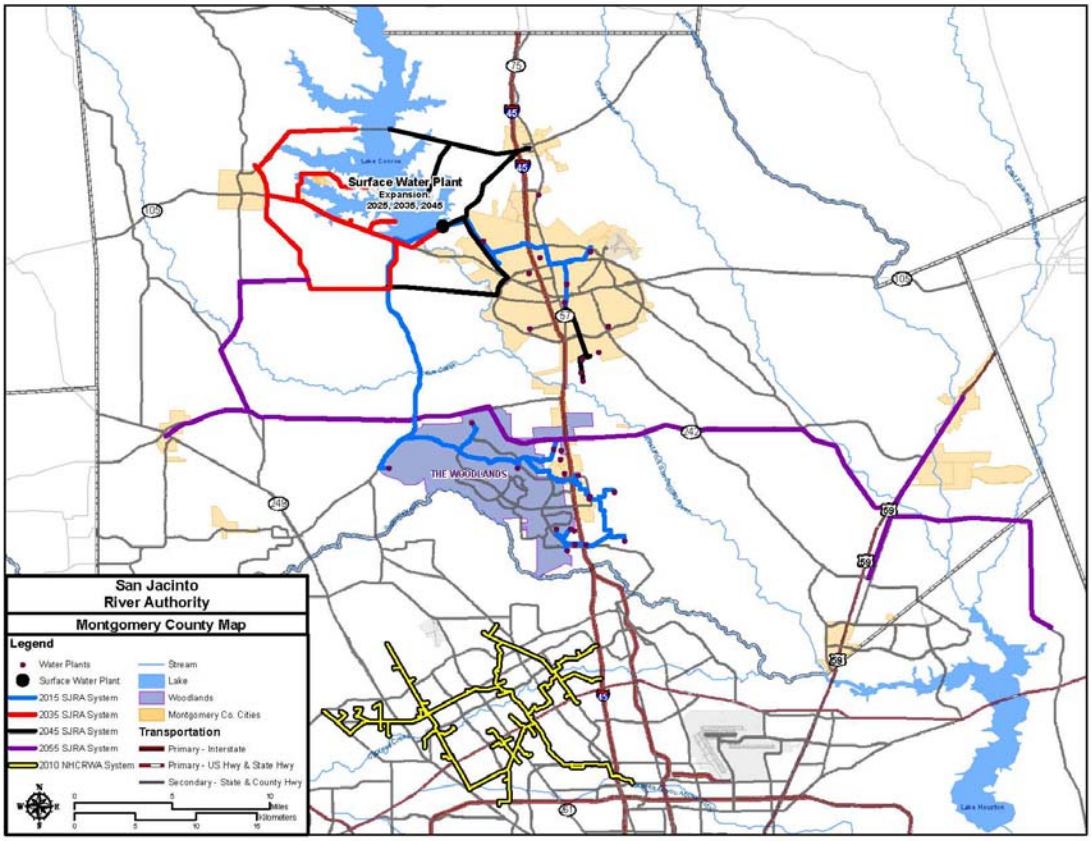

Exhibit 5-1. Preliminary Routes

5.2 SJRA Lake Conroe Water Plus City of Houston Long-Term Water Supply Contract

This alternative includes the following:

- **Prior to 2015** – SJRA executes a long-term raw water supply contract with City of Houston and begins payment of a reservation fee. Initiate and complete planning, environmental permitting, design, land/easement acquisition and construction of raw water intake; surface water treatment plant; and finished water storage, pumping and transmission system.

- **2015** – Divert surface water from Lake Conroe using water rights owned by the SJRA, treat the water at a surface water plant located at Lake Conroe and transmit the treated surface water to the high water demand areas including the City of Conroe and The Woodlands.

- **Prior to each Subsequent Phase** – Initiate and complete planning, environmental permitting, design, land/easement acquisition for required facilities.

- **2025** – Divert surface water from Lake Conroe using remaining water rights owned by the SJRA and begin diversion of City of Houston's water from Lake Conroe, treat the water at the surface water plant located at Lake Conroe and transmit the treated surface water via the transmission system.

- **2035** – Divert surface water from Lake Conroe using water rights owned by the SJRA and City of Houston water, treat the water at the surface water plant located at Lake Conroe and transmit the treated surface water through an expanded transmission system.

- **2045** – Divert surface water from Lake Conroe using water rights owned by the SJRA and City of Houston, treat the water at the surface water plant located at Lake Conroe and transmit the treated surface water through an expanded transmission system.

- **2055** – Utilize system described for 2045 plus divert water from Trinity River in Liberty County using water rights owned by the SJRA; convey raw water to far southeastern Montgomery County; treat the water at a surface water plant located in far southeastern Montgomery County; and transmit the treated surface water through a transmission system to Montgomery County.

5.3 SJRA Lake Conroe Water Plus TRA Long-Term Water Supply Contract

This alternative includes the following:

- **Prior to 2015** – SJRA executes a long-term raw water supply contract with the Trinity River Authority and begins payment of a reservation fee. Initiate and complete planning, environmental permitting, design, land/easement acquisition and construction of raw water intake; surface water treatment plant; and finished water storage, pumping and transmission system.

- **2015** – Divert surface water from Lake Conroe using water rights owned by the SJRA, treat the water at a surface water plant located at Lake Conroe and transmit the treated surface water to the high water demand areas including the City of Conroe and The Woodlands.

- **Prior to 2025** – Initiate and complete planning, environmental permitting, design, land/easement acquisition and construction of: raw water intake in the Trinity River; pump station at the Trinity River north of Huntsville; and a transmission line to the upper end of Lake Conroe as shown in Exhibit 5-2.

- **2025** – Divert surface water from Lake Conroe using remaining water rights owned by the SJRA and begin diversion of Trinity River Authority's water from the Trinity River to Lake Conroe, treat the water at the surface water plant located at Lake Conroe and transmit the treated surface water via the transmission system.

- **Prior to each Subsequent Phase** – Initiate and complete planning, environmental permitting, design, land/easement acquisition for required facilities.

- **2035** – Divert surface water from Lake Conroe using water rights owned by the SJRA and Trinity River Authority's water from the Trinity River to Lake Conroe; treat the water at the surface water plant located at Lake Conroe; and transmit the treated surface water through an expanded transmission system.

- **2045** – Divert surface water from Lake Conroe using water rights owned by the SJRA and Trinity River Authority water in the Trinity River to Lake Conroe, treat the water at the surface water plant located at Lake Conroe and transmit the treated surface water through an expanded transmission system.

- **2055** – Utilize system described for 2045 *plus* divert water from Trinity River in Liberty County using water rights owned by the SJRA; convey raw water to far southeastern Montgomery County; treat the water at a surface water plant located in far southeastern Montgomery County; and transmit the treated surface water through a transmission system to Montgomery County.

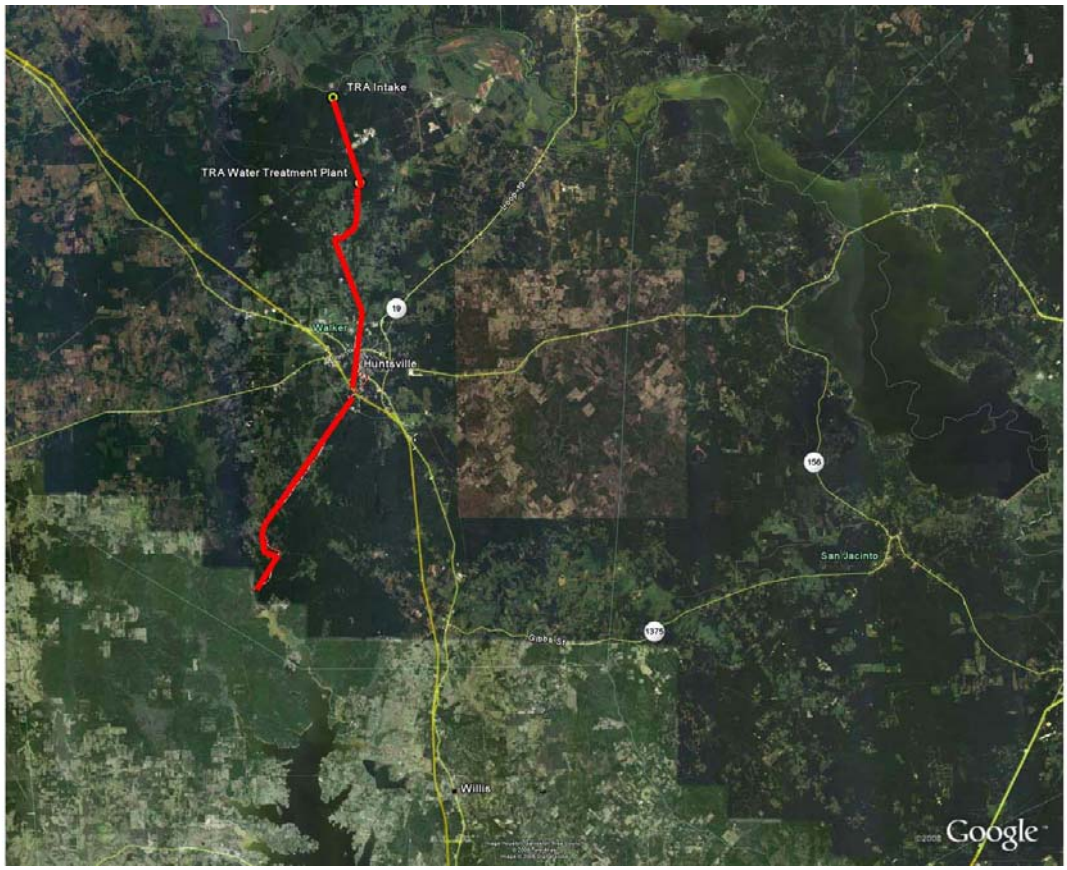

Exhibit 5 – 2. Preliminary TRA Transfer Route

5.4 SJRA Lake Conroe Water Plus City of Houston Long-Term Water Supply Contract and Trinity River Long-Term Replacement Water Supply Contract

This alternative includes the following:

- **Prior to 2015** – SJRA executes a long-term raw water supply contract with City of Houston and begins payment of a reservation fee and executes a long-term raw water supply contract with the Trinity River Authority and begins payment of a reservation fee. Initiate and complete planning, environmental permitting, design, land/easement acquisition and construction of raw water intake; surface water treatment plant; and finished water storage, pumping and transmission system.

- **2015** – Divert surface water from Lake Conroe using water rights owned by the SJRA, treat the water at a surface water plant located at Lake Conroe and transmit the treated surface water to the high water demand areas including the City of Conroe and The Woodlands.

- **Prior to 2025** – Initiate and complete planning, environmental permitting, design, land/easement acquisition and construction of raw water intake in the Trinity River, pump station at the Trinity River north of Huntsville, and transmission line to the upper end of Lake Conroe.

- **2025** – Divert surface water from Lake Conroe using remaining water rights owned by the SJRA and begin diversion of City of Houston's water from Lake Conroe; treat the water at the surface water plant located at Lake Conroe; and transmit the treated surface water via the transmission system. Begin diversion of Trinity River Authority's water from the Trinity River to Lake Conroe to replace water diverted from Lake Conroe to meet the needs of Montgomery County.

- **Prior to each Subsequent Phase** – Initiate and complete planning, environmental permitting, design, land/easement acquisition for required facilities.

- **2035** – Divert surface water from Lake Conroe using water rights owned by the SJRA and City of Houston water in Lake Conroe; treat the water at the surface water plant located at Lake Conroe; and transmit the treated surface water through an expanded transmission system. Divert Trinity River Authority's water from the Trinity River to Lake Conroe to replace water diverted from Lake Conroe to meet the needs of Montgomery County.

- **2045** – Divert surface water from Lake Conroe using water rights owned by the SJRA and City of Houston water in Lake Conroe, treat the water at the surface water plant located at Lake Conroe and transmit the treated surface water through an expanded transmission system. Divert Trinity River Authority's water from the Trinity River to Lake Conroe to replace water diverted from Lake Conroe to meet the needs of Montgomery County.

- **2055** – Utilize system described for 2045 *plus* divert water from Trinity River in Liberty County using water rights owned by the SJRA; convey raw water to far southeastern Montgomery County; treat the water at a surface water plant located in far southeastern Montgomery County; and transmit the treated surface water through a transmission system to Montgomery County.

5.5 Imported Groundwater

This alternative includes the following:

- **Prior to 2015** – SJRA executes a long-term raw water supply contract with purveyor of groundwater and begins payment of a reservation fee. Initiate and complete planning, environmental permitting, design, land/easement acquisition and construction of finished water storage, pumping and transmission system.

- **2015** – Accept delivery of groundwater from purveyor and transmit the treated water to the high water demand areas including the City of Conroe and The Woodlands.

- **Prior to each Subsequent Phase** – Initiate and complete planning, environmental permitting, design, land/easement acquisition for required facilities.

- **2025** – Accept delivery of additional groundwater from purveyor and transmit the treated water via the transmission system.

- **2035** – Accept delivery of additional groundwater from purveyor and transmit the treated water through an expanded transmission system.

- **2045** – Accept delivery of additional groundwater from purveyor and transmit the treated water through an expanded transmission system.

- **2055** – Utilize system described for 2045 *plus* divert water from Trinity River in Liberty County using water rights owned by the SJRA; convey raw water to far southeastern Montgomery County; treat the water at a surface water plant located in far southeastern Montgomery County; and transmit the treated surface water through a transmission system to Montgomery County.

5.6 Cost Analysis

Costs (both future value and 2008 dollars) and present worth value for implementation of the four alternatives evaluated are shown in Table 5-1.

Table 5-1. Implementation Costs

	Current SJRA Conroe Rights (Beginning 2015) + Contract COH Water In Conroe (Beginning 2025)+ SJRA's Trinity River Rights Via Luce Bayou (2055)	Current SJRA Conroe Rights (Beginning 2015) + Contract TRA Water From Trinty U/S of Livingston (Beginning 2025) + SJRA's Trinity River Rights Via Luce Bayou (2055)	Current SJRA Conroe Rights (Beginning 2015) + Contract COH Water In Lake Conroe and TRA Water From Trinty U/S of Livingston (Beginning 2025) + SJRA's Trinity River Rights Via Luce Bayou (2055)	Contract Imported Groundwater (Beginning 2015) + Current SJRA Conroe Rights (Beginning 2045) + SJRA's Trinity River Rights Via Luce Bayou (2055)
	Capital Costs (2008 Dollars)	Capital Costs (2008 Dollars)	Capital Costs (2008 Dollars)	Capital Costs (2008 Dollars)
Phase				
2009-2014 Planning	$100,088,000	$100,088,000	$100,088,000	$80,510,000
2015	$313,002,000	$313,002,000	$313,002,000	$246,547,000
2025	$63,690,900	$321,172,950	$346,192,350	$68,652,150
2035	$252,913,500	$252,913,500	$252,913,500	$269,415,300
2045	$154,747,950	$154,747,950	$154,747,950	$209,321,700
2055	$594,922,650	$594,922,650	$594,922,650	$594,922,650
Total	$1,479,365,000	$1,736,847,050	$1,761,866,450	$1,469,368,800
	Capital Costs (Dollars in Year Constructed)	Capital Costs (Dollars in Year Constructed)	Capital Costs (Dollars in Year Constructed)	Capital Costs (Dollars in Year Constructed)
Phase				
2009-2014 Planning	$110,347,000	$110,347,000	$110,347,000	$88,762,000
2015	$399,479,000	$399,479,000	$399,479,000	$314,664,000
2025	$132,409,000	$667,696,000	$719,709,000	$142,723,000
2035	$856,455,000	$856,455,000	$856,455,000	$912,336,000
2045	$853,592,000	$853,592,000	$853,592,000	$1,154,622,000
2055	$5,345,385,000	$5,345,385,000	$5,345,385,000	$5,345,385,000
	Present Worth Value (2015 thru 2060) (2008 Dollars)	Present Worth Value (2015 thru 2060) (2008 Dollars)	Present Worth Value (2015 thru 2060) (2008 Dollars)	Present Worth Value (2015 thru 2060) (2007 Dollars)
	$2,996,691,827	$3,461,237,563	$3,900,374,038	$5,481,265,502

Unit cost comparisons are shown graphically in Exhibits 5-3 thru 5-6.

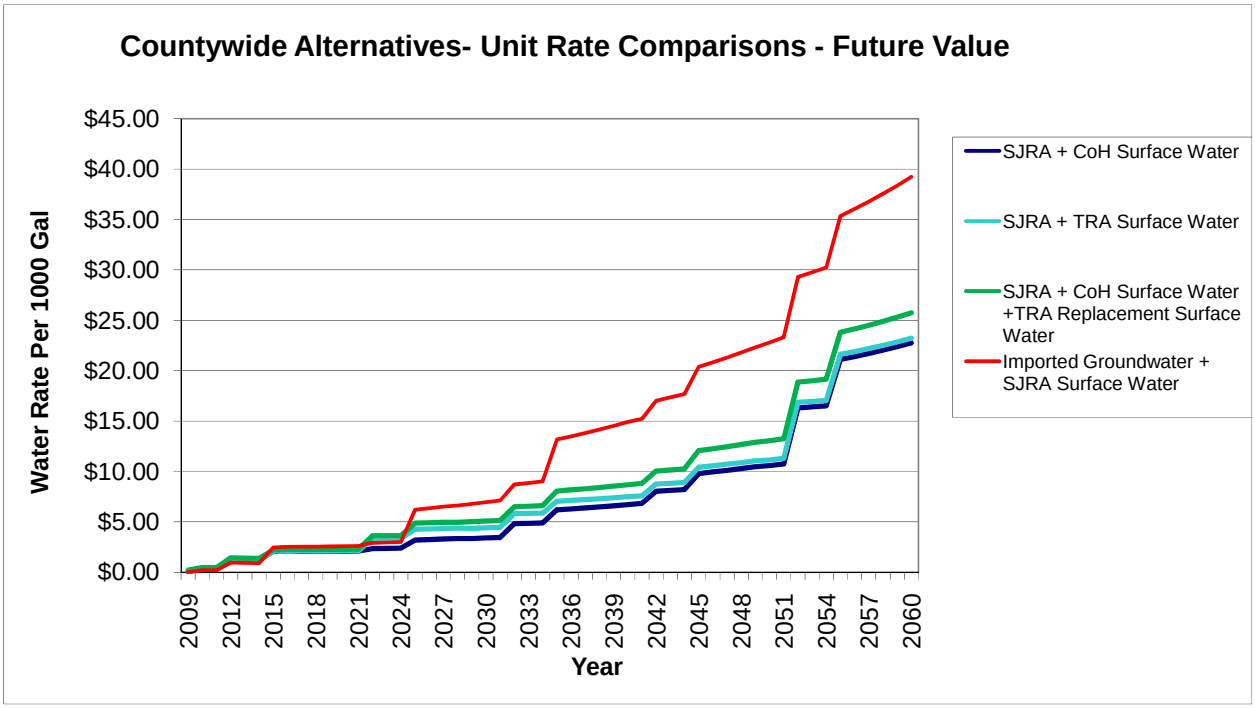

Exhibit 5-3. Comparison of Unit Costs thru 2060 (Future Value)

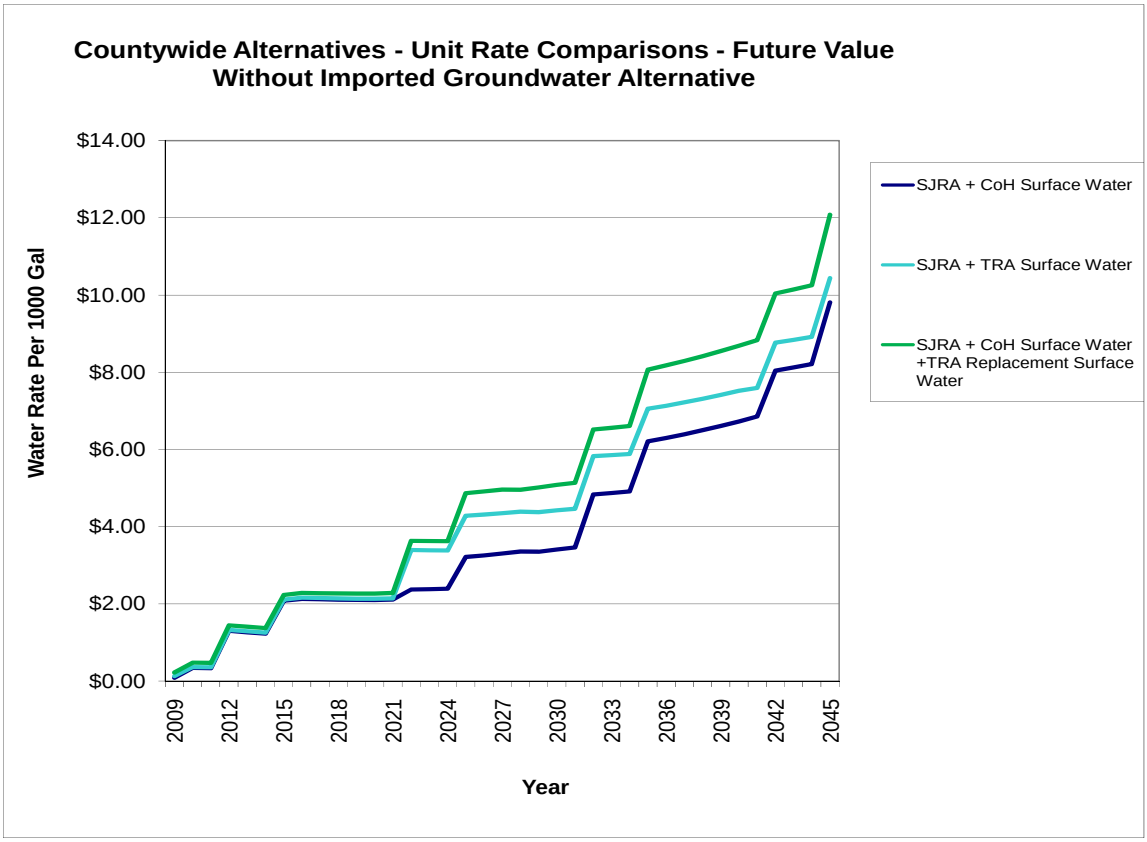

Exhibit 5-4. Comparison of Unit Costs thru 2045 (Future Value)

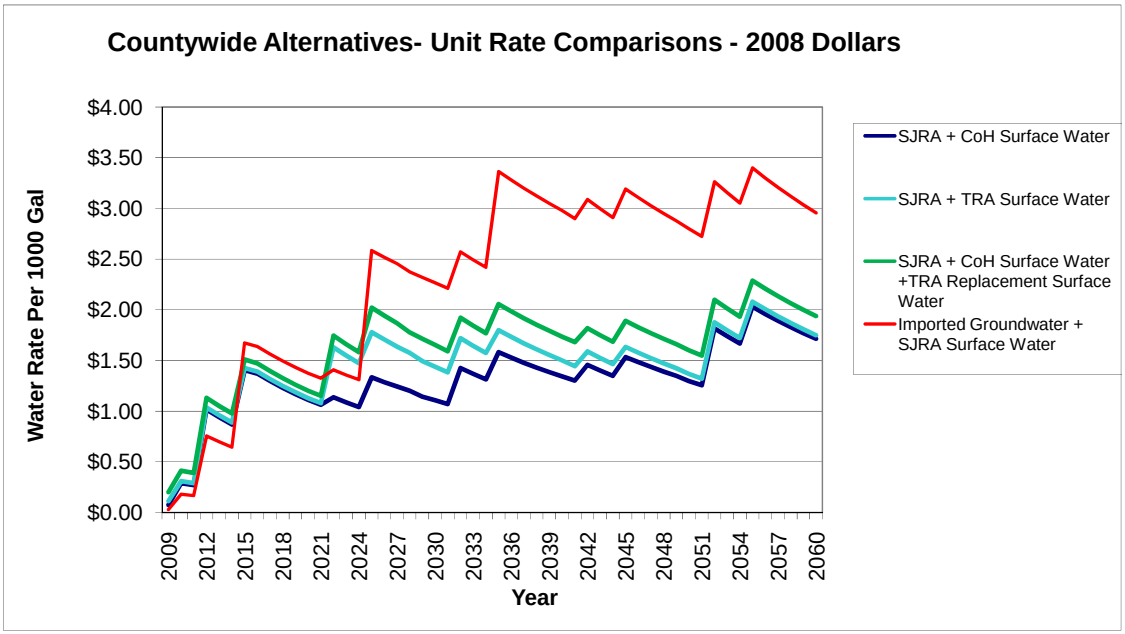

Exhibit 5-5. Comparison of Unit Costs thru 2060 (2008 Dollars)

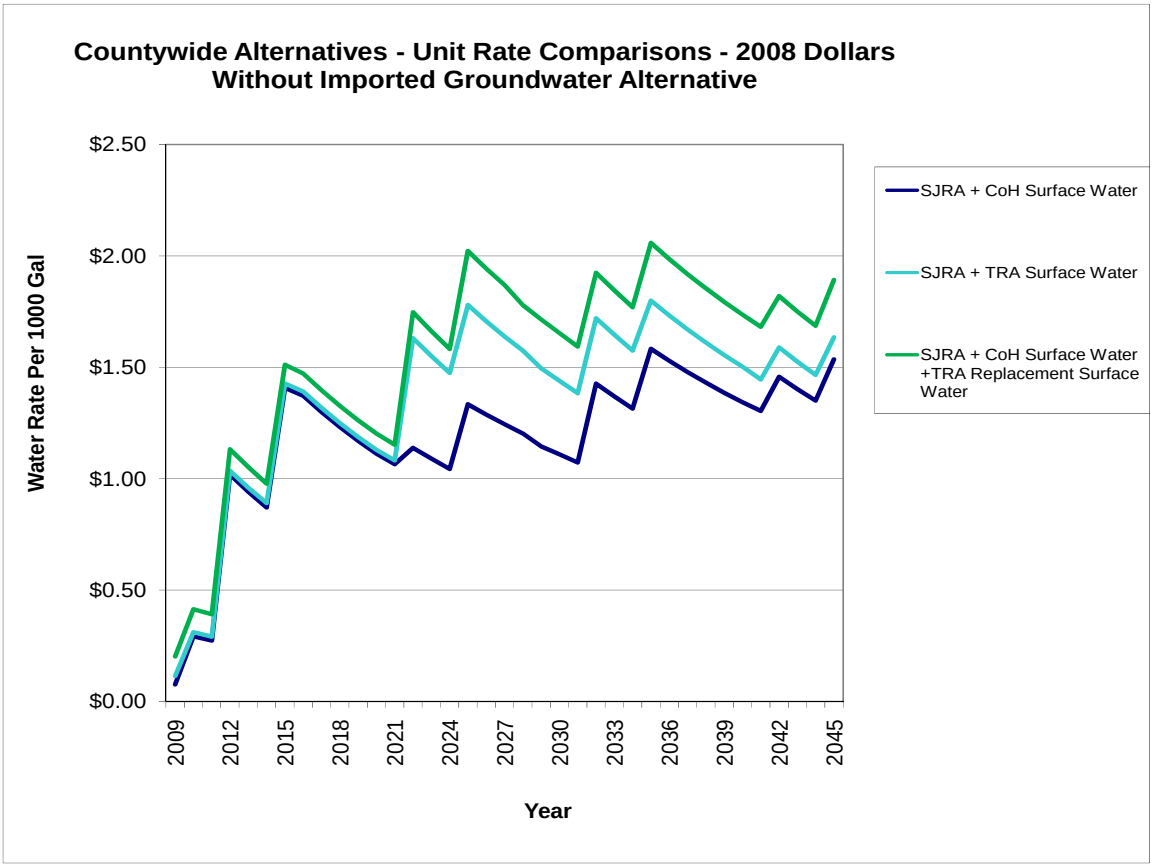

Exhibit 5-6. Comparison of Unit Costs thru 2045 (2008 Dollars)

Section 6 Conclusion and Recommendation

6.1 Conclusion

The most cost-effective source-water supply alternative is the use of SJRA water rights in Lake Conroe plus a long-term water supply contract with the City of Houston for its water in Lake Conroe. While it is anticipated that the final diversion locations and amounts, and infrastructure size and location will vary from the baseline developed in this study, the final conclusion will remain the same.

6.2 Recommendation

It is recommended that all of the permitted yield of Lake Conroe be utilized to supply treated surface water in Montgomery County prior to the conveyance of water from additional sources into the county and that a long-term water supply contract with the City of Houston be executed in a timely manner.