

REGION H

Water Planning Group



2026 REGIONAL WATER PLAN

VOLUME 2 – PART 2

Prepared by:
Region H Water Planning Group

Prepared for:
Texas Water Development Board

With assistance from:
Freese and Nichols, Inc.
INTERA, Inc.

October 2025

Appendices

Volume 2 - Part 1

Appendix ES-A	TWDB DB27 Summary Tables
Appendix 1-A	Selected Bibliography by Topic
Appendix 2-A	Water Demand for Hydrogen Production
Appendix 2-B	Region H Population and Population Demand Revision Request
Appendix 2-C	Major Water Provider Demand Summaries
Appendix 3-A	MAG Peak Factor Documentation
Appendix 3-B	Documentation of Model Files Used in Determining Surface Water Availability
Appendix 3-C	List of Water Rights Used as Basis of Supply
Appendix 3-D	Major Water Provider Supply Summaries
Appendix 3-E	Existing Supply from Run-of-River Diversions
Appendix 4-A	Major Water Provider Needs Summaries
Appendix 5-A	Water Management Strategy Tables

Volume 2 - Part 2

Appendix 5-B	Project and Water Management Strategy Technical Memoranda
--------------	---

Volume 2 - Part 3

Appendix 5B-A	Water Loss Reduction Savings for Municipal WUGs
Appendix 5B-B	Advanced Conservation Savings for Municipal WUGs
Appendix 5B-C	Gallons Per-Capita Daily Goals for Municipal WUGs
Appendix 6-A	Texas Commission on Environmental Quality 303(d) List of Impaired Waters
Appendix 6-B	Impacts to Resources
Appendix 6-C	Agricultural Census and Texas Land Trends Data
Appendix 6-D	Threatened and Endangered Species
Appendix 6-E	Socioeconomic Impacts of Unmet Needs
Appendix 7-A	Current Drought Preparations in Region H
Appendix 7-B	Entities with Existing and Potential Interconnects
Appendix 7-C	Potential Emergency Responses
Appendix 7-D	Model Drought Contingency Plans
Appendix 8-A	Detailed Discussion of Other Regulatory, Admin., and Leg. Recommendations
Appendix 9-A	Implementation Report
Appendix 10-A	Public Hearing Materials
Appendix 10-B	Written Comments
Appendix 10-C	Responses to Written Comments

List of Abbreviations

AEM	Anion Exchange Membrane Electrolyzer
AMI	Automated Metering Infrastructure
ATR	Autothermal Reforming
AWWA	American Water Works Association
B&E	Bay and Estuary
BAWA	Baytown Area Water Authority
BBASC	Basin and Bay Area Stakeholder Committee
BBEST	Basin and Bay Expert Science Team
BEG	Bureau of Economic Geology
BMP	Best Management Practice
BRA	Brazos River Authority
BWA	Brazosport Water Authority
BWSC	Brazosport Water Supply Corporation
CCI	Construction Cost Index
CCUS	Carbon Capture, Utilization and Storage
CES	Center for Energy Studies
cfs	cubic feet per second
CHCRWA	Central Harris County Regional Water Authority
CLCND	Chambers-Liberty Counties Navigation District
CLCWA	Clear Lake City Water Authority
COA	Certificate of Adjudication
COH	City of Houston
CRP	Clean Rivers Program
CRU	Collective Reporting Unit
CWA	Coastal Water Authority
CWSRF	Clean Water State Revolving Fund
DCP	Drought Contingency Plan
DFC	Desired Future Condition
DOR	Drought of Record
DPC	Drought Preparedness Council
DWSRF	Drinking Water State Revolving Fund
DWW	Drinking Water Watch
EPA	Environmental Protection Agency
FBSD	Fort Bend Subsidence District
FSA	Farm Service Agency
FWSD	Fresh Water Supply District
GAM	Groundwater Availability Model
GCD	Groundwater Conservation District
GCWA	Gulf Coast Water Authority
GMA	Groundwater Management Area
gpcd	gallons per-capita daily
GRP	Groundwater Reduction Plan
H2Hubs	Regional Clean Hydrogen Program
H-GAC	Houston-Galveston Area Council
HGSD	Harris-Galveston Subsidence District
IJA	Infrastructure Investment and Jobs Act

IFR	Infrastructure Finance Report
IMPLAN	Impact for Planning Analysis
IPC	Interregional Planning Council
IPP	Initially Prepared Plan
IRA	Inflation Reduction Act
IRENA	International Renewable Energy Agency
IWA	International Water Association
IWRP	Integrated Water Resource Plan
iWUD	Integrated Water Utility Database
LAWA	La Porte Area Water Authority
LNVA	Lower Neches Valley Authority
LSGCD	Lone Star Groundwater Conservation District
LVGUs	Large Volume Groundwater Users
MAG	Modeled Available Groundwater
MCL	maximum contaminant level
mgd	million gallons per day
mg/l	milligrams per liter
MSF	Management Supply Factor
msl	mean sea level
MUDs	Municipal Utility Districts
MWP	Major Water Provider
NCWA	North Channel Water Authority
NFBWA	North Fort Bend Water Authority
NHCRWA	North Harris County Regional Water Authority
NPC	National Petroleum Council
NREL	National Renewable Energy Laboratory
NWR	National Wildlife Refuge
PDSI	Palmer Drought Severity Index
PEM	Proton Exchange Membrane
PPI	Producer Price Index
PWS	Public Water Supply
Region G	Brazos G Regional Water Planning Group
Region I	East Texas Water Planning Group
RHWPG	Region H Water Planning Group
RWP	Regional Water Plan
RWPA	Regional Water Planning Area
RWPG	Regional Water Planning Group
SAM-Houston	Small Area Model Houston
SDC	State Data Center
SJRA	San Jacinto River Authority
SMR	Steam-Methane Reforming
SOEC	Solid Oxide Electrolyzer Cells
SWIFT	State Water Implementation Fund for Texas
SWP	State Water Plan
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TDC	Texas Demographic Center
TDS	Total Dissolved Solids

TPWD	Texas Parks and Wildlife Department
TRA	Trinity River Authority
TSS	Total Suspended Solids
TTWP	Trans-Texas Water Program
TWC	Texas Water Code
TWDB	Texas Water Development Board
UCM	Unified Costing Model
UHCPP	University of Houston Center for Public Policy
UNESCO	United Nations Educational, Scientific and Cultural Organization
URS	Unique Reservoir Site
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USS	Unique Stream Segment
WAM	Water Availability Model
WCP	Water Conservation Plan
WHCRWA	West Harris County Regional Water Authority
WIF	Water Infrastructure Fund
WMS	Water Management Strategy
WRAP	Water Resources Analysis Package
WTP	Water Treatment Plant
WUD	Water Utility Database
WUG	Water User Group
WWP	Wholesale Water Provider
WWTP	Wastewater Treatment Plant

Water Measurements

Acre-foot (ac-ft) = 43,560 cubic feet = 325,851 gallons

Acre-foot per year (ac-ft/yr) = 325,851 gallons per year = 893 gallons per day

Gallon per minute (gpm) = 1,440 gallons per day = 1.6 ac-ft/yr

Million gallons per day (mgd) = 1,000,000 gallons per day = 1,120 ac-ft/yr

APPENDIX 5-B

PROJECT AND WATER MANAGEMENT STRATEGY TECHNICAL MEMORANDA

THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDA TABLE OF CONTENTS

Project	Memorandum
Conservation	
Adv. Municipal Conservation and Water Loss Reduction	CNSV-001
Industrial Conservation	CNSV-002
Irrigation Conservation	CNSV-003
Conveyance	
BWA Transmission and Storage Expansion	CONV-001
CHCRWA Transmission and Internal Distribution	CONV-002
City of Houston GRP Transmission	CONV-003
City of Houston Transmission Expansion	CONV-004
CWA Pipeline Transmission Expansion	CONV-005
CWA Trinity River Conveyance System Improvements	CONV-006
East Texas Transfer	CONV-007
LNVA Neches-Trinity Basin Interconnect	CONV-008
Manvel Supply Expansion	CONV-009
NFBWA Phase 2 Distribution Segments	CONV-010
NHCRWA Distribution Expansion	CONV-011
NHCRWA Transmission Lines	CONV-012
Pasadena Infrastructure Expansion	CONV-013
SJRA Highlands System Enhancement	CONV-014
Southeast Transmission Line Improvements	CONV-015
West University Place Infrastructure Expansion	CONV-016
WHCRWA Distribution Expansion	CONV-017
WHCRWA/NFBWA Transmission Line	CONV-018
Groundwater Development	
Aquifer Storage and Recovery	GWDV-001
Brackish GW Development and GW Blending	GWDV-002
BWA Brackish Groundwater Development	GWDV-003
City of Houston Area 2 Groundwater Infrastructure	GWDV-004
City of Houston Repump and GW Plant Improvements	GWDV-005
Expanded Use of Groundwater	GWDV-006
Fairchilds Supply Infrastructure	GWDV-007
GCWA Groundwater Well Development	GWDV-008
SJRA Catahoula Aquifer Supplies	GWDV-009
Groundwater Reduction Plans	
CHCRWA GRP	GWRP-001
City of Houston GRP	GWRP-002
City of Missouri City GRP	GWRP-003

Project	Memorandum
City of Richmond GRP	GWRP-004
City of Rosenberg GRP	GWRP-005
City of Sugar Land IWRP	GWRP-006
Fort Bend County MUD 25 GRP	GWRP-007
Fort Bend County WCID 2 GRP	GWRP-008
Montgomery County MUDs 8 and 9 Supply Expansion	GWRP-009
Montgomery County Supply Expansion	GWRP-010
NFBWA GRP	GWRP-011
NHCRWA GRP	GWRP-012
WHCRWA GRP	GWRP-013
Reuse	
City of Houston Reuse	REUS-001
City of Pearland Reuse	REUS-002
GCWA Municipal Reuse	REUS-003
NFBWA Member District Reuse	REUS-004
NHCRWA Member District Reuse	REUS-005
River Plantation Reuse	REUS-006
San Jacinto Basin Regional Return Flows	REUS-007
Texas City Industrial Complex Reuse	REUS-008
Wastewater Reclamation for Industry	REUS-009
Wastewater Reclamation for Municipal Irrigation	REUS-010
Westwood Shores MUD Reuse	REUS-011
Surface Water Development	
Allens Creek Reservoir	SWDV-001
BWSC Reservoir and Pump Station Expansion	SWDV-002
GCWA Coastal Desalination	SWDV-003
Lake Somerville Augmentation	SWDV-004
Treatment	
BAWA East SWTP Expansion	TRET-001
BWA Conventional Treatment Expansion	TRET-002
City of Houston EWPP Enhancement	TRET-003
Harris County MUD 50 Surface Water Treatment Plant	TRET-004
Northeast Water Purification Plant Expansion	TRET-005
Pearland Surface Water Treatment Plant	TRET-006
SEWPP Expansion	TRET-007
Other	
Brazos Saltwater Barrier	OTHR-001
GCWA Canal Loss Mitigation	OTHR-002
GCWA Shannon Pump Station Expansion	OTHR-003
LNVA Devers Pump Station Relocation	OTHR-004
Municipal Drought Management	OTHR-005
New and Expanded Contracts	OTHR-006

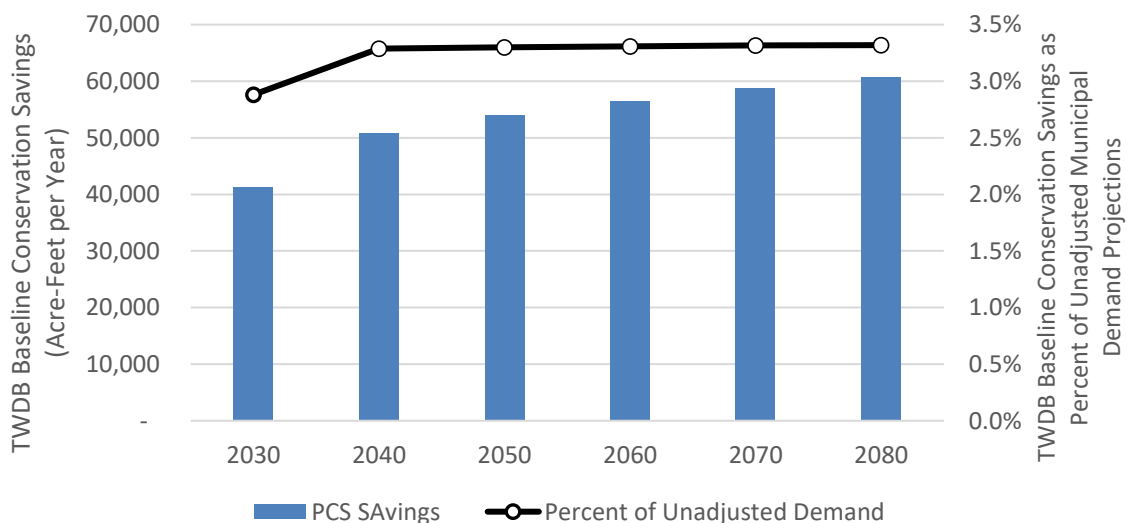
REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Advanced Municipal Conservation and Water Loss Reduction
Project ID:	CNSV-001
Project Type:	Conservation
Potential Supply Quantity (Rounded):	228,912 ac-ft/yr (204.3 mgd)
Implementation Decade:	2030 with ongoing annual expenditures
Development Timeline:	1 year
Project Capital Cost:	\$5,788,817,093 over planning horizon (Sept. 2023)
Unit Water Cost (Rounded):	\$875 per ac-ft (Advanced Conservation) \$735 per ac-ft (Water Loss Reduction)

Strategy Description

Water conservation is a demand management project that proactively causes a decrease of future water needs. Conservation facilitates more efficient use of existing water supplies by allowing existing supplies to serve demands for a longer period of time and/or to delay the need to develop new supplies. The current Region H water demands have an embedded quantity of conservation savings. This quantity has been determined based on the assumption that water will be saved as a result of anticipated future, natural installation of plumbing fixtures and appliances as detailed in relevant legislation. These savings were included in the demand projections developed by TWDB. The resulting savings in Region H are described below in *Figure 1* and amount to as much as 3.3 percent of the total annual (prior to reductions applied by TWDB) municipal water demand.

Figure 1 – TWDB-Applied Baseline Conservation



The use of advanced water conservation projects will accomplish a higher degree of conservation than is already contained within the current demand projections. This technical memorandum illustrates the application of advanced water conservation to Municipal and Municipal County-Other Water User Groups (WUGs) throughout Region H. These projects are recommended for the majority of WUGs in the region, with limited exceptions for those with extremely low existing per-capita demands or leakage losses. Due to the importance of conservation for meeting the growing water demands of the region and as a means to more effectively utilize existing water sources, conservation projects have been applied even for WUGs that do not demonstrate a need throughout the planning period.

For the 2026 round of regional planning, the Region H Water Planning Group (RHWPG) approached the issue of municipal water conservation in two ways. First, the RHWPG reviewed the results of the 2018 through 2022 Water Loss Audit Reports developed by TWDB in order to identify opportunities to implement conservation savings through gradual reduction in water losses. Specific measures for combatting water loss will vary from system to system but may include smart metering, leak detection, line repair, line replacement, or other actions appropriate to an individual system.

The RHWPG also benefitted from a combination of prior analyses and new data and tools in assessing advanced municipal conservation measures beyond embedded plumbing code savings in demand projections. The Texas Water Foundation (TWF), as well as the *Water Conservation by the Yard* report by The Sierra Club, National Wildlife Federation, and Texas Living Water Project, provided valuable insight into conservation practices and savings potential in the Region H area. Also, extremely valuable to Region H's assessment were the Municipal Water Conservation Planning Tool (MWCPT) released by TWDB in 2018 to assist utilities in water conservation planning and reporting, and the Alliance for Water Efficiency (AWE) Conservation Tracking Tool. The MWCPT includes savings, lifespan, cost, and other information on a broad range of conservation measures for single family residential (SFR), multi-family residential (MFR), and industrial, commercial, and institutional (ICI) sectors of municipal water use. The logic and data in the MWCPT and AWE tools, with consideration for other references and knowledge of local water use characteristics, served as the basis for development of the Region H Municipal Regional Conservation Tool (MRCT) used to assess potential savings from advanced municipal conservation practices on a regional scale.

Strategy Analyses

The project analyses for Municipal Conservation include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Estimates of potential savings as a result of water loss reduction were developed using data from the Water Loss Audit Reports prepared by TWDB for the years 2018 through 2022. These reports identified, by utility, the estimated losses of various types calculated from production and sales records, including apparent losses due to unbilled or unmetered usage, metering accuracy limitations, and other causes as well as real losses from line breaks and leakage. For the sake of this analysis, real losses were used as a basis for estimating potential savings.

The utilities identified in the report were associated with either named Municipal WUGs or Municipal County-Other WUGs. On a WUG basis, utility totals of real losses and total system input volume were developed. These totals could then be used to calculate the real loss identified for each unit of system input volume. WUGs with no identified utility records for the years examined were excluded from

the analysis of loss. Real losses were examined by WUG, and WUGs with real losses exceeding ten percent were targeted for potential savings. These WUGs exceeding the ten percent real loss threshold were assumed to reduce the fraction of their demands attributable to real loss by one percent annually throughout the planning period or until they reached the threshold level of ten percent real loss.

It should be noted that the recommended water loss reduction values presented in the 2026 RWP are intended to reflect a conservative estimate of potential savings and are not intended to depict a ten percent real loss rate or one percent per year reduction in loss rate as ideal system performance. Systems may wish to consider more aggressive implementation of loss reduction programs than the conservative recommendation reflected in the RWP, including higher per-year reductions or implementation or continuation of reduction efforts below a ten percent real loss rate. More aggressive programs would facilitate greater overall water savings. For example, increasing annual loss reduction from one to two percent per year would result in approximately 22,000 ac-ft in additional savings across the Region for 2080 conditions. It should also be noted that systems may structure water loss targets in many potential ways besides as a percentage-based goal, such as loss per connection; in recent years, TWDB's water loss audit reporting has focused largely on total and per-connection losses, and this data is available to water systems to assist them in their planning. The RHWPG recommends that all utilities perform regular system audits, aggressively strive to reduce the inefficient and costly leakage loss of water, and establish procedures to rapidly address line breaks. For the utilities which were identified as potential targets, reductions in water loss from this methodology would reduce per-capita demands for individual WUGs as shown in *Table 1*.

Table 1 – Impact of Water Loss Reduction on Per-Capita Demands for Individual WUGs

Reduction in Per Capita Demand (gpcd)	2030	2040	2050	2060	2070	2080
Minimum WUG Savings	0.0	0.1	0.1	0.1	0.1	0.1
Median WUG Savings	1.2	3.6	5.8	7.5	8.7	9.5
Average WUG Savings	1.5	4.2	6.6	8.6	10.2	11.5
Maximum WUG Savings	5.6	16.1	25.6	34.3	42.0	49.1

Projections for advanced municipal conservation beyond passive savings and water loss reduction were estimated using the MRCT, which is based largely on the methods and savings and cost assumptions from the MWCPT, with consideration of local water use characteristics and other information. Due to the presence of embedded residential plumbing code implementation savings in the water demand projections for regional planning, the analysis for Region H focused primarily on measures to reduce outdoor water use, which is a major driver of overall local municipal demand. Consideration was also given to some advanced indoor measures for commercial facilities in the decades 2030 through 2050; by 2060, commercial facilities were assumed to have fully converted to more efficient fixtures. Considered measures included (but were not limited to) home water reports, irrigation audits, commercial kitchen pre-rinse valves, rain barrels, and rebate programs including rebates for:

- Commercial general, dishwasher, and food steamer,
- High-efficiency sprinklers,
- Smart irrigation controllers,

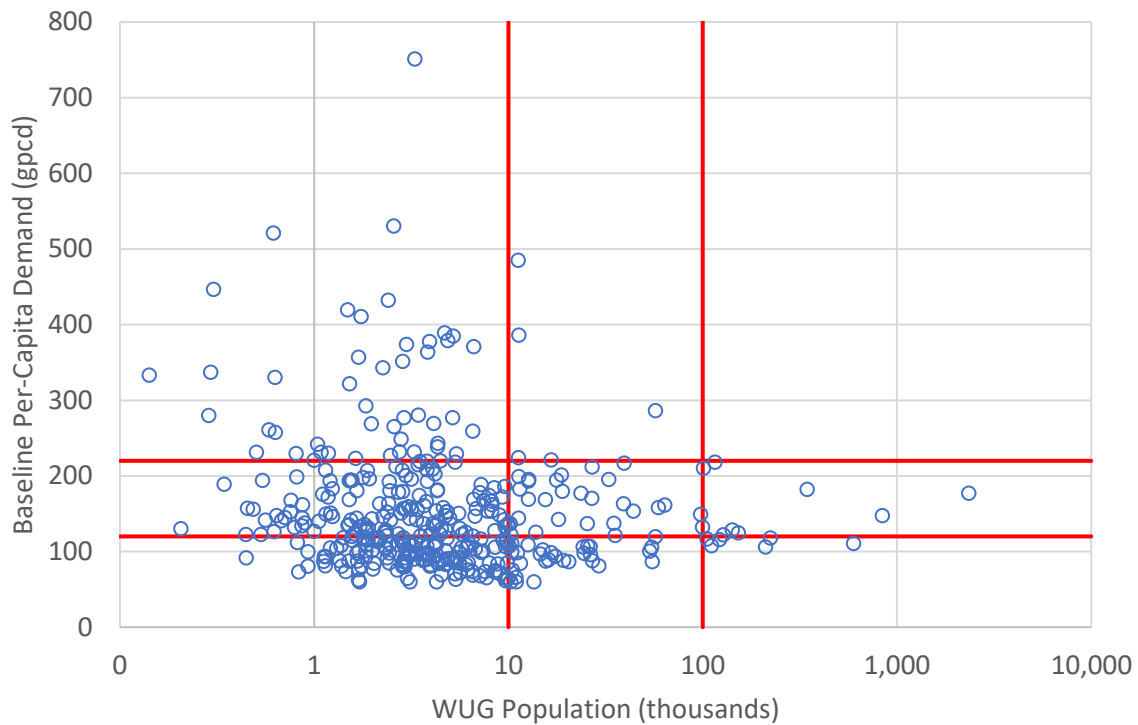
- WaterWise landscape program participation, and
- Rainwater harvesting.

Mandatory outdoor watering restrictions were applied to all municipal WUGs and municipal County-Other WUGs, with the exception of the Woodlands, which already utilizes permanent outdoor watering restrictions. A 2018 report by the Texas Living Waters Project estimates that restrictions on outdoor municipal watering could save two percent to 11 percent of total municipal water use, depending on the amount of education and enforcement implemented by a water utility. Projected savings for the 2026 Region H RWP were based on the assumption that all connections would implement a twice-per-week watering restriction, resulting in overall savings of two percent of the demand projected by TWDB (already inclusive of TWDB-applied baseline conservation). Due to the possibility that not all systems would necessarily implement immediately, estimates for Region H apply the lower end of the savings spectrum identified by the Texas Living Waters Project; entities which in reality implement conservation programs with a significant amount of education and enforcement could see even greater savings of water.

While mandatory outdoor watering restrictions were applied equally to all municipal WUGs in Region H, other measures were implemented at varying levels for different WUGs. Because the financial resources and savings potential varies widely among WUGs, municipal WUGs were grouped into three categories (small, medium, and large) based upon population, with these further divided into categories of low, mid, and high savings potential based upon per-capita demand after the inclusion of baseline savings assumed by TWDB each decade, in gallons per-capita per day (gpcd). This categorization acknowledges that larger WUGs would likely have greater resources available to implement more measures at a more aggressive rate, while smaller WUGs may be limited to more gradual programs. Additionally, WUGs with higher per-capita demands offer the greatest potential for conservation savings, while those with low per-capita demands may have limited savings potential or, through existing proactive conservation programs, have already substantially reduced water use. Breaks in the per-capita demand classification were determined first by using the Jenks Natural Breaks algorithm to best identify the groups with similar values, and to maximize the differences between classes. These break points were then subjectively modified, for the purpose of placing more WUGs in the mid and high savings potential categories and less WUGs in the low savings potential. It was determined that the break points would be those found in *Table 2* and *Figure 2*, which shows the distribution of Region H WUGs in the categories described in *Table 2*.

Table 2 – Summary of Advanced Conservation Categories

GPCD	Population	Category
<=120	<=10,000	Low Potential Small Utility
<=120	>10,000 & <=100,000	Low Potential Medium Utility
<=120	>100,000	Low Potential Large Utility
>120 & <=220	<=10,000	Mid Potential Small Utility
>120 & <=220	>10,000 & <=100,000	Mid Potential Medium Utility
>120 & <=220	>100,000	Mid Potential Large Utility
>220	<=10,000	High Potential Small Utility
>220	>10,000 & <=100,000	High Potential Medium Utility
>220	>100,000	High Potential Large Utility

Figure 2 – Distribution of Region H WUGs in Municipal WUG Conservation Categories

Detailed utility connection data provided by TWDB was used to estimate the future number of single-family, multi-family, and non-residential connections for each WUG. For each WUG category of size and savings potential, an implementation table was developed indicating the potential conservation measures applied and the percentage of connections participating annually. Aggressiveness of recommendations was based upon the WUG category. More measures and higher implementation rates were recommended for large WUGs with higher per-capita demands, and fewer measures and more gradual implementation rates were recommended for smaller WUGs with lower per-capita demands. Automated Meter Reading (AMR) measures were recommended for High and Mid Potential categories for Large and Medium Utilities. Specific implementation rates of each measure are found in *Table 3*, *Table 4*, and *Table 5*.

THIS PAGE INTENTIONALLY LEFT BLANK

Table 3 – Implementation Rates of Single-Family Residential (SFR) Measures

SFR Measure	Percentage of SFR Connections Participating Annually								
	High Potential Large Utility	High Potential Medium Utility	High Potential Small Utility	Mid Potential Large Utility	Mid Potential Medium Utility	Mid Potential Small Utility	Low Potential Large Utility	Low Potential Medium Utility	Low Potential Small Utility
	2030 / 2080	2030 / 2080	2030 / 2080	2030 / 2080	2030 / 2080	2030 / 2080	2030 / 2080	2030 / 2080	2030 / 2080
Home Water Reports	35% / 50%	35% / 50%	35% / 50%	30% / 50%	30% / 50%	30% / 50%	25% / 50%	25% / 50%	25% / 50%
Irrigation Audits – High Users	3% / 5%	2% / 3%	-	3% / 5%	2% / 3%	-	3% / 5%	2% / 3%	-
High-Efficiency Sprinkler Nozzle Rebate	3% / 4%	1.5% / 2.0%	1% / 1%	3% / 4%	1.5% / 2%	1% / 1%	3% / 3%	1.5% / 1.5%	1% / 1%
Smart Irrigation Controller Rebate	3% / 4%	1.5% / 2%	1% / 1%	3% / 4%	1.5% / 2%	1% / 1%	3% / 3%	1.5% / 1.5%	1% / 1%
WaterWise Landscape Rebate	0.25% / 1%	0.25% / 1%	0.25% / 1%	0.25% / 1%	0.25% / 1%	0.25% / 1%	0.25% / 1%	0.25% / 1%	0.25% / 1%
Rainwater Harvesting Rebate	0.25% / 1%	0.25% / 1%	-	0.25% / 1%	0.25% / 1%	-	0.25% / 1%	0.25% / 1%	-
Rain Barrel	0.25% / 1%	0.25% / 1%	-	0.25% / 1%	0.25% / 1%	-	0.25% / 1%	0.25% / 1%	-
Automated Meters	35% / 50%	35% / 50%	-	30% / 50%	30% / 50%	-	-	-	-

Table 4 – Implementation Rates of Multi-Family Residential (MFR) Measures

MFR Measure	Percentage of MFR Connections Participating Annually								
	High Potential Large Utility	High Potential Medium Utility	High Potential Small Utility	Mid Potential Large Utility	Mid Potential Medium Utility	Mid Potential Small Utility	Low Potential Large Utility	Low Potential Medium Utility	Low Potential Small Utility
	2030 / 2080	2030 / 2080	2030 / 2080	2030 / 2080	2030 / 2080	2030 / 2080	2030 / 2080	2030 / 2080	2030 / 2080
Irrigation Audits – High Users	3% / 3%	3% / 3%	-	3% / 3%	3% / 3%	-	2% / 2%	2% / 2%	-
High-Efficiency Sprinkler Nozzle Rebate	3% / 3%	2% / 2%	1% / 1%	3% / 3%	2% / 2%	1% / 1%	2% / 2%	2% / 2%	1% / 1%
Smart Irrigation Controller Rebate	3% / 3%	2% / 2%	1% / 1%	3% / 3%	2% / 2%	1% / 1%	2% / 2%	2% / 2%	1% / 1%
WaterWise Landscape Rebate	0.5% / 2%	0.5% / 2%	0.25% / 1%	0.5% / 2%	0.5% / 2%	0.25% / 1%	0.5% / 2%	0.5% / 2%	0.25% / 1%
Rainwater Harvesting Rebate	0.25% / 1%	0.25% / 1%	-	0.25% / 1%	0.25% / 1%	-	0.25% / 1%	0.25% / 1%	-
Automated Meters	35% / 50%	35% / 50%	-	30% / 50%	30% / 50%	-	-	-	-

Table 5 – Implementation Rates of Industrial, Commercial, & Institutional (ICI) Measures*

ICI Measure	Percentage of ICI Connections Participating Annually								
	High Potential Large Utility	High Potential Medium Utility	High Potential Small Utility	Mid Potential Large Utility	Mid Potential Medium Utility	Mid Potential Small Utility	Low Potential Large Utility	Low Potential Medium Utility	Low Potential Small Utility
	2030 / 2050	2030 / 2050	2030 / 2050	2030 / 2050	2030 / 2050	2030 / 2050	2030 / 2050	2030 / 2050	2030 / 2050
Commercial General Rebate	1% / 0.8%	1% / 0.8%	1% / 0.8%	0.8% / 0.6%	0.8% / 0.6%	0.8% / 0.6%	0.6% / 0.4%	0.6% / 0.4%	0.6% / 0.4%
Kitchen Pre-Rinse Spray Valve Installation	1% / 0.8%	1% / 0.8%	1% / 0.8%	0.8% / 0.6%	0.8% / 0.6%	0.8% / 0.6%	-	-	-
Irrigation Audits – High Users	1% / 1%	0.5% / 0.5%	-	0.5% / 0.5%	0.5% / 0.5%	-	0.5% / 0.5%	0.5% / 0.5%	-
High-Efficiency Sprinkler Nozzle Rebate	1.5% / 1.5%	1% / 1%	1% / 1%	1% / 1%	1% / 1%	1% / 1%	1% / 1%	1% / 1%	1% / 1%
Smart Irrigation Controller Rebate	1.5% / 1.5%	1% / 1%	1% / 1%	1% / 1%	1% / 1%	1% / 1%	1% / 1%	1% / 1%	1% / 1%
WaterWise Landscape Rebate	0.25% / 0.5%	0.25% / 0.5%	0.25% / 0.5%	0.25% / 0.5%	0.25% / 0.5%	0.25% / 0.5%	0.25% / 0.5%	0.25% / 0.5%	0.25% / 0.5%
Rainwater Harvesting Rebate	0.25% / 0.5%	0.25% / 0.5%	--	0.25% / 0.5%	0.25% / 0.5%	-	0.25% / 0.5%	0.25% / 0.5%	-
Commercial Dishwasher Rebate	1% / 0.8%	1% / 0.8%	1% / 0.8%	0.8% / 0.6%	0.8% / 0.6%	0.8% / 0.6%	0.6% / 0.4%	0.6% / 0.4%	-
Commercial Food Steamer Rebate	1% / 0.8%	1% / 0.8%		0.8% / 0.6%	-	-	-	-	-

*Implementation rates for industrial, commercial, and institutional measures are shown for 2020 and 2050, as indoor ICI measures were not recommended after 2050.

THIS PAGE INTENTIONALLY LEFT BLANK

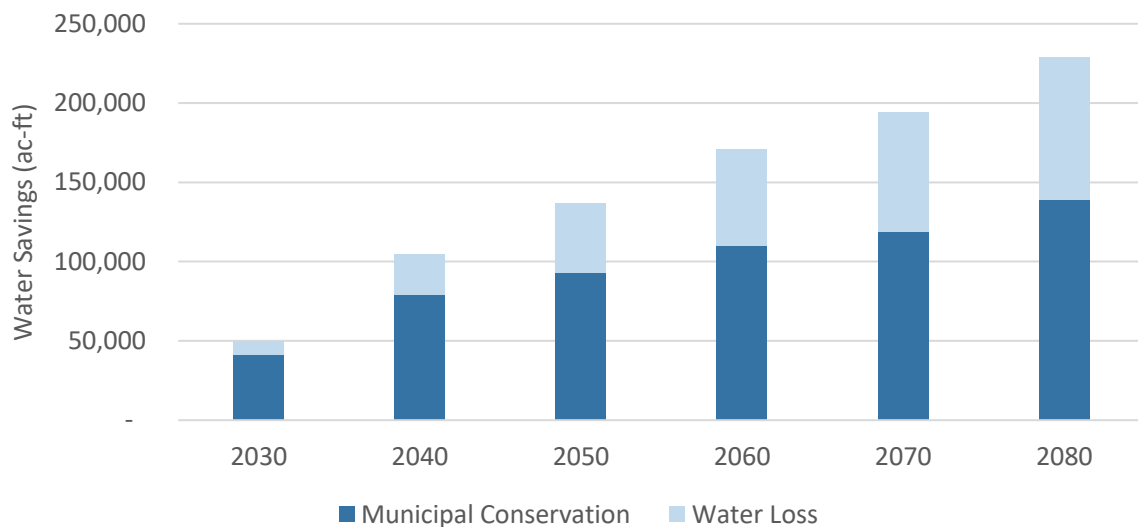
Once the number of units of implementation were determined for each WUG by decade, the applicable water savings assumptions derived from the TWDB MWCPT (per-connection measure savings, measure lifespan and natural replacement rates, cost, etc.) were applied to generate arrays of potential advanced conservation water savings and program cost for each connection type by WUG. Water savings calculations were constrained by a lower boundary of 60 gpcd to prevent recommendation of measures beyond a level feasible for many WUGs; study results indicated that few WUGs would reach this lower threshold even after application of advanced municipal conservation measures. Due to the importance of conservation to meeting the growing water demands of the region and as a means to more effectively utilize existing water sources, municipal conservation measures were applied even for WUGs that do not demonstrate a projected need throughout the planning period.

Table 6 describes the impact on per-capita demands of individual WUGs by the advanced conservation measures recommended by Region H. Resultant savings for water loss reduction and advanced municipal conservation (including mandatory outdoor watering restrictions) beyond embedded savings are illustrated in Figure 3.

Table 6 – Impact of Advanced Conservation on Per-Capita Demands

Reduction in Per Capita Demand (gpcd)	2030	2040	2050	2060	2070	2080
Minimum Entity Savings	0.0	0.0	0.0	0.0	0.0	0.0
Median Entity Savings	4.2	6.5	7.0	7.9	8.4	9.5
Average Entity Savings	4.6	7.2	7.9	8.8	9.2	10.3
Maximum Entity Savings	18.9	26.9	31.8	34.9	34.8	39.1

Figure 3 – Advanced Municipal Conservation and Water Loss Reduction Savings



Combined, the water saved through water loss reduction and the advanced conservation methods analyzed in this study represents 12.9 percent of the year 2080 demand demonstrated in the Region H RWP. However, this projected demand is already reduced by 3.3 percent based on baseline conservation methods applied by TWDB. In total, the effective demand for the region is reduced by

a total of 15.8 percent in 2080 compared against the total demand which is represented by the population demand of Region H prior to application of baseline reductions by TWDB. This information is presented in *Table 7*, below.

Table 7 – Summary of Conservation Savings by Decade

Conservation Metric	Basis	2030	2040	2050	2060	2070	2080
Baseline Conservation	% of Total Demand	2.9%	3.3%	3.3%	3.3%	3.3%	3.3%
Water Loss Reduction	% of RWP Net Demand	0.6%	1.7%	2.8%	3.7%	4.4%	5.1%
Advanced Conservation		3.0%	5.3%	5.9%	6.7%	6.9%	7.9%
Total Additional Conservation (Water Loss + Advanced)		3.6%	7.0%	8.6%	10.3%	11.4%	12.9%
Total Conservation Methods (Baseline + Water Loss + Advanced)	% of Total Demand	6.4%	10.1%	11.6%	13.3%	14.3%	15.8%

Environmental Considerations

Generally, there are no significant negative environmental impacts associated with the Municipal Conservation projects outlined herein. Large-scale structural modifications (constructing physical facilities) are not necessary to implement the Municipal Conservation measures found in this WMS. Therefore, construction impacts are not anticipated. Municipal effluent is a critical and substantial component to baseflows in the Houston area and Municipal Conservation measures, particularly those associated with indoor conservation, will reduce these flows below the level that would occur without conservation in place. However, the reduction in return flows in the receiving basins due to Municipal Conservation would, theoretically, be more than offset by the reduced diversions of water from the source basins. Finally, Municipal Conservation would reduce the amount of energy and chemicals needed to distribute water, resulting in a positive impact on the environment.

Permitting and Development

Accomplishing the Municipal Conservation demand reductions, as described herein, requires proactive implementation. Identification of an appropriate utility or political subdivision to facilitate or implement use of the conservation measures in each of the municipal WUGs is one of the critical issues facing the success of this project.

It should be noted that some WUGs are collections of small systems, which may present challenges to a coordinated effort to reduce water consumption. Individual systems will have varying attitudes toward conservation, with some moving forward with conservation plans and others focusing on revenue generation to support water system operation. The implementation of conservation measures for collective groupings of small systems presents challenges due to the lack of a single point of accountability. Further, these systems may lack the leverage to encourage conservation or lack the economic incentive to reduce billings. However, water conservation does delay the need to

build capital-intensive water supply and distribution projects, which can potentially help offset the need for modest rate adjustments that water conservation creates.

It should be noted that the majority of measures in the Region H municipal conservation approach are incentive-based and not education or enforcement-based. This is primarily due to the difficulty in estimating savings from the latter approaches. However, some WUGS may consider education or other conservation approaches not quantified in this analysis as part of a comprehensive municipal conservation program.

Cost Analysis

Costs for implementation of a water loss reduction program were adapted from the analysis applied in the 2021 Region H Regional Water Plan, with values scaled to September 2023 costs using the Engineering News Record (ENR) Construction Cost Index (CCI). Overall water loss reduction strategy costs for Region H are shown in *Table 8*.

Table 8 – Water Loss Reduction Project Costs

OPINION OF PROBABLE CONSTRUCTION COST						September 2023	
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL		
PROJECT CAPITAL COST SUMMARY							
1	PROGRAM COST	1	LS	\$1,647,604,552	\$1,647,604,552		
PROJECT CAPITAL COST					\$1,647,604,552		
ANNUAL TOTAL							
ANNUAL COST SUMMARY							
		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$6,384,029	\$19,526,034	\$32,466,355	\$44,586,191	\$55,290,200	\$65,076,462
2	YIELD	8,389	25,726	43,579	60,827	75,740	89,637
3	UNIT COST	\$761	\$759	\$745	\$733	\$730	\$726
TOTAL UNIT COST							\$735

Cost estimates for advanced municipal conservation measures were based upon the per-connection cost rates from the TWDB MWCPT, with adjustments for local connection characteristics and multi-family development properties. Overall advanced municipal conservation strategy costs for Region H are shown in *Table 9*. Actual costs will vary by WUG. Generally, unit costs for implementation in smaller communities are more costly. However, these efforts may be made part of a more regional approach that can be accomplished in a more cost-effective manner.

Table 9 – Advanced Municipal Conservation Project Costs

OPINION OF PROBABLE CONSTRUCTION COST						September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL	
PROJECT CAPITAL COST SUMMARY						
1	PROGRAM COST	1	LS	\$4,141,212,541	\$4,141,212,541	
PROJECT CAPITAL COST					\$4,141,212,541	

ITEM DESCRIPTION		ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL PROGRAM COST	\$ 73,447,888.00	\$ 62,865,113.00	\$ 78,873,025.00	\$ 83,419,590.00	\$ 104,975,089.00	\$ 105,405,491.00
TOTAL ANNUAL COST		\$73,447,888	\$62,865,113	\$78,873,025	\$83,419,590	\$104,975,089	\$105,405,491

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$73,447,888	\$62,865,113	\$78,873,025	\$83,419,590	\$104,975,089	\$105,405,491
2	YIELD	41,494	79,224	93,217	109,971	118,599	139,275
3	UNIT COST	\$1,770	\$794	\$846	\$759	\$885	\$757
TOTAL UNIT COST		\$875					

It should be noted that the costs demonstrated here for municipal water conservation programs represent a total cost for offsetting a unit volume of water at the point of delivery. This sets conservation programs apart from other strategies employed in the RWP. In other cases, a comprehensive approach to delivering water to an end-user may include one project that provides for development of raw water, one or more raw water transmission project, a treatment project, and one or more treated water transmission projects to finally deliver water to the demand center. In addition, there are also costs associated with distribution of this water to retail customers which is outside of the scope of the RWP. A comprehensive summation of all of these projects in a layered manner is required to provide the same utility as a conservation program. Therefore, the additive nature of these costs must be considered when they are compared with and contrasted against conservation programs.

Water Management Strategy Evaluation

Based on the analysis provided above, the Municipal Conservation project was evaluated across twelve different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in *Table 10* below.

Table 10 – Water Management Strategy Evaluation

CRITERIA	RATING	EXPLANATION
Cost	1	Conservation costs are moderate to high in early years but decrease with increased participation over time. Costs vary by WUG characteristics, but in many cases may delay or preclude the need for development of more expensive infrastructure. Costs of conservation strategies are extremely low when compared against the combined cost of raw water development, transmission, treatment, and distribution.

CRITERIA	RATING	EXPLANATION
Location	5	Conservation measures generally benefit the WUGs in which they are implemented without need for conveyance but conservation in one WUG may also allow for water to be used by other customers after the demand level is reduced.
Water Quality	3	No known issues related to water quality.
Environmental Land and Habitat	5	No impacts to landform associated with conservation projects.
Environmental Flows	3	No impacts to instream flows. Typically, reductions in return flows are also associated with reduced diversions.
Local Preference	4	No opposition to conservation efforts although local support varies from utility to utility.
Institutional Constraints	5	No permits required for implementation of conservation measures.
Development Timeline	5	Conservation programs can be implemented in a relatively short period of time.
Sponsorship	3	Although sponsors are identified, commitment to implementation varies considerably.
Vulnerability	5	Conservation has no identifiable risk from natural or man-made disasters.
Regionalization	1	Typically implemented at the individual water system level or for a small number of interconnected systems.
Impacts on Other WMS	2	Conservation may negatively impact the availability of return flows for development into indirect reuse projects.

Municipal Conservation is not anticipated to affect acreage, vulnerable species, or agricultural land and production. The projects may potentially reduce surface water diversions and positively impact instream flows by as much as 228,912 ac-ft/yr depending upon the source of potential alternative supplies. Although this project will potentially result in maintaining instream flows in surface water source basins, reduced return flows in receiving basins (as much as 114,456 ac-ft/yr assuming 50 percent return flows through municipal effluent) may reduce potential benefits to those systems.

Water User Group Application

The Municipal Conservation project was evaluated on a basis of several criteria to determine the 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, as shown in *Table 11*.

Table 11 – Suitability of Strategy to Water User Groups

CRITERIA	WUG SUITABILITY
Proximity	Conservation projects do not produce water and only reduce total demand. Therefore, proximity of source and demand is not an issue for implementation.
Size	Conservation projects can generally be scaled to fit the WUG and the need. However, there are limits to how much of the total future need can be offset through conservation alone.
Water Quality	The measure produces no water and only reduces demand. Therefore, water quality of the supply is not impacted.
Unit Cost	The unit cost for this project makes it a viable option for most WUGs aside from those that are already achieving a very low level of per-capita municipal demand.
Other Factors	Successful implementation will ultimately depend on the dedication of individual WUGs to a conservation approach.

References

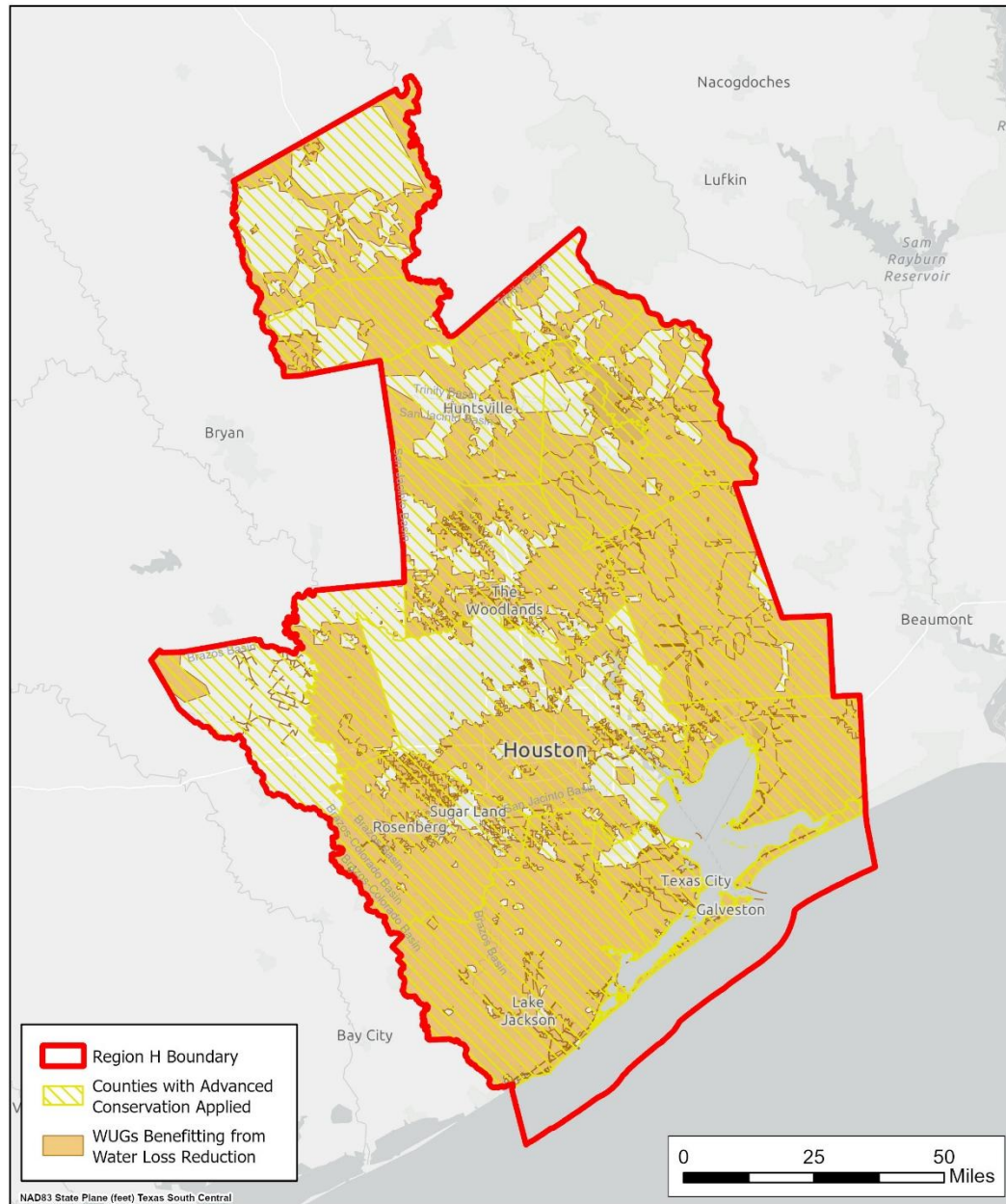
Texas Water Development Board. *Historical Water Loss Audit and Conservation Annual Report Data*. Available at <http://www.twdb.texas.gov/conservation/municipal/waterloss/historical-annual-report.asp>. Last accessed October 2018.

Texas Water Development Board. *Municipal Water Conservation Planning Tool Version 1*. Available at <http://www.twdb.texas.gov/conservation/municipal/plans/index.asp>. November 2018.

Texas Water Development Board. *Quantifying the Effectiveness of Various Water Conservation Techniques in Texas*. May 2002.

Texas Living Waters Project. *Water Conservation by The Yard: A Statewide Analysis of Outdoor Water Savings Potential*. Published by the Sierra Club (Lone Star Chapter) and National Wildlife Federation. March 2018.

Location Map



Advanced Municipal Conservation and Water Loss Reduction



Texas

THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Industrial Conservation
Project ID:	CNSV-002
Project Type:	Conservation
Potential Supply Quantity (Rounded):	3,320-43,892 ac-ft/yr (2.9-39.1 mgd)
Implementation Decade:	2030
Development Timeline:	Varies based on technology
Project Capital Cost:	\$305,856,311 over planning horizon (Sept. 2023)
Unit Water Cost (Rounded):	\$247 to 540 per ac-ft

Project Description

In Southeast Texas, manufacturing water use represents the greatest non-municipal demand center for water. Almost 94 percent of this demand is centered in Brazoria, Galveston, and Harris Counties where substantial infrastructure has been constructed to provide large volumes of surface water for industrial use. Conservation projects have the benefit of not only enhancing the ability to meet needs through the creation of less developed water but also provides an opportunity to offset expansion of these costly raw water conveyances that are required to deliver these supplies.

Senate Bill 1094, enacted by the Texas Legislature in 2003, created the Water Conservation Implementation Task Force to review, evaluate, and recommend optimum levels of water use efficiency and conservation for the state. Members of the Task Force, which were appointed by the Texas Water Development Board (TWDB), were a volunteer group of persons with experience in and commitment to using water more efficiently. The Task Force developed TWDB Report 362 – Water Conservation Best Management Practices Guide, which outlines specific water conservation best management practices (BMPs) for various water uses. The Task Force was a temporary group, but it has been succeeded by the state Water Conservation Advisory Council, created by the Legislature in 2007. Among its other responsibilities, the Council updates the BMP Guide as needed. The BMP Guide is available online on the TWDB website at the following address: <https://www.twdb.texas.gov/conservation/BMPs/index.asp>.

Industrial water conservation BMPs, discussed in the TWDB Water Conservation BMP Guide, include the following:

- Industrial Water Audit
- Industrial Water Waste Reduction
- Industrial Submetering
- Cooling Towers
- Cooling Systems (other than cooling towers)

- Industrial Alternative Sources and Reuse of Process Water
- Rinsing/Cleaning BMP
- Water Treatment
- Boiler and Steam Systems
- Refrigeration (including chilled water)
- Once Through Cooling
- Management and Employee Programs
- Industrial Landscape
- Industrial Site Specific Conservation

Project Analyses

The project analyses for Industrial Conservation include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The nature of industrial demands makes the estimation of water demands a difficult task, in turn creating challenges in estimating potential conservation savings. The actual level of water use by industry is related directly to the product produced and the process employed in this manufacture. Accordingly, information regarding water use is often seen as highly proprietary information. Furthermore, detailed information regarding how water is used at each facility is ultimately required to prescribe specific conservation practices. The reality of water use by industry makes the assignment of specific approaches and savings virtually impossible. However, industry within the region already embraces conservation, efficiency, and internal reuse practices, and additional conservation measures are likely to be readily embraced by industry as they become cost-effective. This is especially true as the cost of water is expected to rise over the coming decades.

In order to estimate conservation savings in Region H, a high-level approach was developed based on historic water use records collected by TWDB. For the purpose of developing the 2026 Region H Regional Water Plan (RWP), data from 2010 to 2019 was provided by TWDB and presented according to each industry reporting.

Based on the historical use, an aggregate level of water use per facility was determined. Applying a linear growth pattern to this trend, it was determined that the overall water use was found to reduce at a rate of approximately 0.95 percent annually. Although it is difficult to directly correlate this level of use with level of output, this reduction was recognized over a period of increasing industrial capacity and demand in the greater Houston area. This was determined to be a conservative representation of conservation across industries in Region H. Over time, this results in an increased level of industrial efficiency when applied on an annual basis. *Table 1* below represents this increase in efficiency over time. By applying these factors to the manufacturing Water User Groups (WUGs) on a county and basis, the project can be assumed to provide conservation savings at the levels depicted in *Table 2*, below.

Table 1 – Projected Industrial Efficiency Factors and Water Savings

		2030	2040	2050	2060	2070	2080
Efficiency	Factor	0.995	0.986	0.976	0.967	0.957	0.948
	% Savings	0.47%	1.42%	2.36%	3.31%	4.25%	5.20%

Table 2 – Potential Industrial Conservation Savings by County (Ac-Ft/Yr)

COUNTY	2030	2040	2050	2060	2070	2080
Austin	0	0	0	1	1	1
Brazoria	1,127	3,506	6,059	8,797	11,730	14,866
Chambers	170	528	913	1,325	1,767	2,240
Fort Bend	19	62	106	155	205	261
Galveston	219	681	1,178	1,710	2,280	2,889
Harris	1,767	5,582	9,820	14,116	18,639	23,402
Leon	4	14	24	35	46	59
Liberty	1	4	6	9	12	15
Madison	0	0	0	0	0	0
Montgomery	10	31	54	78	104	132
San Jacinto	0	0	0	0	0	0
Walker	2	4	7	10	14	17
Waller	1	2	4	6	8	10
TOTAL	3,320	10,414	18,171	26,242	34,806	43,892

Environmental Considerations

Due to the nature of the project, industrial conservation will occur on an as-appropriate basis in entity-appropriate ways across the region. Actual impacts may result from the way these projects are implemented. However, these projects will generally be employed on existing plant sites and therefore not impact habitat. The most likely impact, if any, from these projects will be the result of reduced return flows. However, since the project will offset a limited portion of the overall demand growth projected for Region H, there will continue to be an overall net increase in return flows associated with industrial water demand despite the conservation measures represented here.

Permitting and Development

There are no permitting issues related to the implementation of these projects aside from those that may be related to the implementation of new production technologies.

Cost Analysis

Costs for implementation of an industrial conservation program were estimated using a generalized assumption of \$5,000 in capital infrastructure required per new ac-ft of water-saving infrastructure capacity developed in each decade. This number is intended to be a high-level, conservative estimate;

actual costs would be expected to vary by facility and specific conservation practices implemented. Estimated costs are summarized in *Table 3*.

Table 3: Industrial Conservation Project Costs

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$219,460,000	\$219,460,000
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$76,811,000	\$76,811,000
3	LAND AND EASEMENTS	1	LS	\$0	\$0
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$9,585,311	\$9,585,311
PROJECT CAPITAL COST					\$305,856,311

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$1,627,806	\$5,106,015	\$7,281,490	\$7,760,516	\$8,156,190	\$8,653,848
2	OPERATION AND MAINTENANCE (O&M)	\$166,000	\$520,700	\$908,550	\$1,312,100	\$1,740,300	\$2,194,600
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$1,793,806	\$5,626,715	\$8,190,040	\$9,072,616	\$9,896,490	\$10,848,448

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$1,793,806	\$5,626,715	\$8,190,040	\$9,072,616	\$9,896,490	\$10,848,448
2	YIELD	3,320	10,414	18,171	26,242	34,806	43,892
3	UNIT COST	\$540	\$540	\$451	\$346	\$284	\$247
TOTAL UNIT COST							\$332

Project Evaluation

Based on the analysis provided above, the Industrial Conservation project was evaluated across 12 different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost		Low cost compared to other regional projects.
Location	5	Conservation is applied at point of water use.
Water Quality		No known impacts to water quality.
Environmental Land and Habitat	5	Virtually no opportunity for land or habitat impacts on existing industrial sites.
Environmental Flows	2	Conservation may reduce return flows in the near term but is offset by growth of industrial demands over the long term.
Local Preference	4	Local support for conservation projects as they become economically viable.

CRITERIA	RATING	EXPLANATION
Institutional Constraints	3	Limited identified permitting obstacles.
Development Timeline	5	Projects can be implemented quickly.
Sponsorship	2	Projects may be sponsored by individual industries, but interest level varies and is uncertain. .
Vulnerability	5	Very limited risk to developed infrastructure.
Regionalization	1	Sponsored by and serving single systems.
Impacts on Other Projects	3	No known impacts to other projects.

Industrial Conservation is not anticipated to affect acreage or vulnerable species. However, actual implementation by project sponsors may require development of infrastructure outside the footprint of existing plant facilities in order to realize the potential savings. The projects may potentially reduce surface water diversions and positively impact instream flows by as much as 43,892 ac-ft/yr depending upon the source of potential alternative supplies. Industrial Conservation is not anticipated to impact agricultural land or production.

Water User Group Application

The Industrial Conservation project 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 project as well as other factors that may relate to the auditability of the project to the WUGs served.

CRITERIA	WUG SUITABILITY
Proximity	Project availability in the same location as industrial use throughout Region H.
Size	The nature of this project makes its yield relative to the size of industrial operations.
Water Quality	This project does not produce new water but reduces need by conservation of other supplies.
Unit Cost	The unit cost for this project depends on technology employed and will depend on the cost for alternative water supplies.
Other Factors	This project is suited only to industrial demand. Actual implementation of projects will be performed by manufacturers.

References

Texas Water Development Board Report 362 – Water Conservation Best Management Practices Guide, November 2004.

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Irrigation Conservation
Project ID:	CNSV-003
Project Type:	Conservation
Potential Supply Quantity (Rounded):	103,799 ac-ft/yr (92.6 mgd)
Implementation Decade:	2030
Development Timeline:	1-3 years
Project Capital Cost:	\$2,521,185 for canal lining projects only (Sept. 2023)
Unit Water Cost (Rounded):	\$157 per ac-ft (during loan period) \$155 per ac-ft (after loan period)

Strategy Description

In Southeast Texas, including Region H, irrigated agriculture is dominated by rice production. Although rice is a water-intensive crop, this high demand for water makes it an ideal opportunity for implementation of water conservation practices.

Senate Bill 1094, enacted by the Texas Legislature in 2003, created the Water Conservation Implementation Task Force to review, evaluate, and recommend optimum levels of water use efficiency and conservation for the state. Members of the Task Force, which were appointed by the Texas Water Development Board (TWDB), were a volunteer group of persons with experience in and commitment to using water more efficiently. The Task Force developed TWDB Report 362 – Water Conservation Best Management Practices Guide, which outlines specific water conservation best management practices (BMPs) for various water uses. The Task Force was a temporary group, but it has been succeeded by the state Water Conservation Advisory Council, created by the Legislature in 2007. Among its other responsibilities, the Council updates the BMP Guide as needed. The BMP Guide is available online on the TWDB website at the following address: <https://www.twdb.texas.gov/conservation/BMPs/index.asp>. Various BMPs from this report are discussed and outlined in this project.

To supplement the TWDB Report 362, the report *Potential Rice Irrigation Water Conservation Measures, Water Planning Group - Region H* by James W. Stansel of Texas A&M University proposes several conservation methods to reduce irrigation water demand. The study first addresses on-farm conservation practices. Specifically covered are the benefits of land leveling to reduce the water required for each flush, multiple field inlets to reduce overfilling of the higher cuts, reduced levee spacing to reduce the water required for each flush and replacing irrigation ditches with pipes to reduce seepage and evaporation losses. The study also addresses off-farm conservation through the lining of irrigation canals to reduce losses.

Eight Region H counties have notable irrigation demands related to rice irrigation. This project analyzes the potential for implementation of conservation measures and identifies reasonable quantities of water savings and the associated cost of the project.

Strategy Analyses

The project analyses for Irrigation Conservation include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The first step in identifying potential supply volumes associated with conservation practices was to determine the volume of water demand and associated acreage for rice production in each Region H county. Data collected and compiled by TWDB in the development of water demands and application rates for agriculture were used to determine the percentage of the overall demand attributable to rice which could then be used with application rate to determine the number of acres in production.

For the 2016 Region H Regional Water Plan (RWP), a Geographic Information System (GIS) was created containing data on crop locations as well as aerial imagery. CropScape data from the National Agricultural Statistics Service (NASS) was used to identify locations in Region H that are used for rice production. Data from 2010 through 2012 was used for this purpose as rice acreage is rotated over a number of years. Year 2012 imagery from the National Agriculture Imagery Program (NAIP) was used to investigate areas identified as being active for rice irrigation. Visual inspection was used to determine if fields in the vicinity demonstrated characteristics of conservation practices (laser leveling, reduced levee intervals, etc.) or appeared to be unimproved. Farm lands of both varieties were outlined with polygons identifying them as improved or unimproved. Once a review of Region H rice-producing counties was completed, the resulting polygons were analyzed to determine the percentage of rice production acreage in each county and basin that has already received some level of improvement and would not be considered viable for application of additional conservation projects. Improvement percentages from the 2016 Region H RWP were retained for the current analysis of potential conservation savings. On-farm savings were applied to the annual active acreage estimated from the demand projections for the percentage assumed to be unimproved at a rate of 1.4 ac-ft/ac. Off-farm techniques were applied assuming a canal length of 16.5 feet per active acre and a savings rate of 38.0 ac-ft/mile of canal. *Table 1* below demonstrates the resulting savings identified for each county in every decade of the planning cycle. Note that the potential savings are level over time, which is consistent with the level nature of projected irrigation demands.

Table 1 – Potential Irrigation Conservation Savings by County (Ac-Ft/Yr)

COUNTY	2030	2040	2050	2060	2070	2080
Austin	2,662	2,662	2,662	2,662	2,662	2,662
Brazoria	29,303	29,303	29,303	29,303	29,303	29,303
Chambers	43,258	43,258	43,258	43,258	43,258	43,258
Fort Bend	4,770	4,770	4,770	4,770	4,770	4,770
Galveston	2,459	2,459	2,459	2,459	2,459	2,459
Harris	125	125	125	125	125	125
Liberty	14,702	14,702	14,702	14,702	14,702	14,702
Waller	6,520	6,520	6,520	6,520	6,520	6,520
TOTAL	103,799	103,799	103,799	103,799	103,799	103,799

Environmental Considerations

Due to the nature of the project, project implementation will occur in areas that are already disturbed through use in rice production or that have already been developed for the use of water conveyance to production land. The reduction in overall application of irrigation water may result in a reduction of return flows when fields are drained prior to harvest. These flushes may occur twice a year after the first and second (ratoon) crops and may beneficially impact downstream habitat during the dry summer season. However, these potential impacts are offset by the reduced diversion of water for irrigation purposes. Greater potential for impacts may exist for improvements made to conveyance channels depending on the specifics of the project application.

Permitting and Development

Based on a preliminary desktop review, the following environmental permits and permitting activities may potentially apply to projects other than on-farm practices:

- U.S. Army Corps of Engineers (USACE) Section 404 Permit – All proposed pipeline rights-of-way (ROW), temporary workspace, and access road locations should be delineated for waters of the U.S., including wetlands. The proposed pipeline construction would likely be permitted under Nationwide Permit (NWP) 12-Utility Line Activities either with or without a Pre-construction Notification (PCN) to the USACE depending on the amount of impacts to waters of the U.S. If pipelines are placed within irrigation canals that are channelized streams (waters of the U.S.), construction would likely be permitted under NWP 12 with a PCN or Section 404 Individual Permit (IP) depending on the amount of impacts to waters of the U.S. If channel lining occurs within irrigation canals that are channelized streams (waters of the U.S.), construction would likely be permitted under NWP 3-Maintenance with or without a PCN or Section 404 IP depending on the amount of impacts to waters of the U.S.
- Texas Historical Commission (THC) Coordination - Projects sponsored by public entities that affect a cumulative area greater than five acres or that disturb more than 5,000 cubic yards require advance consultation with the Texas Antiquities Committee according to Section 191.0525 (d) of the Antiquities Code of Texas. Because the proposed pipeline and/or irrigation canal lining may exceed these thresholds, coordination with the THC would be required. The THC may determine that archeological and/or historical surveys are needed.
- Threatened and Endangered Species – All proposed pipeline ROW, temporary workspace, and access road locations as well as lining projects within channelized streams (waters of the U.S.) should be surveyed for potential threatened and endangered species habitat. If preferred habitat for threatened or endangered species is present, presence/absence surveys for the species would be required.

Cost Analysis

Costs for on-farm conservation measures and canal lining were taken from the report by Stansel (2000) and scaled to September 2023 costs using the Engineering News Record (ENR) Construction Cost Index (CCI). Overall costs for Region H are shown in *Table 2* below.

Table 2 – Irrigation Conservation Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$1,751,713	\$1,751,713
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$613,099	\$613,099
3	LAND AND EASEMENTS	1	LS	\$0	\$0
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$156,373	\$156,373
PROJECT CAPITAL COST					\$2,521,185

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$177,393	\$177,393	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$17,517	\$17,517	\$17,517	\$17,517	\$17,517	\$17,517
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
5	ON-FARM CONSERVATION MEASURES	\$16,076,428	\$16,076,428	\$16,076,428	\$16,076,428	\$16,076,428	\$16,076,428
TOTAL ANNUAL COST		\$16,271,339	\$16,271,339	\$16,093,946	\$16,093,946	\$16,093,946	\$16,093,946

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$16,271,339	\$16,271,339	\$16,093,946	\$16,093,946	\$16,093,946	\$16,093,946
2	YIELD	103,799	103,799	103,799	103,799	103,799	103,799
3	UNIT COST	\$157	\$157	\$155	\$155	\$155	\$155
TOTAL UNIT COST		\$156					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	WATER DISTRIBUTION SYSTEM IMPROVEMENTS	1	LS	\$1,751,713	\$1,751,713
PROJECT COST					\$1,751,713

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	WATER DISTRIBUTION SYSTEM IMPROVEMENTS	1.0	%	\$1,751,713	\$17,517
ANNUAL OPERATION AND MAINTENANCE COST					\$17,517

Water Management Strategy Evaluation

Based on the analysis provided above, the Irrigation Conservation project was evaluated across twelve different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	Low cost compared to other regional projects but may be prohibitive compared to the current cost of water for agriculture.
Location	5	Conservation is applied at point of water use.

CRITERIA	RATING	EXPLANATION
Water Quality		Potential improvement due to reduced downstream runoff.
Environmental Land and Habitat	4	Minimal impacts above existing agricultural operations.
Environmental Flows	3	Conservation may reduce return flows at the end of growing seasons but also reduces the necessary diversions for irrigation use.
Local Preference	3	Support by some proactive growers and those that own their own property and can invest in long-term improvements.
Institutional Constraints	5	Limited identified permitting obstacles.
Development Timeline	5	Projects can be implemented quickly, and even off-farm methods have relatively short timelines.
Sponsorship	3	Projects may be sponsored by local farmers and irrigation water providers, but interest level varies and is uncertain.
Vulnerability	5	Very limited risk to developed infrastructure.
Regionalization	1	Typically implemented at the individual farm level.
Impacts on Other Projects	3	No known impacts to other projects.

Irrigation Conservation will impact over 68,000 acres of rice-producing land in Region H. Reduction in impounded water in rice fields may negatively impact migratory species that rely on the artificially wet areas for habitat. Costs associated with the project may impose burden upon rice production if alternative means of finance are not available. The projects may potentially reduce surface water diversions and positively impact instream flows by as much as 103,799 ac-ft/yr depending upon the source of potential alternative supplies. However, the projects may negatively impact dry-weather base flows that occur as a result of draining excess water from rice fields during harvest.

Water User Group Application

The Irrigation Conservation project 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 project as well as other factors that may relate to the suitability of the project to the WUGs served.

CRITERIA	WUG SUITABILITY
Proximity	The project availability is in the same location as irrigation water use for rice production and is focused in Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, and Waller Counties.
Size	The nature of this project makes its yield relative to the size of irrigation operations.
Water Quality	This project does not produce new water but reduces need by conservation of other supplies.
Unit Cost	The unit cost for this project is relatively expensive for irrigation use but is one of the most cost-competitive alternatives for agriculture.
Other Factors	This project is suited only to irrigation demand. Actual implementation of projects will be performed by growers or water suppliers. This process is complicated by the predominance of rice production in Region H being performed on land leased by the producer, often discouraging the long-term investment necessary to implement these programs.

References

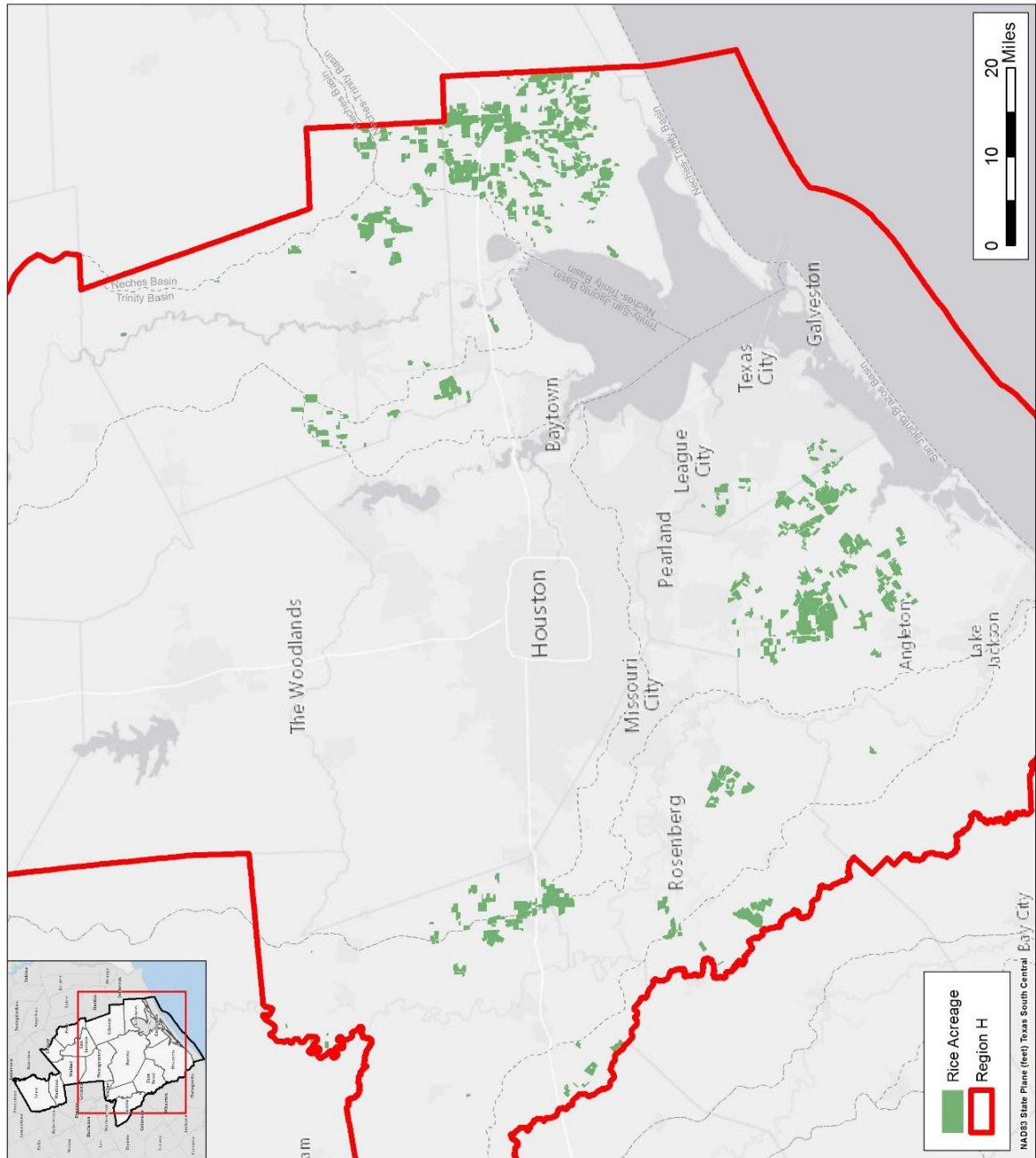
Texas Water Development Board. 2004. *Water Conservation Best Management Practices Guide*, TWDB Report 362.

Stansel, J. W. 2000. *Potential Rice Irrigation Water Conservation Measures*, Water Planning Group - Region H. Texas A&M University System.

Texas Water Development Board. 2001. *Surveys of Irrigation in Texas 1958, 1964, 1969, 1974, 1979, 1984, 1989, 1994, and 2000*. TWDB Report 347.

Texas Parks and Wildlife, <https://tpwd.texas.gov/gis/rtest/>, accessed December 2024.

Location Map



Irrigation Conservation Location Map



THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	BWA Transmission and Storage Expansion
Project ID:	CONV-001
Project Type:	Various
Potential Supply Quantity (Rounded):	16,800 ac-ft/yr (15 mgd)
Implementation Decade:	2030
Development Timeline:	<5 years
Project Capital Cost:	\$84,794,502 (Sept. 2023)
Unit Water Cost (Rounded):	\$437 per ac-ft (during loan period) \$82 per ac-ft (after loan period)

Strategy Description

The Brazosport Water Authority (BWA) serves seven communities in the southern Brazoria County area and provides potable service to Dow Inc. and two Texas Department of Criminal Justice (TDCJ) units, as well as the City of Rosenberg. In December of 2013, BWA concluded a Texas Water Development Board (TWDB) Regional Facility Planning Grant study to examine the potential for serving the current BWA service area as well as other portions of Brazoria County in the future. This study recommended the development of a reverse osmosis (RO) water treatment plant (WTP) at the site of the current BWA surface water treatment plant, as well as expansion of BWA's surface water treatment plant in order to accommodate additional growth within and surrounding the existing service area of the facility. More recently, BWA has identified a need to increase the capacity of its transmission system to serve the increasing demands of its customers. This expansion will allow BWA to supply an increased amount of water to customer entities and facilitates use of supply created under related projects.

Strategy Analyses

The project analyses for the BWA Transmission Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

BWA pumps surface water from its own rights in the Brazos River, as well as water diverted on behalf of others, to provide treated water to municipal, institutional, and industrial water users in Brazoria and Fort Bend Counties. In order to meet the projected future demands of its customer base, BWA has been actively engaged in development of additional supply sources, including brackish groundwater and expanded reservoir storage. BWA has determined that additional transmission

infrastructure capacity will be required in order to provide increased water supply from current and future sources to its wholesale customers. The BWA Transmission Expansion project is anticipated to increase deliverable treated water supply by up to 15 mgd (16,800 ac-ft/yr).

The project concept presented here is adapted from information provided by BWA on anticipated transmission line and storage expansions. BWA expects to construct an additional transmission line of estimated 36 to 48-inch diameter northward from its treatment facility to the Angleton area to tie into the BWA Northern Regional Pipeline, increasing overall conveyance capacity to serve northern customers including the Texas Department of Criminal Justice (TDCJ) Darrington Unit. The expansion would also include development of additional pump station capacity and a five million gallon clearwell. The expansion is anticipated to be online by 2027. BWA additionally anticipates additional ground storage and pump station capacity development near the City of Clute by 2030.

Environmental Considerations

Environmental issues are expected to be minimal due to the use of existing corridors for development. Further environmental study will be conducted as part of the ongoing study of alternatives and configurations.

Permitting and Development

Permitting issues related to the project will be examined more closely during further phases of study. Infrastructure development may result in some construction disturbance which could require mitigation. However, the development of the project primarily within existing right-of-way in an urbanized setting minimizes potential permitting obstacles.

Cost Analysis

A preliminary planning-level cost estimate was developed for the BWA Transmission and Storage Expansion project using standard regional planning assumptions. Construction costs include the estimated cost of transmission lines and associated booster pump stations, as well as a ground storage tank near Clute to facilitate the delivery of an additional 3.5 mgd to Clute and Freeport. Other estimated capital cost components include engineering services, surveying, environmental studies and mitigation, and interest during construction. It was assumed that pipelines would be developed in existing rights-of-way. Regional planning cost estimating assumptions were also applied to estimate annualized debt service and ongoing costs of operation and maintenance. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Project cost estimates are presented in September 2023 dollars in *Table 1*.

Table 1 – BWA Transmission and Storage Expansion Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$59,898,207	\$59,898,207
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$19,016,080	\$19,016,080
3	LAND AND EASEMENTS	1	LS	\$103,896	\$103,896
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$517,068	\$517,068
5	INTEREST DURING CONSTRUCTION	1	LS	\$5,259,251	\$5,259,251
PROJECT CAPITAL COST					\$84,794,502

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$5,966,232	\$5,966,232	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$840,549	\$840,549	\$840,549	\$840,549	\$840,549	\$840,549
3	PUMPING ENERGY COSTS	\$533,552	\$533,552	\$533,552	\$533,552	\$533,552	\$533,552
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$7,340,333	\$7,340,333	\$1,374,101	\$1,374,101	\$1,374,101	\$1,374,101

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$7,340,333	\$7,340,333	\$1,374,101	\$1,374,101	\$1,374,101	\$1,374,101
2	YIELD	16,800	16,800	16,800	16,800	16,800	16,800
3	UNIT COST	\$437	\$437	\$82	\$82	\$82	\$82
TOTAL UNIT COST		\$200					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$16,104,464	\$16,104,464
2	PIPELINES	1	LS	\$38,965,852	\$38,965,852
3	WATER STORAGE TANKS	1	LS	\$4,827,890	\$4,827,890
PROJECT COST					\$59,898,207

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$16,104,464	\$402,612
2	PIPELINES	1.0	%	\$38,965,852	\$389,659
3	WATER STORAGE TANKS	1.0	%	\$4,827,890	\$48,279
ANNUAL OPERATION AND MAINTENANCE COST					\$840,549

Water Management Strategy Evaluation

Based on the analysis provided above, the BWA Transmission and Storage Expansion project was evaluated across twelve different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	4	While not directly generating supply, the project provides conveyance of treated water with only a limited additional cost.

CRITERIA	RATING	EXPLANATION
Location	4	Project reflects conveyance infrastructure from a treatment facility to demand centers.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	5	Limited impacts associated with construction in existing corridors.
Environmental Flows	3	No impact to environmental flows.
Local Preference	4	Local support. Limited opposition.
Institutional Constraints	3	Property availability and limited permitting efforts.
Development Timeline	4	Project to be developed within 5 years.
Sponsorship	4	Brazosport Water Authority is identified as a sponsor and is committed to development.
Vulnerability	5	Minimal risk associated with pipeline infrastructure.
Regionalization	4	Supports multiple customer systems and expands upon existing regionalized supplies.
Impacts on Other WMS	5	Project facilitates the use of treated surface water and treated brackish groundwater from BWA facilities.

Water User Group Application

The BWA Transmission and Storage Expansion project 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.

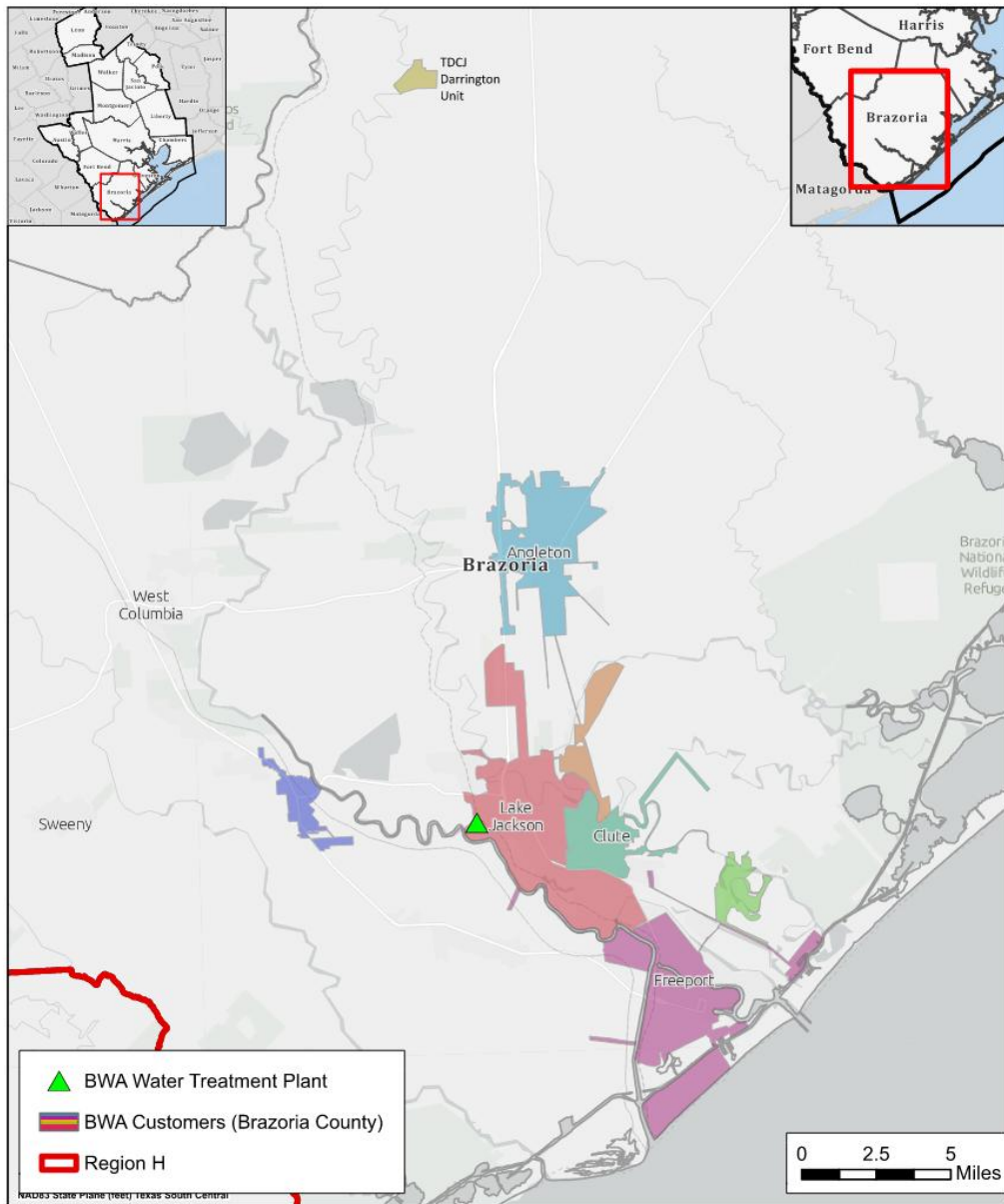
CRITERIA	WUG SUITABILITY
Proximity	This project conveys treated water to BWA customers in southern and northern Brazoria County.
Size	The capacity of this project is based on the projected need of the sponsor's customers.
Water Quality	This project will convey treated, potable water.
Unit Cost	Adds small amount to unit cost of BWA's strategies to provide additional water to wholesale customers.

CRITERIA	WUG SUITABILITY
Other Factors	This project has been identified for a few specific customers of the project sponsor.

References

CDM-Smith. *Brazoria County Regional Water Facility Study*. May 2013.

Location Map



BWA Transmission and Storage Expansion Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Central Harris County Regional Water Authority Transmission and Internal Distribution
Project ID:	CONV-002
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	5,466 ac-ft/yr (4.88 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	5 years
Project Capital Cost:	\$22,717,067 (Sept. 2024)
Unit Water Cost (Rounded):	\$314 per ac-ft (during loan period) \$22 per ac-ft (after loan period)

Strategy Description

The Harris-Galveston Subsidence District (HGSD) has established requirements for entities within its boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the Central Harris County Regional Water Authority (CHCRWA) has contracted with the City of Houston (COH) to receive treated surface water. The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH. In order to utilize sufficient supplies to meet future surface water conversion obligations, CHCRWA is developing expansions to its transmission and distribution infrastructure.

Strategy Analyses

The project analyses for CHCRWA Transmission and Internal Distribution include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

CHCRWA will continue to deliver surface water to certain districts within the Authority to meet the requirements of its Groundwater Reduction Plan (GRP). The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH, which is reflected in the Regional Plan as an existing supply. In order to meet future water demands and regulatory conversion obligations, the Authority has continued development and implementation of its GRP program. The Authority has increased its

supply reservation from COH from an original reservation of 2.12 mgd (2,374 ac-ft/yr) currently applied in the Regional Plan as existing supply to 7.0 mgd (7,840 ac-ft/yr). CHCRWA is developing expanded transmission infrastructure to convey supplies from a new shared pipeline with COH and North Harris County Regional Water Authority (NHCRA). Transmission facilities include a connection to a NHCRA pipeline along Hardy Toll Road and another connection along TC Jester Blvd. CHCRWA is also developing an expansion of the infrastructure network through which it supplies its member districts.

Environmental Considerations

Infrastructure development may result in some construction disturbance which could require mitigation. The most significant impact associated with the GRP is the source supply, which requires the interbasin transfer of surface water supplies.

Permitting and Development

CHCRWA is subject to contractual requirements established by COH as well as any relevant permitting required by the State of Texas and HGSD. Development of expanded distribution infrastructure will cause some degree of surface disturbance, which may require permitting and mitigation. Infrastructure development is also likely to require acquisition of additional easements or property.

Cost Analysis

Planning-level capital cost estimates for the CHCRWA Transmission and Internal Distribution project were provided by the Authority's engineering consultant; capital costs included estimates for engineering and legal fees, contingency, land acquisition, surveying, environmental studies and mitigation, and cost of bond issuance. Capital costs were scaled to a September 2023 equivalent cost using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. Capital costs for interest during construction and annual cost components such as annualized debt service and operations and maintenance costs were assumed using standard Regional Planning costing assumptions. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs are presented in *Table 1*.

Table 1 – CHCRWA Transmission and Internal Distribution Project Costs

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$12,010,000	\$12,010,000
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$6,330,000	\$6,330,000
3	LAND AND EASEMENTS	1	LS	\$930,000	\$930,000
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$60,000	\$60,000
5	INTEREST DURING CONSTRUCTION	1	LS	\$3,387,067	\$3,387,067
PROJECT CAPITAL COST					\$22,717,067

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$1,598,397	\$1,598,397	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$120,100	\$120,100	\$120,100	\$120,100	\$120,100	\$120,100
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$1,718,497	\$1,718,497	\$120,100	\$120,100	\$120,100	\$120,100

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$1,718,497	\$1,718,497	\$120,100	\$120,100	\$120,100	\$120,100
2	YIELD	5,466	5,466	5,466	5,466	5,466	5,466
3	UNIT COST	\$314	\$314	\$22	\$22	\$22	\$22
TOTAL UNIT COST		\$119					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$10,280,000	\$10,280,000
2	METER STATIONS	1	LS	\$1,730,000	\$1,730,000
PROJECT COST					\$12,010,000

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES	1.0	%	\$10,280,000	\$102,800
2	METER STATIONS	1.0	%	\$1,730,000	\$17,300
ANNUAL OPERATION AND MAINTENANCE COST					\$120,100

Water Management Strategy Evaluation

Based on the analysis provided above, the CHCRWA Transmission and Internal Distribution project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	4	The CHCRWA Transmission and Internal Distribution, while not directly generating supply, provides conveyance with a reasonable level of additional cost.
Location	4	Reflects conveyance infrastructure from major transmission pipelines to demand centers.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	3	Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.
Local Preference	4	Local support. Limited opposition.
Institutional Constraints	3	Permits expected with minimal problems. Property available.
Development Timeline	4	Project to be developed within five years.
Sponsorship	5	Sponsors identified and project is in development.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No known significant impacts to other projects.

The CHCRWA Transmission and Internal Distribution includes the construction of several pipeline segments. The majority of this impact will be in urbanized areas with limited impacts to habitat. However, the project will not directly impact environmental flows. The CHCRWA Transmission and Internal Distribution is not anticipated to impact agricultural land or production.

Water User Group Application

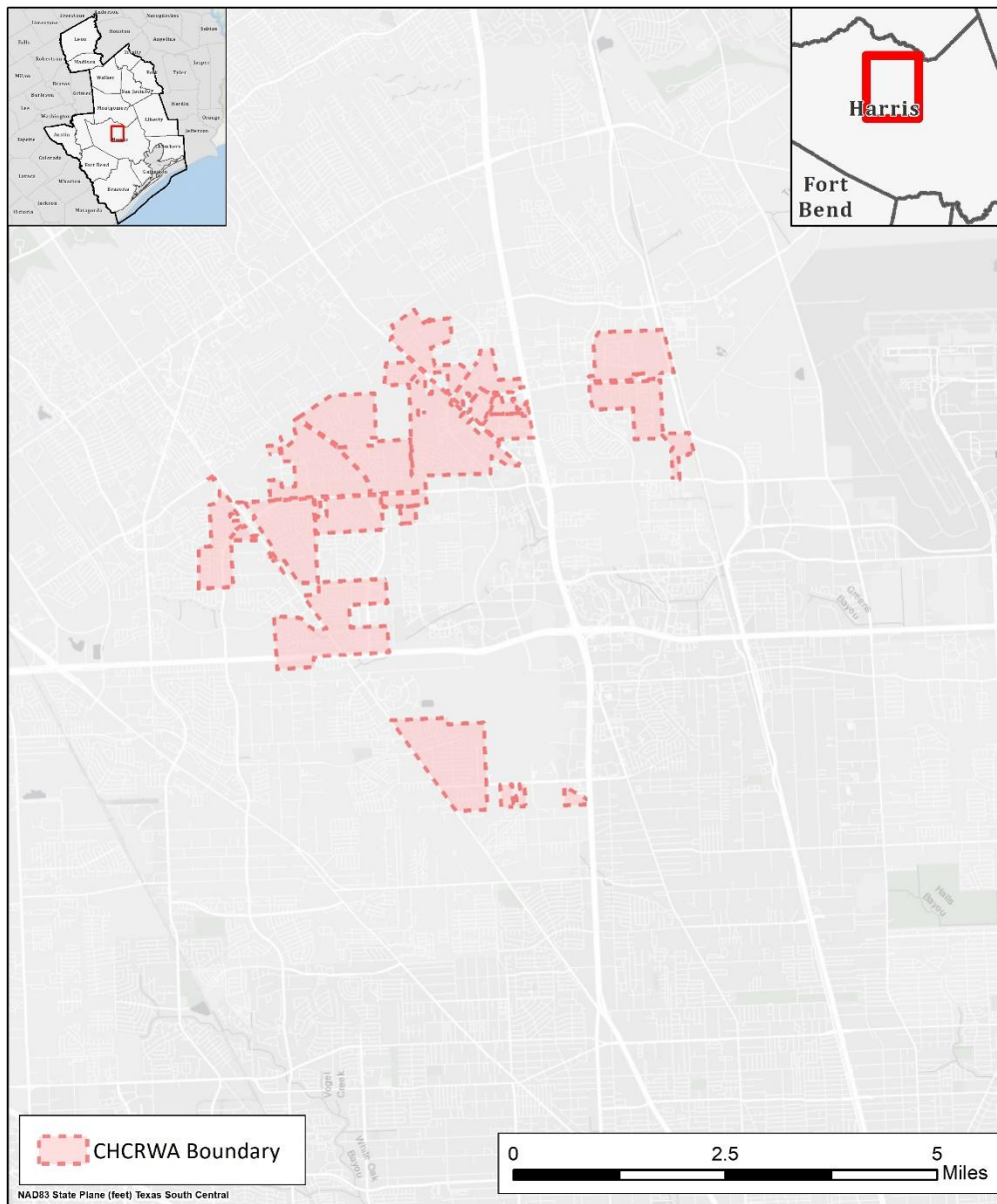
The CHCRWA Transmission and Internal Distribution project was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality 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 anticipated that the project will only serve member districts of the CHCRWA.

CRITERIA	WUG SUITABILITY
Proximity	Conveyance infrastructure from major transmission pipelines to demand centers.
Size	Conveyance is sized to convey the requisite amount of source water.
Water Quality	Conveys treated water of quality appropriate for municipal use.
Unit Cost	Adds small amount to unit cost of CHCRWA's surface water conversion process.
Other Factors	Reduces dependence on Gulf Coast Aquifer groundwater.

References

Central Harris County Regional Water Authority. *Transmission and Distribution System Expansion Preliminary Planning Report*, prepared by IDS Engineering Group, July 2016.

Location Map



CHCRWA Transmission and Internal Distribution Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	City of Houston GRP Transmission
Project ID:	CONV-003
Project Type:	Conveyance
Potential Supply Quantity (Rounded):	51,789 ac-ft/yr (46.2 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	<5 years
Project Capital Cost:	\$260,640,042 (Sept. 2023)
Unit Water Cost (Rounded):	\$347 per ac-ft (during loan period) \$50 per ac-ft (after loan period)

Strategy Description

The Harris-Galveston Subsidence District (HGSD) has established requirements for entities within its boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged heavy pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the City of Houston (COH) has used its surface water rights and treatment capacity to provide an alternative to groundwater pumpage. The COH has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand. In order to utilize sufficient supplies to meet future surface water conversion obligations, COH is developing multiple infrastructure projects related to the treatment and distribution of surface water. The project also supports the City's One Water Houston approach to integrated, sustainable management of water resources.

Strategy Analyses

The project analyses for COH Groundwater Reduction Plan (GRP) Transmission include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The COH has developed significant infrastructure for the development, treatment, and delivery of surface water supplies. These projects have formed the fundamental basis for much of the region's conversion from groundwater to alternative water sources. In several cases, such as the regional water authorities, COH supplies are already used as an alternative source of water and will continue to be a critical resource in the future.

In addition to providing water to regional authorities for their GRPs, COH maintains compliance with

HGSD rules through its own use of surface water supplies within the City's retail water service area. COH has also made an opportunity available for other water users to join the COH GRP to promote synergy in addressing the region's water supply issues. Of the 92 total participants in the COH GRP, 49 can be identified as named Water User Groups (WUGs) in the Region H Regional Water Plan (RWP).

In some cases, COH does not provide direct surface water supplies to these participants. Instead, COH provides its own over-conversion as a service to these participants to account for their pumpage of groundwater, causing a net reduction in overall groundwater use. In effect, the requirement for groundwater conversion is met jointly across the GRP as is done by other GRP sponsors in the region. However, COH is planning to begin delivery of treated surface water to some of these participants by developing several new pipelines as part of the COH GRP Transmission project. Four transmission lines are considered for development, with three planned for implementation by 2030 and the fourth by 2035. The Kingwood Conversion Water Transmission Line, the Group B Transmission Line, and the Group C Transmission Line, which are scheduled for completion by 2030, are expected to provide supply of 20.0 mgd, 5.24 mgd, and 8 mgd, respectively, for a total increase of 33.24 mgd (37,229 ac-ft/year). The Willowchase Conversion, scheduled for completion by 2035, will provide an estimated supply quantity increase of 13 mgd (14,560 ac-ft/year).

Environmental Considerations

Environmental issues are expected to be limited, as pipelines will primarily be constructed in developed areas in the northern part of the greater Houston area. Further environmental study will be conducted as part of the ongoing study of alternatives and configurations.

Permitting and Development

Permitting issues related to the project will be examined more closely during further phases of study. Infrastructure development may result in some construction disturbance which could require mitigation. However, the development of the project primarily within existing right-of-way in an urbanized setting minimizes potential permitting obstacles.

Cost Analysis

Project costs were provided by COH. Capital costs for engineering, design, construction, and contingency, environmental mitigation, land acquisition, and interest during construction costs were assumed to be included in the costs provided by COH. Standard assumptions for regional planning were applied to determine annualized debt service and annual operating and maintenance costs. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated project costs for the COH GRP Transmission project are shown in *Table 1* in September 2023 dollars.

Table 1 – COH GRP Transmission Total Estimated Project Cost

OPINION OF PROBABLE CONSTRUCTION COST						September 2023	
ITEM	DESCRIPTION			QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY							
1	CONSTRUCTION AND NON-CONSTRUCTION COSTS (ENGINEERING, LAND ACQUISITION, ETC.)			1	LS	\$260,640,042	\$260,640,042
PROJECT CAPITAL COST							\$260,640,042

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (GRP Transmission 2030)	\$11,302,806	\$11,302,806	\$0	\$0	\$0	\$0
2	DEBT SERVICE (GRP Transmission 2040)	\$0	\$7,036,108	\$7,036,108	\$0	\$0	\$0
3	OPERATION AND MAINTENANCE (GRP Transmission 2030)	\$1,606,400	\$1,606,400	\$1,606,400	\$1,606,400	\$1,606,400	\$1,606,400
4	OPERATION AND MAINTENANCE (GRP Transmission 2040)	\$0	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000
TOTAL ANNUAL COST		\$12,909,207	\$20,945,314	\$9,642,508	\$2,606,400	\$2,606,400	\$2,606,400

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$12,909,207	\$20,945,314	\$9,642,508	\$2,606,400	\$2,606,400	\$2,606,400
2	YIELD	37,229	51,789	51,789	51,789	51,789	51,789
3	UNIT COST	\$347	\$404	\$186	\$50	\$50	\$50
TOTAL UNIT COST		\$173					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES (GRP Transmission 2030)	1	LS	\$160,640,042	\$160,640,042
2	PIPELINES (GRP Transmission 2040)	1	LS	\$100,000,000	\$100,000,000
PROJECT COST					\$260,640,042

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES (GRP Transmission 2030)	1.0	%	\$160,640,042	\$1,606,400
2	PIPELINES (GRP Transmission 2040)	1.0	%	\$100,000,000	\$1,000,000
ANNUAL OPERATION AND MAINTENANCE COST					\$2,606,400

Water Management Strategy Evaluation

Based on the analysis provided above, the COH GRP Transmission project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	4	The COH GRP Transmission project, while not directly generating supply, provides conveyance of treated water with moderately low additional cost.
Location	4	Reflects conveyance infrastructure from treatment to demand centers.
Water Quality	3	No impacts to water quality.
Environmental Land and Habitat	3	Limited concerns. Environmental impacts can be mitigated.
Environmental Flows	3	No impact to environmental flows.
Local Preference	4	Minimal local opposition expected.
Institutional Constraints	3	Property available and limited permitting efforts.
Development Timeline	4	Projected may be implemented within 5 years.
Sponsorship	5	Sponsors identified and in the process of developing project.
Vulnerability	5	Minimal risk associated with pipeline infrastructure.
Regionalization	4	Supports existing regional systems across an extensive area.
Impacts on Other WMS	3	No impacts on other WMS are expected.

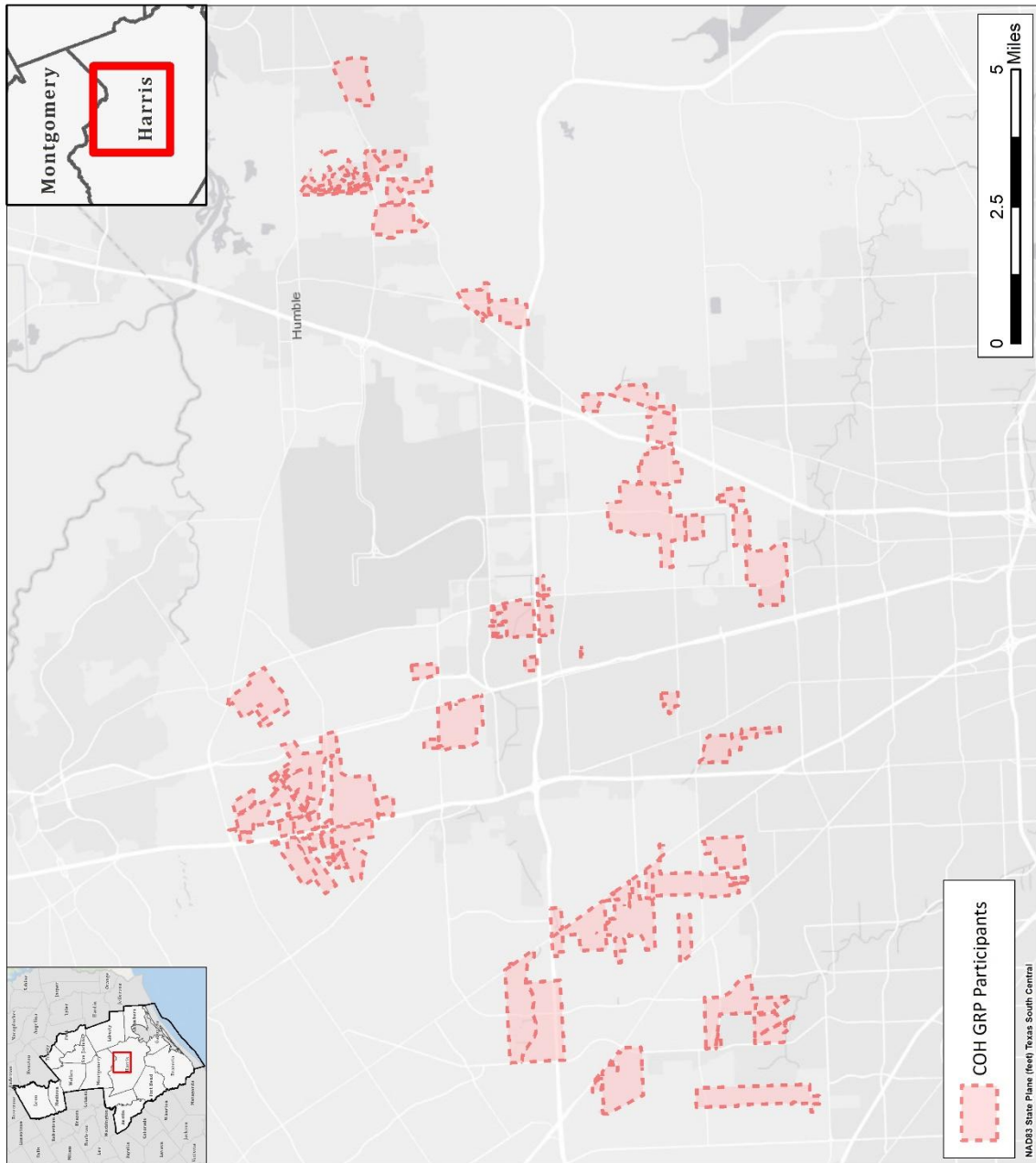
The majority of the impact of this project will be in urbanized areas with limited impacts to habitat. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The COH GRP Transmission project 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.

CRITERIA	WUG SUITABILITY
Proximity	This project is intended to provide water to participants in the COH GRP.
Size	The capacity of this project is based on needs projected by the project sponsor.
Water Quality	This project will convey treated surface water.
Unit Cost	The unit cost for this project is a reasonable price for transmission of treated water for municipal use.
Other Factors	This project is identified for a few specific potential customers of COH.

Location Map



City of Houston GRP Transmission Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	City of Houston Transmission Expansion
Project ID:	CONV-004
Project Type:	Conveyance
Potential Supply Quantity (Rounded):	483,280 ac-ft/yr (431.4 mgd)
Implementation Decade:	2030
Development Timeline:	<5 years
Project Capital Cost:	\$508,742,379 (Sept. 2023)
Unit Water Cost (Rounded):	\$83 per ac-ft (during loan period) \$11 per ac-ft (after loan period)

Strategy Description

The City of Houston (COH) serves an extensive portion of the region, both within its direct retail service area and as a provider to other water systems. This service area has experienced rapid population growth in recent years and is additionally a major industrial and commercial center. COH has identified a number of future transmission and large-scale distribution lines to meet the needs of residents and customer systems; it should be noted that the COH Transmission Expansion project described in this memorandum excludes transmission associated more directly with the COH Groundwater reduction Plan (GRP) and with expansion of the Southeast Transmission Line, both of which are described by separate technical memoranda. The COH Transmission Expansion project will increase conveyance capacity to increase deliverable supply. The project also supports the City's One Water Houston approach to integrated, sustainable management of water resources.

Strategy Analyses

The project analyses for COH Transmission Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

COH has developed significant infrastructure for the development, treatment, and delivery of surface water supplies, with this infrastructure forming the basis for much of the region's water supply. COH has determined that additional transmission infrastructure capacity will be required in order to provide increased water supply from current and future sources to its regionalized water supply system, which serves not only the City itself but also numerous wholesale customers. This infrastructure will work in conjunction with other water management strategies and projects recommended in the RWP, including the COH GRP, COH treatment plant expansions, and source water

development projects in order to increase regional supply.

For the 2026 RWP, COH identified nine major near-term transmission expansion, extension, and construction projects as part of the COH Transmission Expansion project, which are summarized in *Table 1*. Combined peak capacity for these segments is anticipated to allow up to 431.4 mgd, or approximately 483,280 ac-ft/yr, of additional regional water supply to be utilized.

Table 1 – COH Transmission and Distribution Major Segments

Implementation Decade	Project Name
2030	I-45 -AHPS Transmission Line
	Fuqua Extension to SH-288 Transmission Line
	Greenbriar to Southwest Repump Station Transmission Line
	Fuqua Line Extension from SH-288 to Hiram Clark Rd.
	IAH Surface Water Transmission Line
	Westheimer Waterline
	Sims Bayou Extension
	Bellaire Blvd Waterline
2040	Spring Branch Transmission Line

Environmental Considerations

Environmental issues are expected to be limited, as pipelines will primarily be constructed in developed areas in the greater Houston area. Infrastructure development may result in some construction disturbance which could require mitigation.

Permitting and Development

Permitting issues related to the project will be examined more closely during further phases of study. Infrastructure development may result in some construction disturbance which could require mitigation. However, the development of the project primarily within existing right-of-way in an urbanized setting minimizes potential permitting obstacles.

Cost Analysis

Preliminary planning-level costs for identified transmission development were provided by COH. These values were assumed to be inclusive of capital costs for engineering, design, construction, contingency, environmental mitigation, land acquisition, and interest during construction. Standard assumptions for regional planning were applied to determine annualized debt service and annual operating and maintenance costs. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated project costs for the COH Transmission Expansion project are shown in *Table 2* in September 2023 dollars.

Table 2 – COH Transmission and Distribution Total Estimated Project Cost

OPINION OF PROBABLE CONSTRUCTION COST						September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL	
PROJECT CAPITAL COST SUMMARY						
1	TRANSMISSION EXPANSIONS	1	LS	\$508,742,379	\$508,742,379	
PROJECT CAPITAL COST					\$508,742,379	

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (TRANSMISSION 2030)	\$33,684,829	\$33,684,829	\$0	\$0	\$0	\$0
2	DEBT SERVICE (TRANSMISSION 2040)	\$0	\$2,110,832	\$2,110,832	\$0	\$0	\$0
3	OPERATION AND MAINTENANCE (TRANSMISSION 2030)	\$4,787,424	\$4,787,424	\$4,787,424	\$4,787,424	\$4,787,424	\$4,787,424
4	OPERATION AND MAINTENANCE (TRANSMISSION 2040)	\$0	\$534,355	\$534,355	\$534,355	\$534,355	\$534,355
5	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
6	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$38,472,253	\$41,117,440	\$7,432,611	\$5,321,779	\$5,321,779	\$5,321,779

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$38,472,253	\$41,117,440	\$7,432,611	\$5,321,779	\$5,321,779	\$5,321,779
2	YIELD	465,528	483,336	483,336	483,336	483,336	483,336
3	UNIT COST	\$83	\$85	\$15	\$11	\$11	\$11
TOTAL UNIT COST		\$36					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES (TRANSMISSION 2030)	1	LS	\$478,742,379	\$478,742,379
2	PIPELINES (TRANSMISSION 2040)	1	LS	\$30,000,000	\$30,000,000
PROJECT COST					\$508,742,379

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES (TRANSMISSION 2030)	2.5	%	\$478,742,379	\$4,787,424
2	PIPELINES (TRANSMISSION 2040)	2.5	%	\$30,000,000	\$300,000
ANNUAL OPERATION AND MAINTENANCE COST					\$5,087,424

Water Management Strategy Evaluation

Based on the analysis provided above, the COH Transmission Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	The COH Transmission Expansion project, while not directly generating supply, provides conveyance of treated water with small additional cost.
Location	4	Reflects conveyance infrastructure from treatment to demand centers.
Water Quality	3	No impacts to water quality.
Environmental Land and Habitat	3	Limited concerns. Environmental impacts can be mitigated.
Environmental Flows	3	No impact to environmental flows.
Local Preference	4	Minimal local opposition expected.
Institutional Constraints	3	Property available and limited permitting efforts.
Development Timeline	4	Individual segments of project may be implemented within 5 years.
Sponsorship	5	Sponsors identified and in the process of developing project.
Vulnerability	5	Minimal risk associated with pipeline infrastructure.
Regionalization	4	Will increase regionalization by decreasing reliance on groundwater and increasing transmission around the greater Houston area
Impacts on Other WMS	3	No impacts on other WMS are expected.

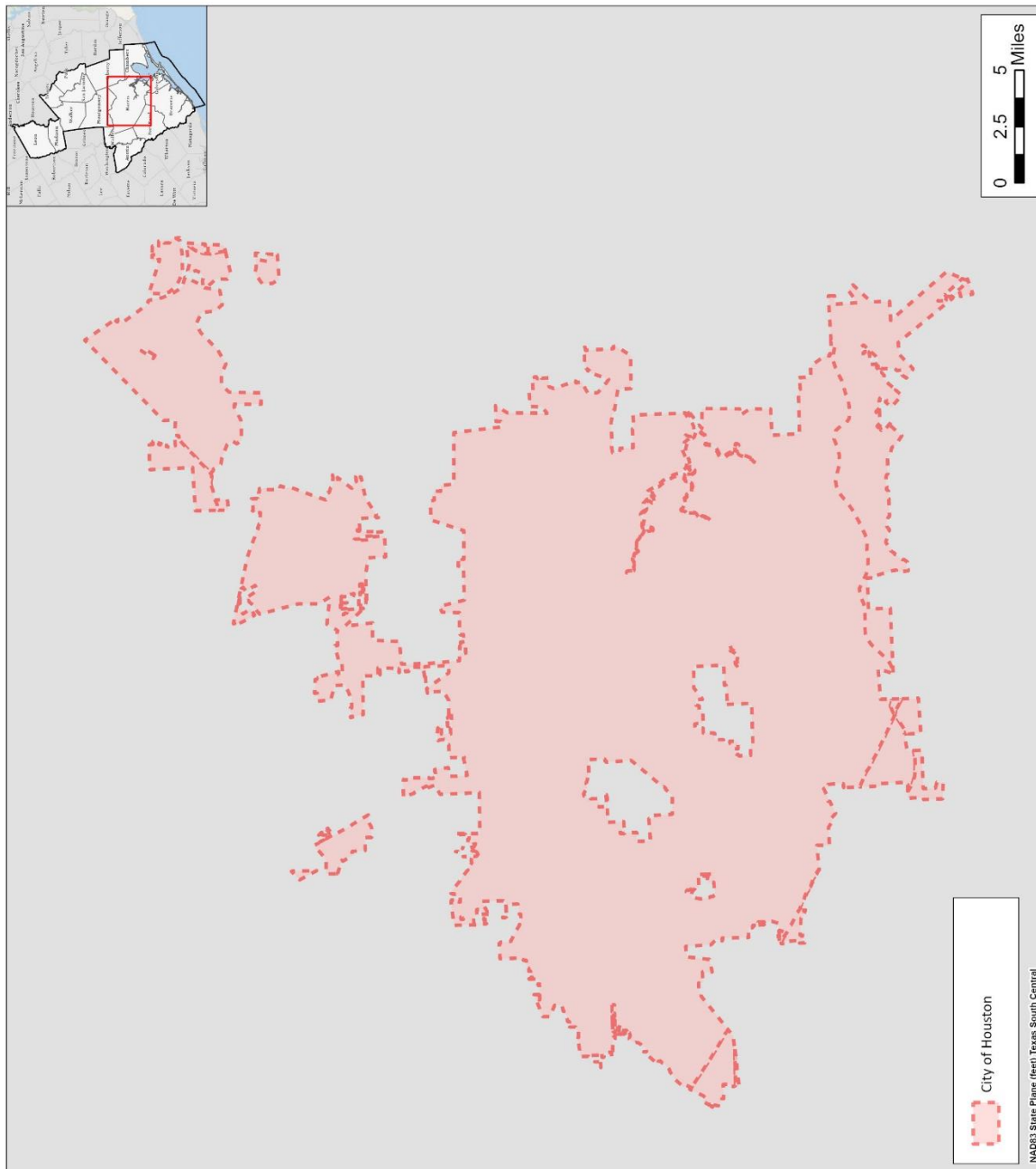
The COH Transmission Expansion project includes approximately 27 miles of pipelines. The majority of this impact will be in urbanized areas with limited impacts to habitat. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The COH Transmission Expansion project 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.

CRITERIA	WUG SUITABILITY
Proximity	This project is intended to provide water to the retail service area of COH as well as customer.
Size	The capacity of this project is based on needs projected by the project sponsor.
Water Quality	This project will convey treated surface water.
Unit Cost	The unit cost for this project is a reasonable price for transmission of treated water for municipal use.
Other Factors	This project is identified for specific customers of COH but offers a broader overall indirect benefit due to the role of the system to regional water supply.

Location Map



City of Houston Transmission Expansion Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	CWA Pipeline Transmission Expansion
Project ID:	CONV-005
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	459,200 ac-ft/yr peak capacity (410 mgd peak capacity)
Implementation Decade:	2040 (2031 to 2040 for individual lines)
Development Timeline:	5-15 years
Project Capital Cost:	\$1,741,814,566 (Sept. 2023)
Unit Water Cost (Rounded):	\$305 per ac-ft (during loan period) \$38 per ac-ft (after loan period)

Strategy Description

The City of Houston (COH) operates several major surface water treatment plants in Harris County. Collectively, these facilities provide treated water to the COH distribution system as well as a number of regional partners and contract customers. The facilities provide an important tie between raw water supplies in the Trinity and San Jacinto River Basins to demands as far west as the Brazos River Basin in Fort Bend County. The COH East Water Purification Plant (EWPP) and Southeast Water Purification Plant (SEWPP) receive raw water from sources located in the Trinity River Basin and conveyed through a canal and pipeline network owned and maintained by the Coastal Water Authority (CWA). The CWA system also conveys water supplies for other major water providers, including conveyance of Trinity River Basin supplies to the San Jacinto River Authority (SJRA) Highlands system.

CWA diverts surface water from the Trinity River at its Trinity River Pump Station in Liberty County, which is subsequently conveyed through the CWA Main Canal to the Lynchburg Reservoir and Pump Station. Raw water supplies are subsequently conveyed from the Lynchburg facilities through several CWA pipeline systems to the EWPP, SEWPP, and other demand centers. CWA and COH have determined that, as regional demand increases in both the Houston service area and among wholesale customers of COH, additional pipeline transmission capacity from water sources to treatment facilities will be required to meet growing surface water demands. Expansion of transmission capacity will allow a greater amount of water demand to be met from existing water sources and will facilitate multiple strategies including Groundwater Reduction Plans (GRPs). The project also supports the COH One Water Houston approach to integrated, sustainable management of water resources.

Strategy Analyses

The project analyses for CWA Pipeline Transmission Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Trinity River Basin water diverted and conveyed by the CWA system constitutes a substantial portion of the water supply for the greater Houston area. CWA and COH have determined that additional transmission infrastructure capacity will be required in order to provide increased water supply from current and future sources to the City and its numerous wholesale customers. This infrastructure will work in conjunction with other water management strategies and projects recommended in the RWP, including the COH GRP, COH treatment plant expansions, and source water development projects in order to increase regional supply. For the 2026 RWP, transmission expansions were identified for five of CWA's pipeline systems, which are summarized in *Table 1*. Values in the table are preliminary estimates and may be adjusted during project design and development. The new transmission lines are expected to follow the paths of the existing CWA pipelines, reducing easement requirements and construction and environmental impacts. Combined peak capacity for these segments is anticipated to allow up to 410 mgd, or approximately 459,200 ac-ft/yr, of additional regional water supply to be utilized.

Table 1 – CWA Transmission Expansion Pipeline Segments

CWA Pipeline System	Length (miles)	Diameter (inches)
A	11	96
B	2.5	96
C	9	120
D	1.5	120 to 144
410/411	4	48

Environmental Considerations

Infrastructure development may result in some construction disturbance which could require mitigation. Diversions will be made from existing water rights and at the existing diversion location.

Permitting and Development

Development of expanded transmission infrastructure will cause some degree of surface disturbance, which may require permitting and mitigation. Use of existing rights of way is expected to minimize permitting and mitigation efforts. This project provides conveyance for diversions permitted under existing water rights.

Cost Analysis

Costs were developed for the CWA Pipeline Transmission Expansion project based on the estimated cost and infrastructure capacity data provided by the project sponsor, in conjunction with standard

Regional Water Planning costing procedures and assumptions. Construction, engineering, legal, contingency, land, and environmental costs were obtained from sponsor data and scaled to a September 2023 equivalent cost using the Construction Cost Index (CCI) and Producer Price Index (PPI) in accordance with TWDB guidance. Additional costs, including interest during construction, annualized debt service, annual operating costs, and pumping energy costs were developed based on standard assumptions for regional planning. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Costs are presented in September 2023 equivalent costs in *Table 2*.

Table 2 – CWA Pipeline Transmission Expansion Estimated Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$1,220,377,219	\$1,220,377,219
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$365,349,288	\$365,349,288
3	LAND AND EASEMENTS	1	LS	\$44,675,644	\$44,675,644
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$3,378,987	\$3,378,987
5	INTEREST DURING CONSTRUCTION	1	LS	\$108,033,428	\$108,033,428
PROJECT CAPITAL COST					\$1,741,814,566

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$122,555,948	\$122,555,948	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$12,203,772	\$12,203,772	\$12,203,772	\$12,203,772	\$12,203,772
3	PUMPING ENERGY COSTS	\$0	\$5,269,168	\$5,269,168	\$5,269,168	\$5,269,168	\$5,269,168
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$0	\$140,028,889	\$140,028,889	\$17,472,940	\$17,472,940	\$17,472,940

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$140,028,889	\$140,028,889	\$17,472,940	\$17,472,940	\$17,472,940
2	YIELD	-	459,200	459,200	459,200	459,200	459,200
3	UNIT COST	\$0	\$305	\$305	\$38	\$38	\$38
TOTAL UNIT COST							\$145

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$1,220,377,219	\$1,220,377,219
PROJECT COST					\$1,220,377,219

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES	1.0	%	\$1,220,377,219	\$12,203,772
ANNUAL OPERATION AND MAINTENANCE COST					\$12,203,772

Water Management Strategy Evaluation

Based on the analysis provided above, the CWA Pipeline Transmission Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

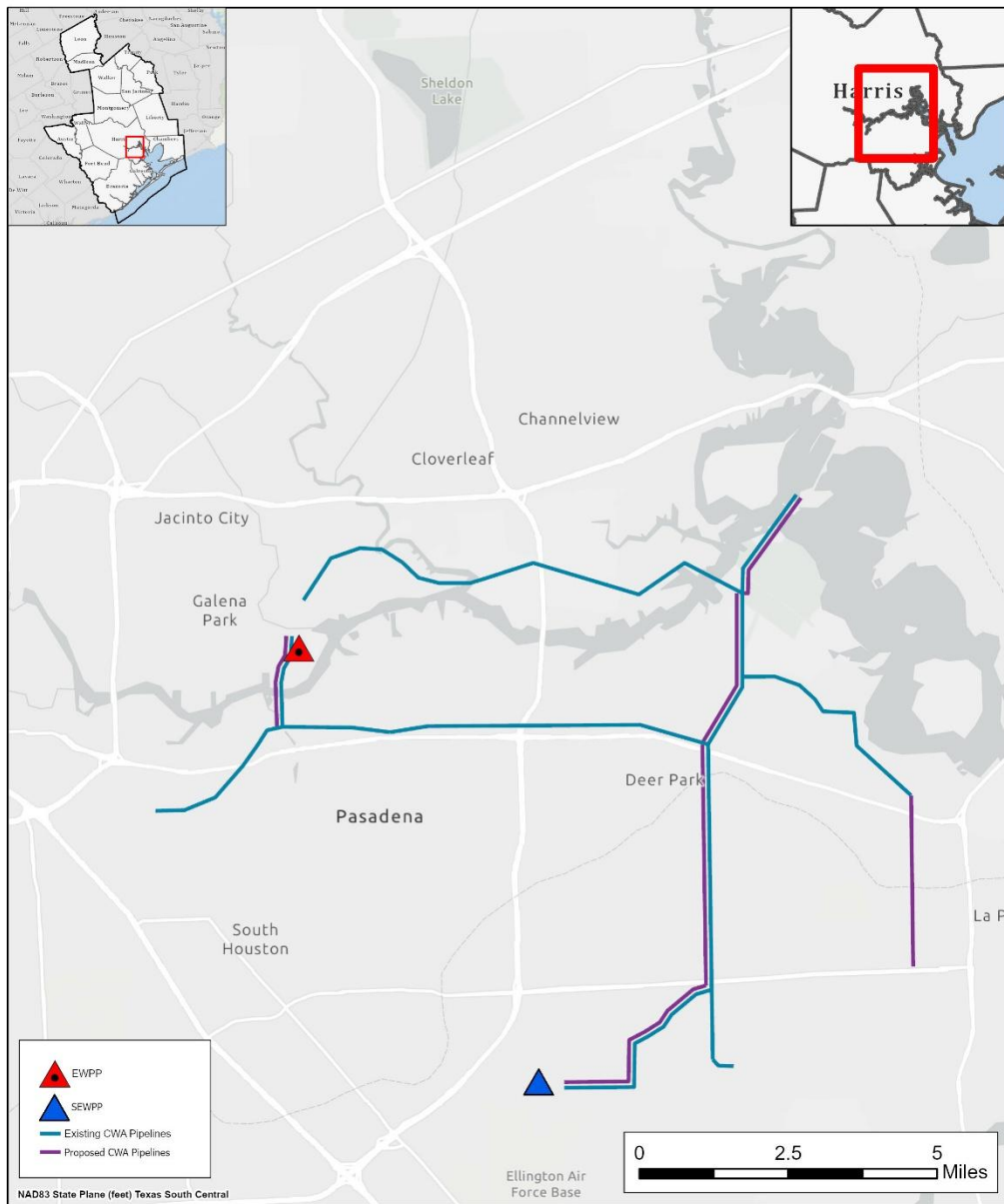
CRITERIA	RATING	EXPLANATION
Cost	4	Costs for the project are relatively low compared to other strategies.
Location	4	Project provides raw water conveyance from source location to an existing treatment facility.
Water Quality	3	No known issues related to water quality.
Environmental Land and Habitat	3	Expansion likely to be constructed along existing rights-of-way, so impacts on habitat are expected to be limited and can be mitigated.
Environmental Flows	3	Project may reduce instream flows by providing conveyance for a larger portion of the permitted diversions.
Local Preference	3	No known significant opposition.
Institutional Constraints	3	Permits expected with minimal problems. Property available.
Development Timeline	4	Project development for individual pipeline segments could be completed in less than 10 years.
Sponsorship	5	Sponsor has identified project and is in the planning and design phase, and a portion of project funding has been secured.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Project creates substantial additional regional supply and supports multiple existing regionalized systems.
Impacts on Other WMS	5	Provides conveyance of surface water to treatment facilities to increase surface water supplies to entities served by the COH Groundwater Reduction Plan and others.

The CWA Pipeline Transmission Expansion project includes approximately 29 miles of pipelines. The majority of this impact will be in existing rights of way with limited impacts to habitat. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The CWA Pipeline Transmission Expansion project 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 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.

CRITERIA	WUG SUITABILITY
Proximity	Conveyance infrastructure from raw water source to existing water treatment plants will increase supply availability in the existing service area of the EWPP.
Size	Conveyance is sized based on needs anticipated by project sponsor.
Water Quality	Project will provide raw water which will require treatment for some uses such as municipal supply.
Unit Cost	The project would have a low overall unit cost. However, additional costs may be added to treat and distribute water for municipal uses.
Other Factors	This project is identified for customers of COH but offers a broader overall indirect benefit due to the role of the system to regional water supply.

Location Map**CWA Pipeline Transmission Expansion
Location Map**

Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	CWA Trinity River Conveyance System Improvements
Project ID:	CONV-006
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	224,000 ac-ft/yr peak capacity (200 mgd peak capacity)
Implementation Decade:	2040 (2031)
Development Timeline:	5-10 years
Project Capital Cost:	\$125,457,460 (Sept. 2023)
Unit Water Cost (Rounded):	\$50 per ac-ft (during loan period) \$11 per ac-ft (after loan period)

Strategy Description

The City of Houston (COH) operates several major surface water treatment plants in Harris County. Collectively, these facilities provide treated water to the COH distribution system as well as a number of regional partners and contract customers. The facilities provide an important tie between raw water supplies in the Trinity and San Jacinto River Basins to demands as far west as the Brazos River Basin in Fort Bend County. The COH East Water Purification Plant (EWPP) and Southeast Water Purification Plant (SEWPP) receive raw water from sources located in the Trinity River Basin and conveyed through a canal and pipeline network owned and maintained by the Coastal Water Authority (CWA). The CWA system also conveys water supplies for other major water providers, including conveyance of Trinity River Basin supplies to the San Jacinto River Authority (SJRA) Highlands system.

The CWA Trinity River Conveyance System includes the Trinity River Pump Station, Lynchburg Pump Station, Main Canal, Cedar Point Lateral Canal, and the Canal Maintenance Facility. Raw water supplies from the Trinity River Conveyance System are subsequently conveyed through several CWA pipeline systems to the EWPP, SEWPP, and other demand centers. CWA and COH have determined that, as regional demand increases in both the Houston service area and among wholesale customers of COH, additional pump station and canal capacity in the CWA Trinity River Conveyance System will be required. Expansion of system capacity will allow a greater amount of water demand to be met from existing water sources and will facilitate multiple strategies including Groundwater Reduction Plans (GRPs). The project also supports the COH One Water Houston approach to integrated, sustainable management of water resources.

Strategy Analyses

The project analyses for CWA Trinity River Conveyance System Improvements include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Trinity River Basin water diverted and conveyed by the CWA Trinity River Conveyance System constitutes a substantial portion of the water supply for the greater Houston area. CWA and COH have determined that additional infrastructure capacity will be required in order to provide increased water supply to the City and its numerous wholesale customers. This infrastructure will work in conjunction with other water management strategies and projects recommended in the RWP, including the COH GRP, COH treatment plant expansions, and source water development projects in order to increase regional supply.

Key project components identified by CWA include installation of additional pumps at the Trinity River Pump Station and Lynchburg Pump Station, widening of portions of the Main Canal and Cedar Point Lateral to increase conveyance capacity, expanded associated facilities, monitoring and control equipment, and other appurtenances. These infrastructure elements are anticipated to allow up to 200 mgd, or 224,000 ac-ft/yr, of additional regional water supply to be utilized.

Environmental Considerations

Infrastructure development may result in some construction disturbance which could require mitigation. Diversions will be made from existing water rights and at the existing diversion location.

Permitting and Development

Development of enhanced pumping and conveyance capacity will cause some degree of surface disturbance, which may require permitting and mitigation. This is expected to be minimal, as the majority of construction is expected to occur on existing CWA infrastructure sites. This project provides conveyance for diversions permitted under existing water rights.

Cost Analysis

Costs were developed for the CWA Trinity River Conveyance System Improvements project based on the estimated cost and infrastructure capacity data provided by the project sponsor, in conjunction with standard Regional Water Planning costing procedures and assumptions. Construction, engineering, legal, contingency, land, and environmental costs were obtained from sponsor data and scaled to a September 2023 equivalent cost using the Construction Cost Index (CCI) and Producer Price Index (PPI) in accordance with TWDB guidance. Additional costs, including interest during construction, annualized debt service, annual operating costs, and pumping energy costs were developed based on standard assumptions for regional planning. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Costs are presented in September 2023 equivalent costs in *Table 1*.

Table 1 – CWA Trinity River Conveyance System Improvements Estimated Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$107,071,116	\$107,071,116
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$14,454,600	\$14,454,600
3	LAND AND EASEMENTS	1	LS	\$0	\$0
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$3,931,744	\$3,931,744
PROJECT CAPITAL COST					\$125,457,460

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$8,827,322	\$8,827,322	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$1,687,441	\$1,687,441	\$1,687,441	\$1,687,441	\$1,687,441
3	PUMPING ENERGY COSTS	\$0	\$691,382	\$691,382	\$691,382	\$691,382	\$691,382
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$0	\$11,206,145	\$11,206,145	\$2,378,823	\$2,378,823	\$2,378,823

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$11,206,145	\$11,206,145	\$2,378,823	\$2,378,823	\$2,378,823
2	YIELD	-	224,000	224,000	224,000	224,000	224,000
3	UNIT COST	\$0	\$50	\$50	\$11	\$11	\$11
TOTAL UNIT COST							\$26

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$41,115,308	\$41,115,308
2	WATER DISTRIBUTION SYSTEM IMPROVEMENTS	1	LS	\$65,955,808	\$65,955,808
PROJECT COST					\$107,071,116

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$41,115,308	\$1,027,883
2	WATER DISTRIBUTION SYSTEM IMPROVEMENTS	1.0	%	\$65,955,808	\$659,558
ANNUAL OPERATION AND MAINTENANCE COST					\$1,687,441

Water Management Strategy Evaluation

Based on the analysis provided above, the CWA Trinity River Conveyance System Improvements project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	The project, while not directly generating supply, provides conveyance of treated water with small additional cost.
Location	4	Project provides raw water conveyance from source location to existing treatment facilities.
Water Quality	3	No known issues related to water quality.

CRITERIA	RATING	EXPLANATION
Environmental Land and Habitat	3	System improvements likely to be constructed on existing facility sites and along existing rights-of way. Impacts on habitat are expected to be limited or can be mitigated.
Environmental Flows	3	Project may reduce stream flows by providing conveyance for a larger portion of permitted diversions.
Local Preference	3	No known significant opposition.
Institutional Constraints	3	Property available and limited permitting efforts.
Development Timeline	4	Project development could be completed in less than ten years.
Sponsorship	5	Sponsor has identified project and is in the planning and design phase, and a portion of project funding has been secured.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Project creates substantial additional regional supply and supports existing regional systems.
Impacts on Other WMS	5	Provides conveyance of surface water to pipelines and treatment facilities to increase surface water supplies to entities served by the COH. Significant positive impacts, synergy achieved.

The majority of this project development will occur on existing pump station and canal sites, with limited impacts to habitat. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

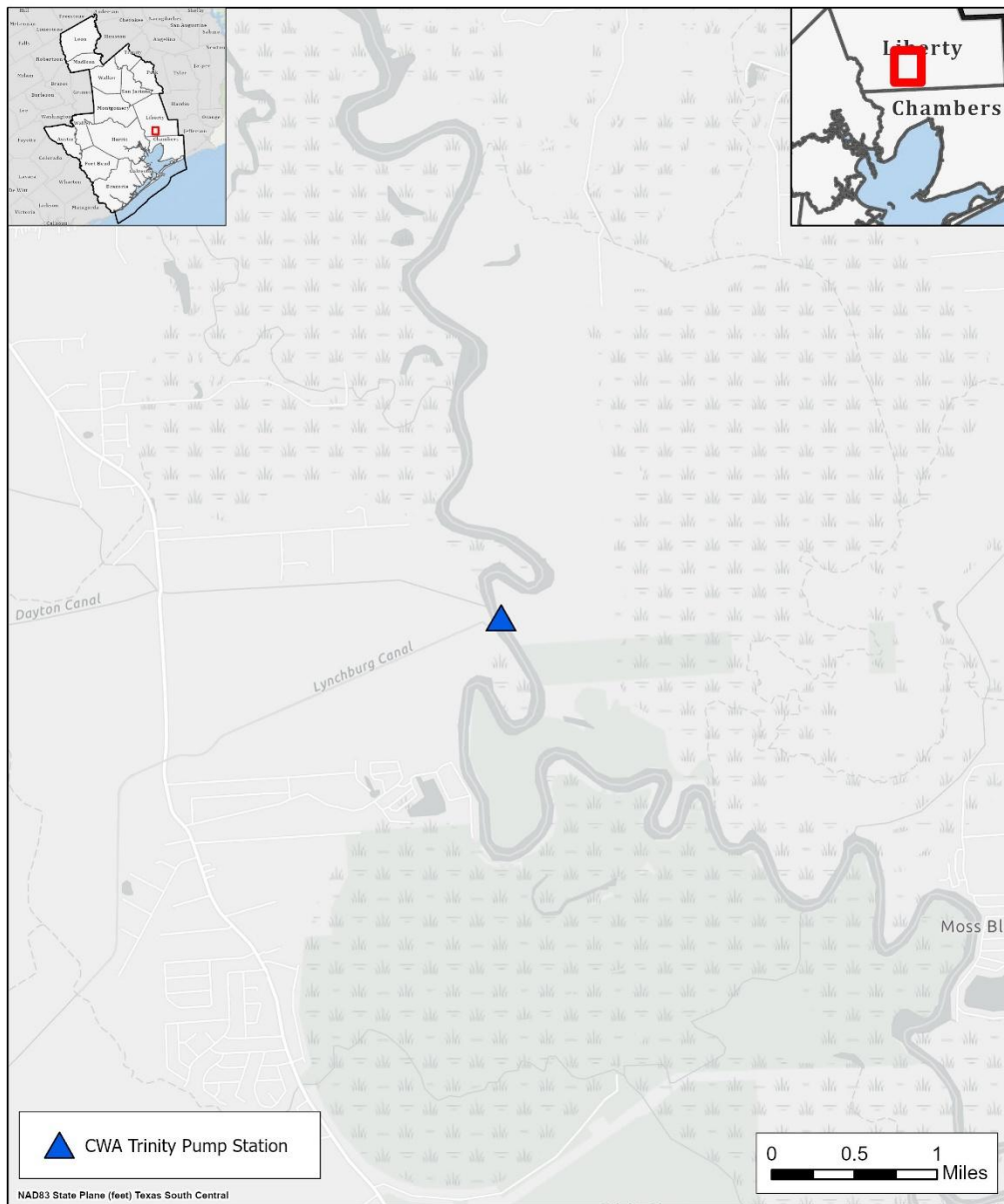
Water User Group Application

The CWA Trinity River Conveyance System Improvements project 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.

CRITERIA	WUG SUITABILITY
Proximity	Conveyance infrastructure from raw water source to existing water treatment plant will increase supply availability in the existing service area of the EWPP and SEWPP.

CRITERIA	WUG SUITABILITY
Size	The capacity of this project is based on needs projected by the project sponsor.
Water Quality	Project will provide raw water which will require treatment for some uses such as municipal supply.
Unit Cost	The project would have a low overall unit cost. However, additional costs may be added to treat and distribute water for municipal uses.
Other Factors	This project is identified for customers of COH but offers a broader overall indirect benefit due to the role of the system to regional water supply.

Location Map



CWA Trinity River Conveyance System Improvements Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	East Texas Transfer
Project ID:	CONV-007
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	250,000 ac-ft/yr (223 mgd)
Implementation Decade:	2050
Development Timeline:	20 years
Project Capital Cost:	\$663,513,060 (Sept. 2023)
Unit Water Cost (Rounded):	\$216 per ac-ft (during loan period) \$29 per ac-ft (after loan period)

Strategy Description

After the development of identified, in-region projects throughout Region H, additional needs are identified that will require water from a newly developed or transmitted source. Development of water supplies within the Region H basins becomes increasingly difficult as competing water supply interests, along with environmental uses, utilize the remaining, developable supplies.

An alternative to this is the transfer and use of supplies that have already been developed in the eastern basins in the state. Specifically, developed water supplies in Toledo Bend Reservoir in the Sabine River Basin present a viable alternative for meeting future needs in Region H. Conveyance of these supplies to the Trinity River Basin allows for the use of this water through existing conveyance infrastructure. There are additional challenges in utilizing these supplies in the western portion of Region H where routes of transmission are inhibited by the development of the greater Houston area.

This memorandum summarizes a high-level concept for the transmission of water from East Texas through canal and pipeline conveyance to diversion points in the Trinity and Brazos River Basins. The strategy, as applied in the 2026 Regional Water Plan (RWP), focuses on conveyance to the Trinity River. Information related to conveyance from the Trinity River to the Brazos River is included for informational purposes. The project also supports the City's One Water Houston approach to integrated, sustainable management of water resources.

Strategy Analyses

The project analyses for the East Texas Transfer include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

A review of existing project concepts was conducted in order to develop the concept for transmission from Toledo Bend Reservoir to Region H. This includes studies by the Sabine River Authority of Texas (SRA-TX) and Lower Neches Valley Authority (LNVA), as well as the existing Trans-Texas Water Program and a study developed in 2014 for the Gulf Coast Water Authority (GCWA). The conveyance route was divided into three distinct segments for consideration in this project.

- Sabine to Neches – Utilize an improved Gulf Coast Pump Station to convey water released from Toledo Bend along the Sabine River to the Neches River Basin.
- Neches to Trinity – Utilize two canal segment connections to convey water diverted from the Neches River from the LNVA main canal to the LNVA-Devers Canal and then on to the Trinity River near the Coastal Water Authority (CWA) Trinity River Pump Station.
- Trinity to Brazos – Develop a pipeline conveyance from Lake Livingston to convey water to the Brazos River Basin. This route will require a repump station that is located near the existing Lake Conroe Dam which allows for this conveyance to serve needs in the San Jacinto River Basin as well.

In order to execute the full scope of this project, water conveyed from eastern basins will be exchanged with water that will be conveyed farther west. For instance, water entering the Trinity at the Trinity River Pump Station will be utilized in lieu of water released from Lake Livingston in order for that water to be moved to the west and into the San Jacinto and Brazos River Basins. This arrangement requires not only significant infrastructure to accomplish but also cooperation of large water rights holders such as the City of Houston in order to make the exchanges possible.

Environmental Considerations

Any project of this magnitude will include environmental challenges to be resolved during planning, design, and construction. To the extent possible, existing canal conveyances are utilized in order to prevent the disturbance of surrounding habitat. Specific environmental obstacles would be identified during routing studies of the proposed alignments.

Particular focus on environmental impacts was assessed for the Trinity to Brazos River segment, as it crosses a section of the Sam Houston National Forest. Preliminary discussions with the United States Forest Service (USFS) indicate that there are opportunities to utilize existing corridors in the area in order to develop a project with minimal impacts. As with other segments, further study in the routing phase of the project will better identify the potential obstacles and approaches to mitigation in order to make this project successful. Further coordination with local, state, and national agencies, such as TPWD and USFWS, is necessary to prevent and mitigate potential environmental impacts.

Project development would also need to consider opportunities to address the potential for introduction of exotic or invasive species into additional basins. For instance, invasive aquatic species, including zebra mussels (*Dreissena polymorpha*), water hyacinth (*Eichhorcia crassipes*), giant salvinia (*Salvinia molesta*), and hydrilla (*Hydrilla verticillata*), have been discovered in Lake Livingston in the Trinity River Basin.

Environmental flows will be impacted through the movement of water from one basin to another. Actual impacts will be determined during the permitting process for the interbasin transfer of water outside of the terms currently granted under permit.

Permitting and Development

Although water rights are currently held for the storage and appropriation of water in the Sabine River Basin, amendments to these permits are required to allow for conveyance to western basins. Furthermore, additional, unappropriated flows may also be permitted in excess of these supplies and conveyed out of the basin for purpose of this project. These steps will require a permit process with the Texas Commission on Environmental Quality (TCEQ) to make water available for the project. Use of this water through interbasin transfer is administered under Section 11.085 of the Texas Water Code which includes several requirements in order to obtain necessary permits:

- Providing the cost of water, category of use, and cost of diverting and conveying water to proposed users.
- Conducting public meetings in the basin of origin and the receiving basin.
- Providing notice of an application to permit holders, county judges, city mayors, groundwater conservation districts, and state legislators associated with each basin.
- Publishing notice of application in newspapers of general circulation.
- Giving consideration to comments received through the permit application's public process.

In granting the permit, consideration shall be given to:

- The need for water in the basin of origin and receiving basin.
- The availability of alternative water supplies to the receiving basin.
- The purpose of use for the water within the receiving basin.
- Methods for avoiding waste and implementing water conservation and also for putting the transferred water to beneficial use.
- The projected economic impacts.
- Impacts to existing rights, instream uses, water quality, aquatic and riparian habitat, and bays and estuaries.
- The proposed mitigation to the basin of origin.

Finally, the commission may grant the application only to the extent that:

- The detriments to the basin of origin are less than the benefits to the receiving basin.
- The applicant has prepared a drought contingency plan and has developed and implemented a water conservation plan that will result in the highest practicable level of conservation and efficiency.

Additional environmental permitting will also be required for the development of infrastructure critical to project development. This includes but is not limited to:

- U.S. Army Corps of Engineers Section 404 Permit and mitigation plan.
- National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS).
- Cultural Resources Survey and National Register of Historic Places (NRHP) testing.
- Ancillary studies as directed by Texas Parks and Wildlife (TPWD) and U.S. Fish and Wildlife Service.

In accordance with the guidance in Title 31, Texas Administrative Code § 357.34(e)(6), evaluation of the strategy for the 2026 Regional Water Plan included examination of projected needs in the basin of origin for the supply as well as the receiving basin. These needs are summarized in *Table 1*. The

Toledo Bend Reservoir, which is the source for the strategy, is located on the Sabine River in the eastern portion of Region I, and is downstream of Regions C and D.

Table 1 – Projected Water Needs in the Sabine and San Jacinto River Basins

River Basin	Region	Projected Water Need (ac ft)					
		2030	2040	2050	2060	2070	2080
Sabine	C	1,151	4,879	10,079	14,577	19,201	22,504
Sabine	D	17,970	21,544	24,358	26,766	29,672	32,991
Sabine	I	841	934	1,053	1,245	1,361	1,478
Sabine River Basin Total		19,962	27,357	35,490	42,588	50,234	56,973
San Jacinto	G	118	145	169	189	213	239
San Jacinto	H	188,056	330,214	373,112	401,933	424,279	447,650
San Jacinto Basin Total		188,174	330,359	373,281	402,122	424,492	447,889

Cost Analysis

Costs were developed for the Sabine to Neches and Neches to Trinity segments of the project. These planning-level estimates are shown below in *Table 2*. It should be noted that these costs do not include the cost of purchasing the water since it is subject to negotiation between the seller (SRA) and future buyers.

Table 2 – East Texas Transfer Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$455,910,318	\$455,910,318
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$159,568,611	\$159,568,611
3	LAND AND EASEMENTS, ENVIRONMENTAL FEES	1	LS	\$6,761,205	\$6,761,205
4	INTEREST DURING CONSTRUCTION	1	LS	\$41,153,399	\$41,153,399
PROJECT CAPITAL COST					\$663,513,060

ITEM DESCRIPTION		ANNUAL TOTAL					
ANNUAL COST SUMMARY							
		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$0	\$46,685,493	\$46,685,493	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$0	\$5,832,359	\$5,832,359	\$5,832,359	\$5,832,359
3	PUMPING ENERGY COSTS	\$0	\$0	\$1,482,427	\$1,482,427	\$1,482,427	\$1,482,427
TOTAL ANNUAL COST		\$0	\$0	\$54,000,279	\$54,000,279	\$7,314,786	\$7,314,786

ITEM DESCRIPTION		ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$0	\$54,000,279	\$54,000,279	\$7,314,786	\$7,314,786
2	YIELD	-	-	250,000	250,000	250,000	250,000
3	UNIT COST	\$0	\$0	\$216	\$216	\$29	\$29
TOTAL UNIT COST							\$123

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$84,883,750	\$84,883,750
2	WATER DISTRIBUTION SYSTEM IMPROVEMENTS	1	LS	\$371,026,568	\$371,026,568
PROJECT COST					\$455,910,318

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$84,883,750	\$2,122,094
2	WATER DISTRIBUTION SYSTEM IMPROVEMENTS	1.0	%	\$371,026,568	\$3,710,266
ANNUAL OPERATION AND MAINTENANCE COST					\$5,832,359

Water Management Strategy Evaluation

Based on the analysis provided above, the East Texas Transfer project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	The project would have a low overall unit cost.
Location	1	Considerable interbasin transfer between various entities required to convey water from outside of Region H.
Water Quality	3	No known water quality issues identified.
Environmental Land and Habitat	2	Some environmental issues anticipated but may be mitigated through adequate planning and design.
Environmental Flows	2	Project alters environmental flows patterns in each basin although these impacts will be limited through prescribed environmental flows standards.
Local Preference	3	Currently no significant local support or opposition to the project.
Institutional Constraints	1	Significant challenges to pursue permits and acquire required right-of-way.
Development Timeline	3	Estimated development timeline of 20 years.
Sponsorship	3	Sponsors identified based on needs and the required mechanics of the project. Currently, these stakeholders are not actively committed to development.
Vulnerability	2	Substantial risk to infrastructure related to natural disasters along the Gulf Coast that may impact any portion of the project from the Sabine River Basin to Region H.
Regionalization	5	Supports regionalization through conveyance of extensive supply into Region H, potentially supporting multiple regional systems.
Impacts on Other WMS	4	Project enables the use of existing water supplies and may be combined with other projects such as TRA to SJRA Transfer to achieve comprehensive, regional goals.

The East Texas Transfer includes up to 34 miles of new canal construction. The East Texas Transfer will potentially reduce water within the Sabine River Basin below the recently constructed pump station by as much as 250,000 ac-ft/yr. This volume of water is already permitted for full consumptive

use within the basin. The project may result in as much as 125,000 ac-ft/yr of additional flow in the receiving basins assuming 50 percent return flows through municipal effluent. Construction will require permanent impacts to agricultural lands in some areas along the corridor of conveyance, but actual impacts will be determined by final configuration.

Water User Group Application

The East Texas Transfer project 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 project as well as other factors that may relate to the suitability of the project to the WUGs served.

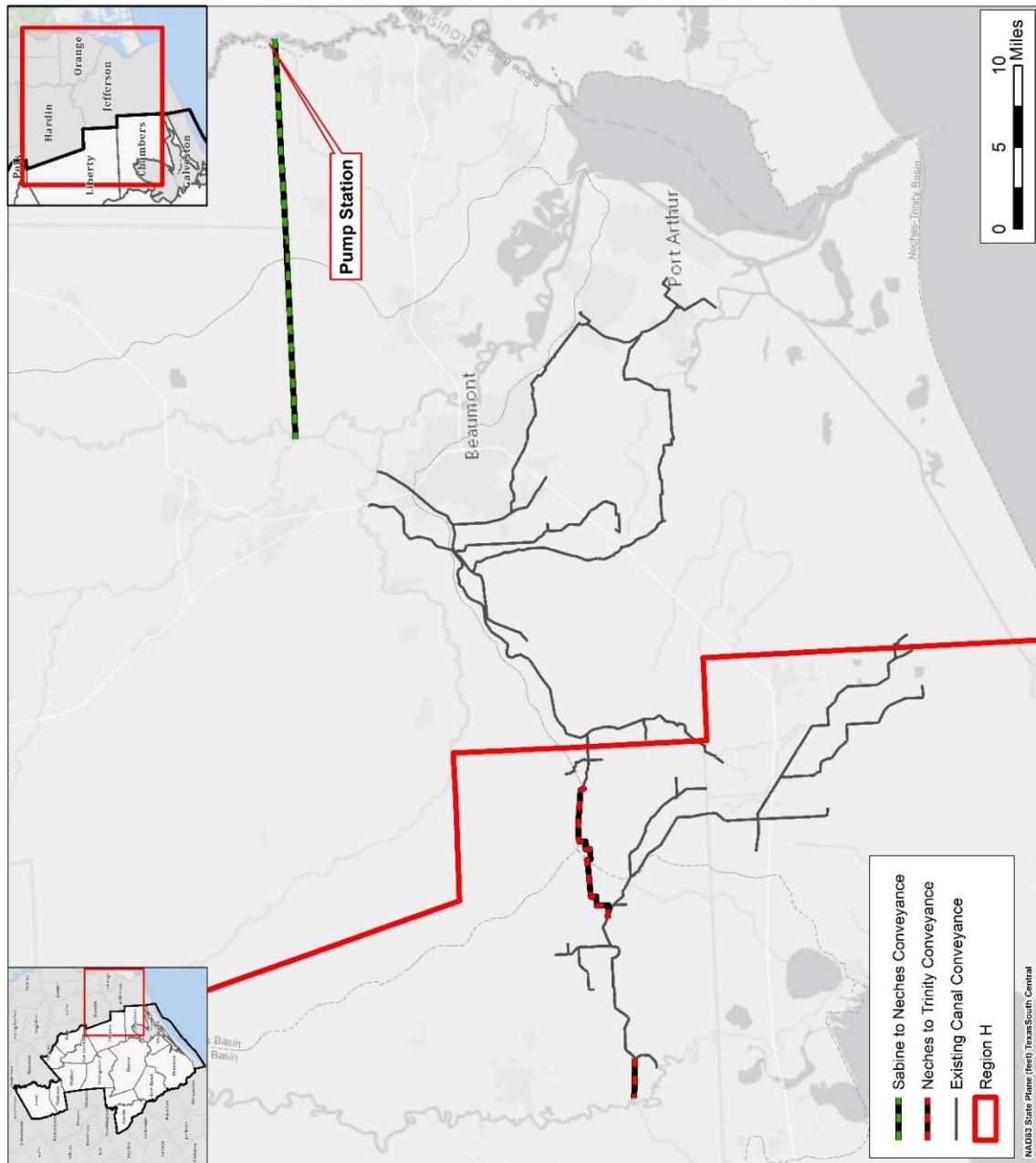
CRITERIA	WUG SUITABILITY
Proximity	This project will deliver water to locations where it may be utilized through existing take points in the Trinity and San Jacinto Basins. The Brazos River Basin may also receive supply through future expansions.
Size	The magnitude of this project dictates that it be accomplished by major water providers in response to large, growing demands among their many customers. In effect, this water may be utilized by WUGs of many sizes that receive water from these major providers.
Water Quality	Project will provide raw water which will require treatment for some uses such as municipal supply.
Unit Cost	The project would have a low overall unit cost. However, additional costs may be added (i.e. treatment costs) for some uses.
Other Factors	This project will be accomplished by specific, regional water providers based on strategic needs when current water supplies become inadequate to meet future needs. Projected needs in the basin of origin and in the receiving basins are summarized in Chapter 4. At the time the IBT is permitted, it will be necessary to demonstrate that permittees have implemented a water conservation plan that will result in the highest practicable levels of water conservation and efficiency achievable within their jurisdiction, per Texas Administrative Code §297.18 and Texas Water Code §11.085. Region H recommends advanced water conservation for all municipal WUGs prior to the application of any strategies, including IBT alternatives.

References

Freese and Nichols, Inc. for Gulf Coast Water Authority. 2014. *Long Range Water Supply Study – Detailed Evaluation of Selected Strategies*.

Sabine River Authority of Texas, Lower Neches Valley Authority, San Jacinto River Authority, City of Houston, Brazos River Authority, and Texas Water Development Board. 1998. *Trans-Texas Water Program, Southeast Area, Final Report*.

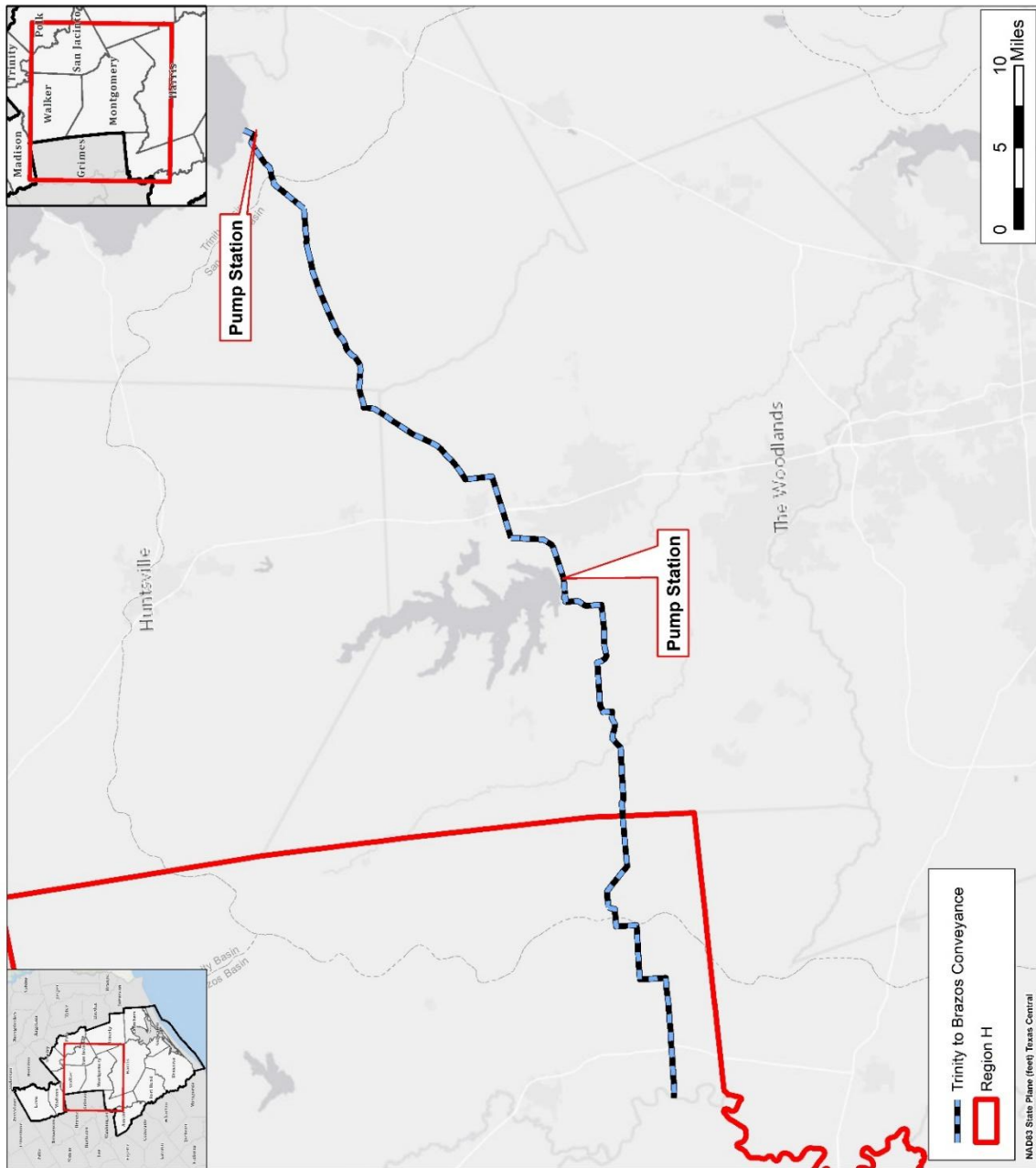
Location Map – Sabine to Trinity



East Texas Interbasin Transfer Sabine to Trinity Segments Location Map



Location Map – Trinity to Brazos



East Texas Interbasin Transfer Trinity to Brazos Segment Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	LNVA Neches-Trinity Basin Interconnect
Project ID:	CONV-008
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	67,000 ac-ft/yr (59.8 MGD)
Implementation Decade:	2040
Development Timeline:	15 years
Project Capital Cost:	\$127,821,515 (Sept. 2023)
Unit Water Cost (Rounded):	\$165 per ac-ft (during loan period) \$31 per ac-ft (after loan period)

Strategy Description

As a part of its long-term strategic water plan, the Lower Neches Valley Authority (LNVA) is planning to construct an approximately 13-mile, 84-inch diameter pipeline and a 62,000 gpm pump station connecting the Freeman Lateral of the LNVA system with the Devers 3rd Main Canal of the Devers system. The connection point to the Freeman Lateral is located within the Neches-Trinity Coastal Basin; however, the intake for this canal is on Pine Island Bayou within the Neches River Basin. The proposed pipeline enables the movement of Neches River water westward toward the upper reaches of the Devers Canal system and potentially back into the Trinity River. The water from this strategy will enable LNVA to provide water for irrigation customers in Region H, as well as to serve new industries as they emerge along the IH-10 corridor.

The cost for this project includes infrastructure and operational costs related to water conveyance. Ultimately, individual water users will make contracts with LNVA to purchase the water supply created by this project. The cost for raw water will need to be negotiated with LNVA and will reflect the wholesale water rates of this entity at the time a contract is made.

Strategy Analyses

The project analyses for the LNVA Neches-Trinity Basin Interconnect project include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The quantity of supply from this strategy represents the estimated average volume of water that could be conveyed through the pipeline and was estimated by LNVA as part of its long-term planning. This equates to approximately 67,000 ac-ft/yr beginning in 2040 and continuing through the planning period. The reliability of this water supply is considered high due to the availability of water from the Neches River.

Environmental Considerations

The impact to the environment due to pipeline and pump station construction is expected to be moderate, and the conveyance of water from the Neches River to Liberty County should have minimal impact to environmental water needs in Jefferson County and to the surrounding habitat, and a low impact to cultural resources in the area. Water transfers may also act as a potential route by which exotic or invasive species are introduced into a basin. Potential species impacts and examination of opportunities to avoid or mitigate impacts would be expected to be considered during the detailed project planning and design process. There are no bays or estuaries in close proximity to the project area located in Jefferson and Liberty Counties. Further study in the design phase of the project would identify in greater detail the potential obstacles and approaches to mitigation in order to make the project successful.

Permitting and Development

The development of this strategy is dependent on the long-term planning goals of LNVA and customers in Liberty County. Development of transmission infrastructure may require some permitting.

Cost Analysis

Planning level cost estimates for the LNVA Neches-Trinity Basin Interconnect project are included in the table below. Projected capital cost estimates were provided by LNVA. Capital costs include planning, design, land, environmental and permitting, and construction of conveyance infrastructure. The annual cost was estimated assuming a debt service of 3.5% for 20 years, in accordance with standard TWDB regional water planning cost assumptions. Costs are presented in September 2023 equivalent costs in *Table 1*.

Table 1 – LNVA Neches-Trinity Basin Interconnect Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$64,589,549	\$64,589,549
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$25,099,000	\$25,099,000
3	PLANNING, DESIGN, AND REAL ESTATE	1	LS	\$14,245,919	\$14,245,919
4	ENVIRONMENTAL AND PERMITTING	1	LS	\$4,829,125	\$4,829,125
5	INTEREST DURING CONSTRUCTION	1	LS	\$19,057,922	\$19,057,922
PROJECT CAPITAL COST					\$127,821,515

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$8,993,659	\$8,993,659	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$894,831	\$894,831	\$894,831	\$894,831	\$894,831
3	PUMPING ENERGY COSTS	\$0	\$1,175,820	\$1,175,820	\$1,175,820	\$1,175,820	\$1,175,820
TOTAL ANNUAL COST		\$0	\$11,064,310	\$11,064,310	\$2,070,651	\$2,070,651	\$2,070,651

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$11,064,310	\$11,064,310	\$2,070,651	\$2,070,651	\$2,070,651
2	YIELD	-	67,000	67,000	67,000	67,000	67,000
3	UNIT COST	\$0	\$165	\$165	\$31	\$31	\$31
TOTAL UNIT COST							\$85

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$16,595,710	\$16,595,710
2	PIPELINES	1	LS	\$47,993,839	\$47,993,839
PROJECT COST					\$64,589,549

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$16,595,710	\$414,893
2	PIPELINES	1.0	%	\$47,993,839	\$479,938
ANNUAL OPERATION AND MAINTENANCE COST					\$894,831

Water Management Strategy Evaluation

This LNVA Neches-Trinity Basin Interconnect project benefits irrigators and industrial water users who may become customers of LNVA. This strategy is expected to have a positive impact on the water supply security of these future customers. This project will reduce the demands on other water resources located in Liberty County. From a social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth. Based on the analysis provided above, the LNVA Neches-Trinity Basin Interconnect project was evaluated across twelve different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Cost	5	The project would have a low overall unit cost. Total costs for customers will also include the contract cost of water.
Location	3	Interbasin transfer between entities is required to convey water from outside of Region H.
Water Quality	3	No known water quality issues identified.
Environmental Land and Habitat	3	Environmental concerns are limited and impacts along the pipeline route can be mitigated during development.
Environmental Flows	2	Project may reduce instream flows within the Neches River Basin, with diversions made within the terms of an existing permit.
Local Preference	3	Currently no significant local support or opposition to the project.
Institutional Constraints	3	Permitting and development expected with minimal problems. Rural property along route is available.
Development Timeline	4	Project to be developed within 15 years.
Sponsorship	5	LNVA is identified as a sponsor and is actively pursuing development.
Vulnerability	5	Minimal risk from natural or man-made disasters related to infrastructure.
Regionalization	3	Supports service to multiple customer entities.
Impacts on Other WMS	3	Project is not anticipated to impact other management strategies.

The LNVA Neches-Trinity Basin Interconnect will include approximately 13 miles of pipeline. The project is not anticipated to affect endangered or vulnerable species or to impact agricultural land or production. This strategy is expected to have a positive impact on the water supply security of agriculture.

Water User Group Application

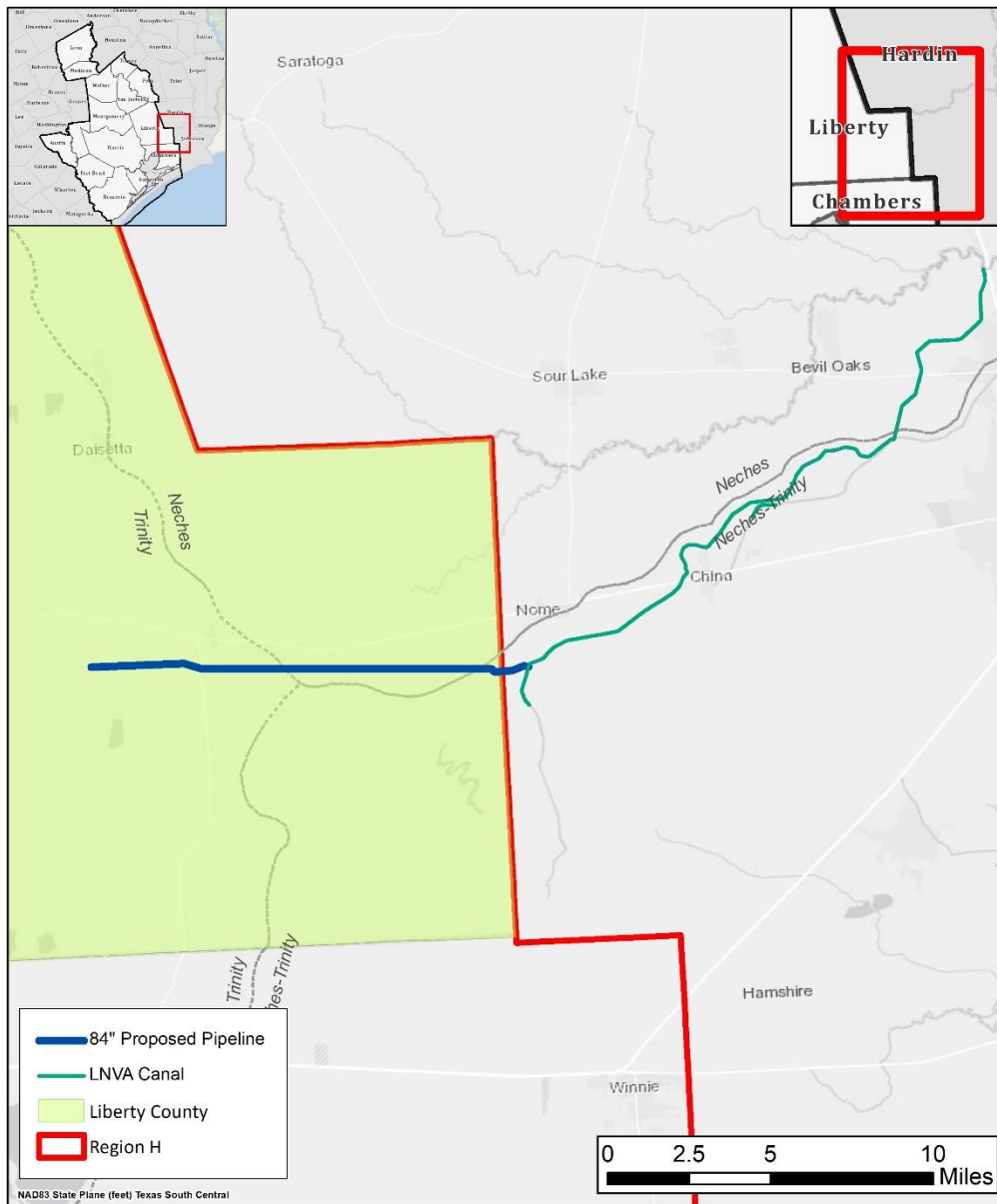
The LNVA Neches-Trinity Basin Interconnect project was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the 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.

Criteria	WUG Suitability
Proximity	The proposed pipeline enables the transfer of water in Jefferson County (Region I) to Liberty County (Region H). This will enable LNVA to provide water for irrigation customers in Region H, as well as to serve industries along the IH-10 corridor.
Size	The capacity of this project provides supply to meet LNVA's irrigation customer demands, as well as to potentially supply other industries in Region H in Liberty County.
Water Quality	This project will convey raw water, which is suitable for irrigation use. If the water will be used for other industries, treatment may be required.
Unit Cost	The costs of this project are low compared to many other infrastructure projects in the RWP.
Other Factors	This project is identified primarily for irrigation customers in Liberty County but could also potentially supply other customers with future needs. Projected needs in the basin of origin and in the receiving basins are summarized in Chapter 4. At the time the project is permitted, it will be necessary to demonstrate that permittees have implemented a water conservation plan that will result in the highest practicable levels of water conservation and efficiency achievable within their jurisdiction, per Texas Administrative Code §297.18 and Texas Water Code §11.085. Region H recommends advanced water conservation for all municipal WUGs prior to the application of any strategies.

References

Lower Neches Valley Authority. 2020. *30-Year Long Term Strategic Plan*.

Location Map



LNVA Neches-Trinity Basin Interconnect Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Manvel Supply Expansion
Project ID:	CONV-009
Project Type:	Conveyance
Potential Supply Quantity (Rounded):	7,840 ac-ft/yr (7.0 mgd)
Implementation Decade:	2030 (initial phase)
Development Timeline:	5 years
Project Capital Cost:	\$62,235,692 (Sept. 2023)
Unit Water Cost (Rounded):	\$616 per ac-ft (during loan period) \$57 per ac-ft (after loan period)

Strategy Description

The City of Manvel, located in Brazoria County, currently relies on groundwater to meet its customer demands, except for a small amount of direct reuse. In order to address expected growth within its service area, as well as potential expansion of its service area, the City has developed a Master Water Plan. The City has secured a water supply contract from the Brazos River Authority (BRA) for 3,731 ac-ft/yr which is available from BRA's system operation permit. Additionally, the City is exploring options for procurement of treated surface water supplies from the City of Pearland or Gulf Coast Water Authority (GCWA). This increased supply would support water service to areas within the city limits and extraterritorial jurisdiction, including development outside of its current retail water service area.

Strategy Analyses

The project analyses for the Manvel Supply Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The 2022 Master Water Plan for Manvel investigates several options for addressing anticipated future groundwater needs, including balanced surface water and groundwater usage, constraining groundwater to a set percentage of anticipated demand, or development of surface water only. The analyses in the Master Plan recommend utilizing an approach combining surface water and groundwater sources, with treated surface water potentially purchased from the City of Pearland or GCWA. The Master Plan estimates that the initial phase of surface water supply would be 4 million gallons per day (mgd), or 4,480 ac-ft/yr, implemented by 2030; this would need to be increased to 7 mgd (7,840 ac-ft/yr) by 2037.

Environmental Considerations

The primary impact associated with the implementation of this water management project is the increase in diversions from the Brazos River. Increased diversion of water from the Brazos River will result in some minimal decreases in instream flow downstream of the intake point. However, these diversions would be made from existing water rights owned by a wholesale water provider, and no new water rights permits would be required for this project. Some surface disturbance may be associated with development of surface water treatment facilities and transmission infrastructure.

Permitting and Development

Procurement of surface water supplies from the City of Pearland or Gulf Coast Water Authority would require a new supply contract. The addition of surface water supplies is expected to necessitate additional conveyance infrastructure which may involve additional permitting requirements.

Cost Analysis

Capital costs of the surface water treatment plant and transmission expansion were provided in the City's Master Water Plan for a conceptual supply from the City of Pearland and have been scaled to an equivalent September 2023 cost. Additional costs, including cost of interest during construction, annualized debt service, and annual operating costs were also developed based on standard assumptions for regional planning. A total cost estimate for the Manvel Supply project is shown in *Table 1*.

Table 1 – Manvel Supply Expansion Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$44,904,321	\$44,904,321
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$13,471,296	\$13,471,296
3	LAND AND EASEMENTS	1	LS	\$0	\$0
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$3,860,075	\$3,860,075
PROJECT CAPITAL COST					\$62,235,692

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (2030 EXPANSION)	\$1,930,375	\$1,930,375	\$0	\$0	\$0	\$0
2	DEBT SERVICE (2040 EXPANSION)	\$0	\$2,448,596	\$2,448,596	\$0	\$0	\$0
3	OPERATION AND MAINTENANCE (2030 EXPANSION)	\$197,951	\$197,951	\$197,951	\$197,951	\$197,951	\$197,951
4	OPERATION AND MAINTENANCE (2040 EXPANSION)	\$0	\$251,092	\$251,092	\$251,092	\$251,092	\$251,092
5	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
6	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$2,128,326	\$4,828,014	\$2,897,639	\$449,043	\$449,043	\$449,043

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$2,128,326	\$4,828,014	\$2,897,639	\$449,043	\$449,043	\$449,043
2	YIELD	4,480	7,840	7,840	7,840	7,840	7,840
3	UNIT COST	\$475	\$616	\$370	\$57	\$57	\$57
TOTAL UNIT COST		\$256					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$44,904,321	\$44,904,321
PROJECT COST					\$44,904,321

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES	1.0	%	\$44,904,321	\$449,043
ANNUAL OPERATION AND MAINTENANCE COST					\$449,043

Water Management Strategy Evaluation

Based on the analysis provided above, the Manvel Supply Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	3	Unit cost of the project, as depicted, is moderate and decreases significantly after debt service.
Location	5	Project is located near demand center and includes transmission components for delivery to potential customers.

CRITERIA	RATING	EXPLANATION
Water Quality	3	No known issues regarding water quality.
Environmental Land and Habitat	4	Limited environmental impacts associated with identified site.
Environmental Flows	2	Minor reduction in environmental flows.
Local Preference	4	No known opposition.
Institutional Constraints	4	Surface water must be procured through a contract.
Development Timeline	4	Project development, including permitting, could be accomplished in approximately five years or less.
Sponsorship	4	The City of Manvel has identified the project in its Water Master Plan.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	2	Serves sponsor entity and a limited number of customers.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

Water User Group Application

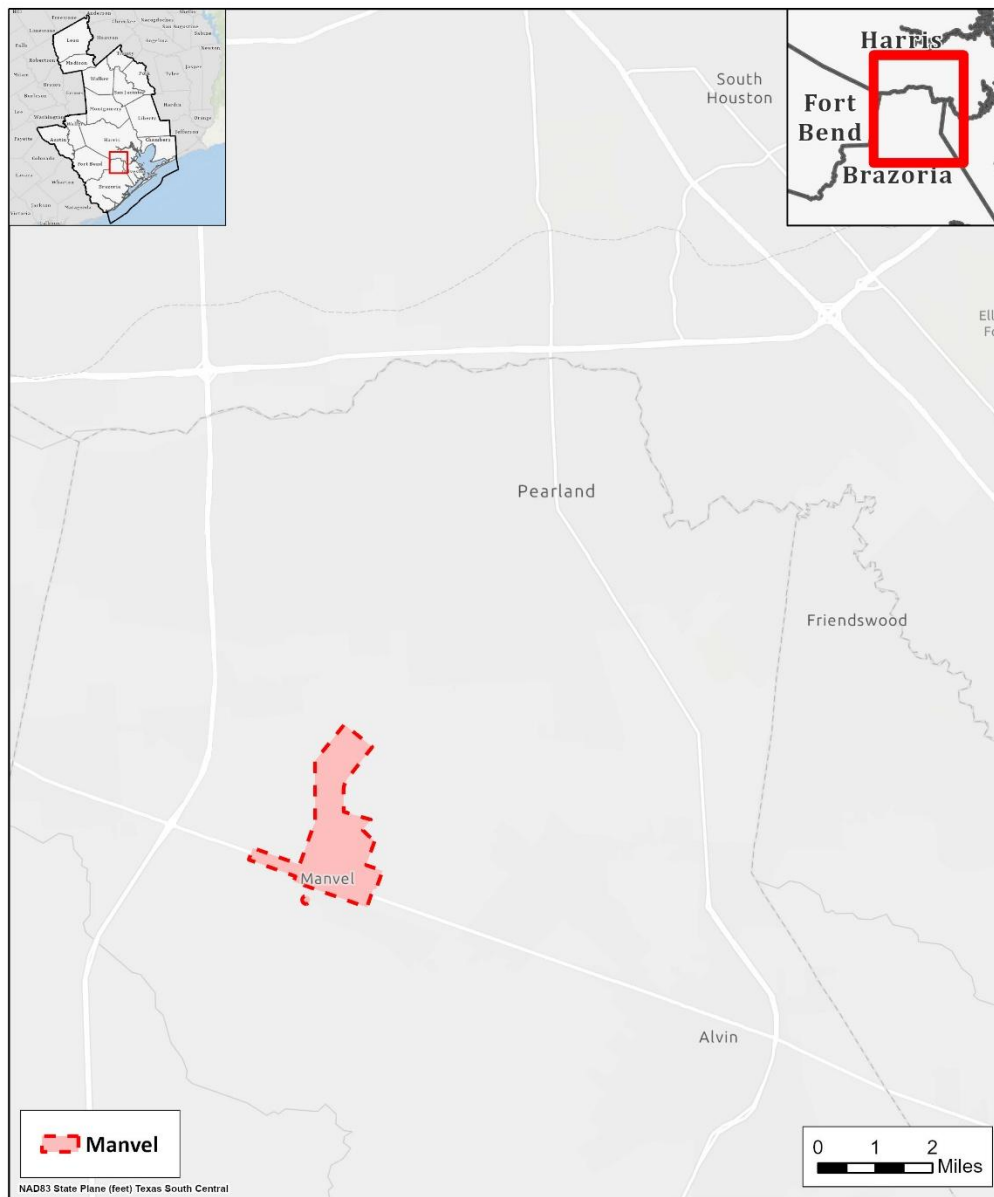
The Manvel Supply Expansion project was evaluated on the basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use.
Size	The capacity of this project is based on demands projected by the project sponsor.
Water Quality	Project provides treated water suitable for municipal use.
Unit Cost	Near-term and long-term unit costs are reasonable for target uses.
Other Factors	This project is identified for serving the City of Manvel and surrounding areas.

References

HDR Inc. *City of Manvel: 2022 Master Water Plan*. February 2022.

Location Map



Manvel Supply Expansion Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	North Fort Bend Water Authority Phase 2 Distribution Segments
Project ID:	CONV-010
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	76,720 ac-ft/yr (68.5 mgd) (conveyance only – supply generated by other projects)
Implementation Decade:	2030 (2024)
Development Timeline:	5 years
Project Capital Cost:	\$129,366,992 (Sept. 2023)
Unit Water Cost (Rounded):	\$136 per ac-ft (during loan period) \$17 per ac-ft (after loan period)

Strategy Description

The Harris-Galveston Subsidence District (HGSD) and Fort Bend Subsidence District (FBSD) have established requirements for entities within their boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the North Fort Bend Water Authority (NFBWA) and West Harris County Regional Water Authority (WHCRWA) have contracted with the City of Houston (COH) to receive treated surface water. Both Authorities have already developed transmission and distribution infrastructure to meet their initial obligations for reducing groundwater demand and are receiving water from COH. In order to utilize sufficient supplies to meet future surface water conversion obligations, NFBWA must expand the distribution infrastructure network through which it supplies its member districts.

Strategy Analyses

The project analyses for the NFBWA Phase 2 Distribution Segments include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The NFBWA will deliver surface water to the majority of the MUDs and the City of Fulshear within the Authority to meet the requirements of its Groundwater Reduction Plan (GRP) approved by the FBSD. The NFBWA Phase 2 Distribution Segments will allow for greater overall volume to be conveyed and conversion of additional districts to surface water.

Environmental Considerations

The NFBWA has engaged in a variety of activities and investigations for projects within the Authority, as summarized below. Note that the following descriptions are not limited to studies of the NFBWA Phase 2 Distribution Segments and also include studies related to NFBWA and WHCRWA's proposed future shared transmission infrastructure. The Authority relies on COH and WHCRWA to address the environmental considerations of projects for which those entities are primarily responsible.

- Threatened and Endangered Species Study - There were no threatened and/or endangered species identified at the time of field investigation. This does not eliminate the possibility of threatened and/or endangered species inhabiting the proposed route area at the time of construction. Further, reconnaissance did identify some habitats conducive for threatened and/or endangered species. At the time of final design and construction, an additional investigation of the area will be required to verify these species have not inhabited the construction area.
- Cultural Resources Study – Investigation revealed limited potential for cultural/archeological resources within the portion along Buffalo Bayou. The majority of this route lies within residential development where any cultural/archeological resources have been previously handled by the landowner. It is anticipated that the Texas Historical Commission will require field investigations prior to construction to verify no archeological sites exist along the proposed route.
- Reconnaissance of Potential Wetlands and Waters of the United States - Historical aerial photography and National Wetland Inventory (NWI) maps identified areas displaying characteristics consistent with potential wetland habitats. Field reconnaissance identified these areas and verified that in the opinion of the environmental consultant, the landscape does not appear to contain any potential wetlands. Depending on the amount of time between the investigation and construction, the Authority may reconfirm this assessment. If conditions have changed, then permitting or avoidance (trenchless construction) of these aquatic resources would be decided at that time. Given that the on-site investigation did not reveal any obvious wetland features, any subtle or smaller wetlands determined to be in the construction zone will most likely be avoided via trenchless construction.
- Limited Phase 1 Environmental Site Assessment (ESA) - The Phase 1 ESA investigation documented environmental conditions that could impact future land use or planned development, including installation of water line segments. No known hazardous material sites or oil and gas sites were identified. The proposed alignments are within the vicinity of gas stations; however, the alignment is located to avoid close proximity to these gas stations. Segments have a low potential for presence of hazardous materials or substances based on research conducted for this report.

Permitting and Development

The North Fort Bend Water Authority is subject to requirements imposed by COH as well as the State of Texas. Development of expanded distribution infrastructure will cause some degree of surface disturbance, which may require permitting and mitigation. Infrastructure development is also likely to require acquisition of additional easements or property. As indicated above, the Authority relies on the COH and WHCRWA to address the permitting and development requirements of projects for which those entities are primarily responsible.

Cost Analysis

An estimate of capital cost for the NFBWA Phase 2 Distribution Expansion was provided by the sponsor and was assumed to be inclusive of cost components in addition to construction, including those associated with engineering, land acquisition, legal costs, and environmental studies. Capital costs were scaled to a September 2023 equivalent cost using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. Debt service and annual operations and maintenance costs were calculated using standard Regional Planning procedures. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs are presented in *Table 1*.

Table 1 – NFBWA Phase 2 Distribution Segments Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$129,366,992	\$129,366,992
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$0	\$0
3	LAND AND EASEMENTS	1	LS	\$0	\$0
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$0	\$0
PROJECT CAPITAL COST					\$129,366,992

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$9,102,401	\$9,102,401	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$1,293,670	\$1,293,670	\$1,293,670	\$1,293,670	\$1,293,670	\$1,293,670
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$10,396,071	\$10,396,071	\$1,293,670	\$1,293,670	\$1,293,670	\$1,293,670

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$10,396,071	\$10,396,071	\$1,293,670	\$1,293,670	\$1,293,670	\$1,293,670
2	YIELD	76,720	76,720	76,720	76,720	76,720	76,720
3	UNIT COST	\$136	\$136	\$17	\$17	\$17	\$17
TOTAL UNIT COST		\$56					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$129,366,992	\$129,366,992
PROJECT COST					\$129,366,992

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES	1.0	%	\$129,366,992	\$1,293,670
ANNUAL OPERATION AND MAINTENANCE COST					\$1,293,670

Water Management Strategy Evaluation

Based on the analysis provided above, the NFBWA Phase 2 Distribution Segments project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	The NFBWA Phase 2 Distribution Segments, while not directly generating supply, allow conveyance with small additional cost.
Location	4	Reflects conveyance infrastructure from major transmission pipelines to demand centers.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	3	Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.
Local Preference	4	Local support. Limited opposition.
Institutional Constraints	3	Permits expected with minimal problems. Property available.
Development Timeline	5	Project to be developed within five years.
Sponsorship	5	Sponsors identified and project is in development.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No known significant impacts to other projects.

The NFBWA Phase 2 Distribution Segments include up to 30 miles of pipelines. The majority of this impact will be in urbanized areas with limited impacts to habitat. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The NFBWA Phase 2 Distribution Segments project 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 anticipated that the project will only serve NFBWA and any entities that it provides with water supply.

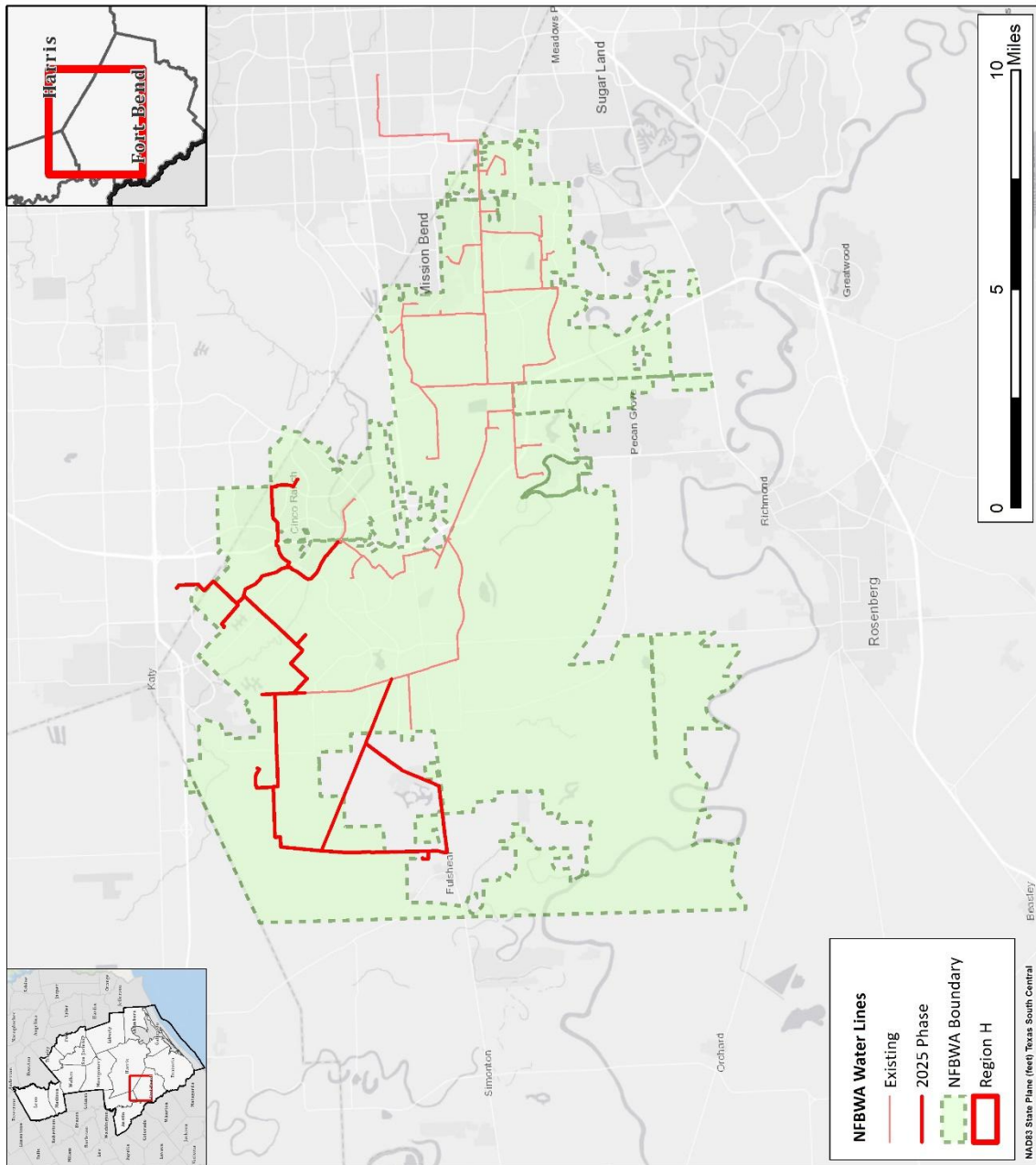
CRITERIA	WUG SUITABILITY
Proximity	Conveyance infrastructure from major transmission pipelines to demand centers.
Size	Conveyance is sized to convey the requisite amount of source water.
Water Quality	Conveys treated water of quality appropriate for municipal use.
Unit Cost	Adds small amount to unit cost of NFBWA's surface water conversion process.
Other Factors	Reduces dependence on Gulf Coast Aquifer groundwater.

References

Fort Bend Subsidence District. *Fort Bend Subsidence District 2013 Regulatory Plan*, August 2013.

North Fort Bend Water Authority Groundwater Reduction Plan. 2008. Brown and Gay, Inc.

Location Map



NFBWA Phase 2 Distribution Segments Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	North Harris County Regional Water Authority Distribution Expansion
Project ID:	CONV-011
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	143,360 ac-ft/yr (128 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	<10 years (per phase)
Project Capital Cost:	\$3,426,249,606 (Sept. 2023)
Unit Water Cost (Rounded):	\$1,443 per ac-ft (during loan period) \$151 per ac-ft (after loan period)

Strategy Description

The Harris-Galveston Subsidence District (HGSD) and Fort Bend Subsidence District (FBSD) have established requirements for entities within their boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged heavy pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the North Harris County Regional Water Authority (NHCRWA) has contracted with the City of Houston (COH) to receive treated surface water. The Authority has already developed transmission and distribution infrastructure to its initial obligations for reducing groundwater demand and are receiving water from COH. In order to utilize sufficient supplies to meet future surface water conversion obligations, NHCRWA is developing a phased expansion of the distribution infrastructure network through which it supplies its member districts, allowing for greater overall volume conveyed and conversion of additional districts to surface water.

Strategy Analyses

The project analyses for NHCRWA Distribution Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH, which is reflected in the Regional Plan as an existing supply. In order to meet future water demands and regulatory conversion obligations, the Authority has continued development and implementation of its

Groundwater Reduction Plan (GRP) program, increasing its supply reservation and planning for large scale transmission to its service area. NHCRWA will engage in a phased expansion of the distribution infrastructure network through which it supplies its member districts, allowing for greater overall volume conveyed and conversion of additional districts to surface water. The ongoing year 2025 expansion will include development of an expanded distribution pipeline network and two new pump station facilities, one near the Hardy Toll Road and Richey Road, and the other west of SH 249 near the Heron Lakes subdivision. The existing Louetta Regional Water Plant will be expanded, and two groundwater wells will be added to the system. The year 2025 expansion will bring the total number of districts in the NHCRWA surface water service area to over 100. A subsequent 2035 expansion of the distribution pipeline system will allow surface water to be conveyed to approximately 36 additional districts. Other infrastructure measures implemented in this phase will include three additional wells, a new West Regional Water Plant, and enhancements to the Spears Road Pump Station and Louetta Regional Water Plant. The 2045 conversion phase will involve limited expansion of infrastructure.

Environmental Considerations

Infrastructure development may result in some construction disturbance which could require mitigation. The most significant impact associated with the GRP is the source supply, which requires the interbasin transfer of surface water supplies.

Permitting and Development

NHCRWA is subject to contractual requirements established by COH as well as any relevant permitting required by the State of Texas and HGSD. Development of expanded distribution infrastructure will cause some degree of surface disturbance, which may require permitting and mitigation. Infrastructure development is also likely to require acquisition of additional easements or property.

Cost Analysis

Detailed estimates of capital costs for the 2025 phase of the NHCRWA Distribution Expansion were provided by the project sponsor in their associated SWIFT funding application and other sponsor data. Construction costs associated with 36-inch and 84-inch transmission lines, which were included in the 2018 SWIFT funding application, are not reflected in this cost estimate but are instead included in the costs associated with the NHCRWA Transmission Line project. For 2035 and 2045 phases of the NHCRWA Distribution Expansion, estimates of capital cost from the NHCRWA GRP were scaled to a September 2023 equivalent cost using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. Other cost components not included in the GRP, such as interest during construction, annualized debt service, and annualized operations and maintenance costs, were assumed using standard Regional Planning costing assumptions. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs are presented in *Table 1*.

Table 1 – NHCRWA Distribution Expansion Project Costs

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$1,821,169,342	\$1,821,169,342
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$915,149,925	\$915,149,925
3	LAND AND EASEMENTS	1	LS	\$357,747,903	\$357,747,903
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$3,192,580	\$3,192,580
5	INTEREST DURING CONSTRUCTION	1	LS	\$328,989,856	\$328,989,856
PROJECT CAPITAL COST					\$3,426,249,606

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (2025 PHASE)	\$55,954,619	\$55,954,619	\$0	\$0	\$0	\$0
2	DEBT SERVICE (2035 PHASE)	\$0	\$76,693,574	\$76,693,574	\$0	\$0	\$0
3	DEBT SERVICE (2045 PHASE)	\$0	\$0	\$108,426,419	\$108,426,419	\$0	\$0
4	OPERATION AND MAINTENANCE (2025 PHASE)	\$5,260,105	\$5,260,105	\$5,260,105	\$5,260,105	\$5,260,105	\$5,260,105
5	OPERATION AND MAINTENANCE (2035 PHASE)	\$0	\$8,245,053	\$8,245,053	\$8,245,053	\$8,245,053	\$8,245,053
6	OPERATION AND MAINTENANCE (2045 PHASE)	\$0	\$0	\$8,177,955	\$8,177,955	\$8,177,955	\$8,177,955
7	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
8	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$61,214,724	\$146,153,350	\$206,803,106	\$130,109,532	\$21,683,113	\$21,683,113

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$61,214,724	\$146,153,350	\$206,803,106	\$130,109,532	\$21,683,113	\$21,683,113
2	YIELD	143,360	143,360	143,360	143,360	143,360	143,360
3	UNIT COST	\$427	\$1,019	\$1,443	\$908	\$151	\$151
TOTAL UNIT COST		\$683					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS (2035 PHASE)	1	LS	\$151,847,369	\$151,847,369
2	PIPELINES (2025 PHASE)	1	LS	\$393,376,218	\$393,376,218
3	PIPELINES (2035 PHASE)	1	LS	\$428,813,306	\$428,813,306
4	PIPELINES (2045 PHASE)	1	LS	\$817,795,491	\$817,795,491
5	WATER TREATMENT PLANTS (2025 PHASE)	1	LS	\$13,263,431	\$13,263,431
5	WELL FIELDS (2035 PHASE)	1	LS	\$16,073,527	\$16,073,527
PROJECT COST					\$1,821,169,342

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS (2035 PHASE)	2.5	%	\$151,847,369	\$3,796,184
2	PIPELINES (2025 PHASE)	1.0	%	\$393,376,218	\$3,933,762
3	PIPELINES (2035 PHASE)	1.0	%	\$428,813,306	\$4,288,133
4	PIPELINES (2045 PHASE)	1.0	%	\$817,795,491	\$8,177,955
5	WATER TREATMENT PLANTS (2025 PHASE)	10.0	%	\$13,263,431	\$1,326,343
6	WELL FIELDS (2035 PHASE)	1.0	%	\$16,073,527	\$160,735
ANNUAL OPERATION AND MAINTENANCE COST					\$21,683,113

Water Management Strategy Evaluation

Based on the analysis provided above, the NHCRWA Distribution Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may

be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	3	The project unit cost is moderate to moderately low during each phase of debt service and declines after debt service completion.
Location	4	Reflects distribution infrastructure from major transmission pipelines to demand centers.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	3	Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.
Local Preference	4	Local support. Limited opposition.
Institutional Constraints	3	Permits expected with minimal problems. Property available.
Development Timeline	4	Project to be developed within ten years.
Sponsorship	5	Sponsors identified and project is in development.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No known significant impacts to other projects.

The NHCRWA Distribution Expansion includes up to 155 miles of pipelines. The majority of this impact will be in urbanized areas with limited impacts to habitat. The NHCRWA Distribution Expansion will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The NHCRWA Distribution Expansion project 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.

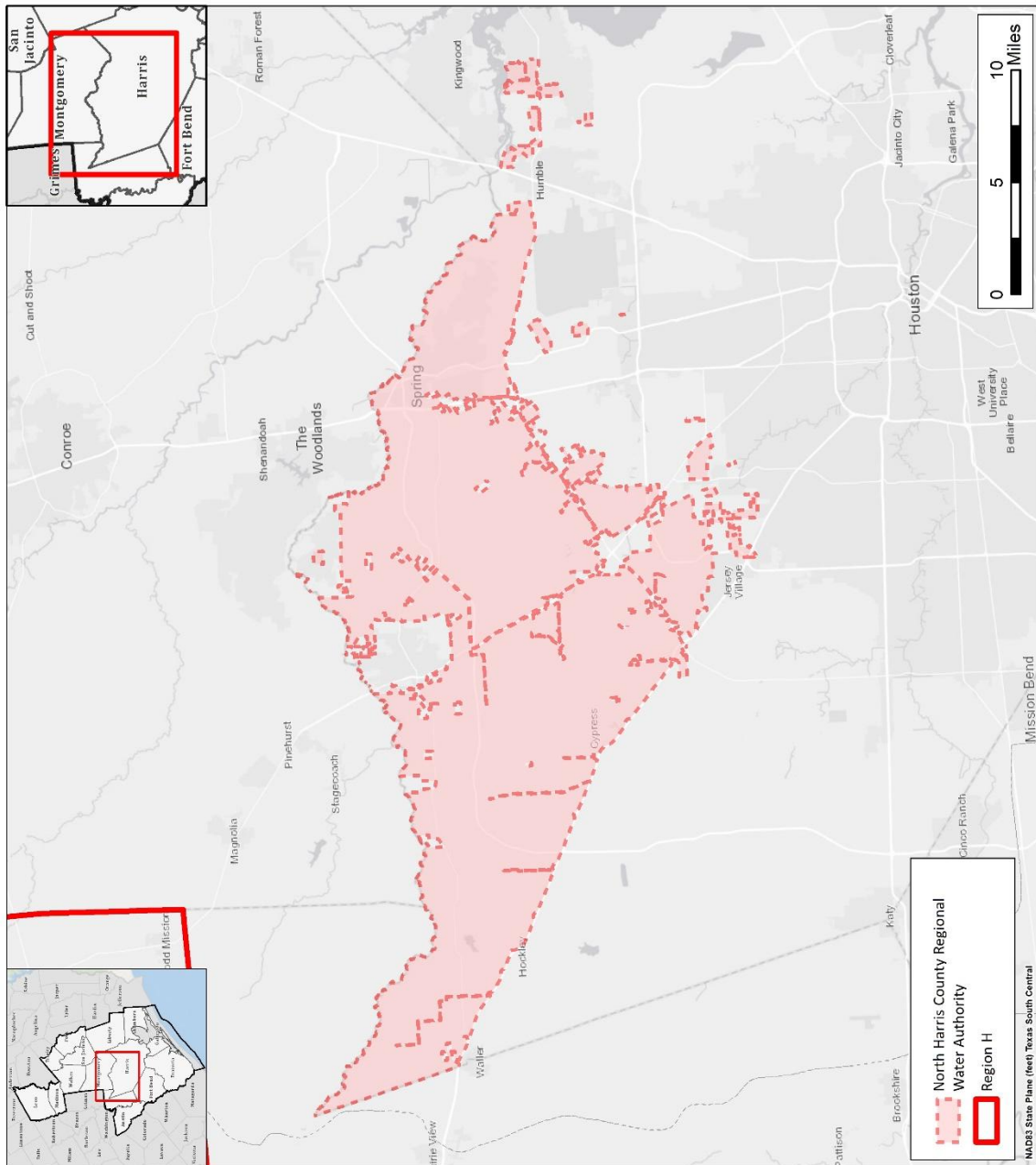
CRITERIA	WUG SUITABILITY
Proximity	Distribution infrastructure from major transmission pipelines to demand centers.
Size	Conveyance is sized to convey the requisite amount of source water.
Water Quality	Conveys treated water of quality appropriate for municipal use.
Unit Cost	Reflects a portion of the overall cost to implement NHCRWA’s surface water conversion.
Other Factors	Reduces dependence on Gulf Coast Aquifer groundwater.

References

AECOM. *2014 North Harris County Regional Water Authority Groundwater Reduction Plan*, prepared for NHCRWA, June 2014.

Harris-Galveston Subsidence District. *Harris-Galveston Subsidence District 2013 District Regulatory Plan*, May 2013.

Location Map



NHCRWA Distribution Expansion Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	North Harris County Regional Water Authority Transmission Lines
Project ID:	CONV-012
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	143,360 ac-ft/yr (128 mgd)
Implementation Decade:	2030
Development Timeline:	5 years
Project Capital Cost:	\$319,224,924 (Sept. 2023)
Unit Water Cost (Rounded):	\$179 per ac-ft (during loan period) \$23 per ac-ft (after loan period)

Strategy Description

The Harris-Galveston Subsidence District (HGSD) and Fort Bend Subsidence District (FBSD) have established requirements for entities within their boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the North Harris County Regional Water Authority (NHCRWA) has contracted with the City of Houston (COH) to receive treated surface water. The Authority has already developed transmission and distribution infrastructure to its initial obligations for reducing groundwater demand and are receiving water from COH. In order to utilize sufficient supplies to meet future surface water conversion obligations, NHCRWA is developing transmission infrastructure to convey additional treated surface water to its service area from connections with a large pipeline developed jointly by COH, NHCRWA, and the Central Harris County Regional Water Authority (CHCRWA).

Strategy Analyses

The project analyses for NHCRWA Transmission Lines include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH, which is reflected in the Regional Plan as an existing supply. In order to meet future water demands and regulatory conversion obligations, the Authority has continued development and implementation of its Groundwater Reduction Plan (GRP) program, increasing its supply reservation and planning for large

scale transmission to its service area. A major 84-inch pipeline jointly sponsored by and serving COH, NHCRWA, and CHCRWA has recently been completed and conveys water from the COH Northeast Water Purification Plant (NEWPP) westward to a point just west of Interstate 45 along a route roughly parallel to Beltway 8. The NHCRWA Transmission Lines will convey this water to the Authority service area in several segments. A 54-inch line will run north from the shared transmission along the Hardy Toll Road to a pump station near Richey Road. Another line of 84-inch diameter will run westward from the terminus of the shared pipeline to a proposed pump station near the Heron Lakes subdivision slightly west of SH 249. A smaller 36-inch line will branch off at TC Jester Blvd and connect to the existing Spears Road Pump Station.

Environmental Considerations

Infrastructure development may result in some construction disturbance which could require mitigation. The most significant impact associated with the project is the source supply, which requires the interbasin transfer of surface water supplies.

Permitting and Development

NHCRWA is subject to contractual requirements established by COH as well as any relevant permitting required by the State of Texas and HGSD. Development of expanded transmission infrastructure will cause some degree of surface disturbance, which may require permitting and mitigation. Infrastructure development is also likely to require acquisition of additional easements or property.

Cost Analysis

Planning-level capital cost estimates for the SH 249 pump station and 84-inch pipeline were provided by the project sponsor and were assumed to be inclusive of cost components such as contingency, engineering, land acquisition, legal costs, and environmental studies and mitigation. Construction costs associated with 36-inch and 84-inch transmission lines were included in the sponsor's SWIFT funding application in 2018 and have been included in the estimated cost of the NHCRWA Transmission Lines project; however, other capital costs associated with these pipelines were also associated with distribution infrastructure and are instead reflected as part of the total cost of the NHCRWA Distribution Expansion project in the Regional Plan. Capital costs were scaled to a September 2023 equivalent cost using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. Other cost components not included in the GRP, such as interest during construction, annualized debt service, and annualized operations and maintenance costs, were assumed using standard regional planning costing assumptions. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs are presented in *Table 1*.

Table 1 – NHCRWA Transmission Lines Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$271,629,153	\$271,629,153
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$0	\$0
3	LAND AND EASEMENTS	1	LS	\$0	\$0
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$47,595,771	\$47,595,771
PROJECT CAPITAL COST					\$319,224,924

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$22,461,009	\$22,461,009	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$3,263,518	\$3,263,518	\$3,263,518	\$3,263,518	\$3,263,518	\$3,263,518
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$25,724,527	\$25,724,527	\$3,263,518	\$3,263,518	\$3,263,518	\$3,263,518

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$25,724,527	\$25,724,527	\$3,263,518	\$3,263,518	\$3,263,518	\$3,263,518
2	YIELD	143,360	143,360	143,360	143,360	143,360	143,360
3	UNIT COST	\$179	\$179	\$23	\$23	\$23	\$23
TOTAL UNIT COST		\$75					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$36,481,752	\$36,481,752
2	PIPELINES	1	LS	\$235,147,401	\$235,147,401
PROJECT COST					\$271,629,153

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$36,481,752	\$912,044
2	PIPELINES	1.0	%	\$235,147,401	\$235,147,401
ANNUAL OPERATION AND MAINTENANCE COST					\$3,263,518

Water Management Strategy Evaluation

Based on the analysis provided above, the NHCRWA Transmission Lines project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	4	The NHCRWA Transmission Lines, while not directly generating supply, allow conveyance with small additional cost.
Location	4	Reflects conveyance infrastructure from major transmission pipelines to demand centers.

CRITERIA	RATING	EXPLANATION
Water Quality		No known water quality issues.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	3	Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.
Local Preference	4	Local support. Limited opposition.
Institutional Constraints	3	Permits expected with minimal problems. Property available.
Development Timeline	5	Project to be fully developed within five years.
Sponsorship	5	Sponsors identified and project is in development.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No known significant impacts to other projects.

The NHCRWA Transmission Lines will include up to 14 miles of large-diameter pipelines. The majority of this impact will be in urbanized areas with limited impacts to habitat. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The NHCRWA Transmission Lines project 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.

CRITERIA	WUG SUITABILITY
Proximity	Conveyance infrastructure from major transmission pipelines to demand centers.
Size	Conveyance is sized to convey the requisite amount of source water.
Water Quality	Conveys treated water of quality appropriate for municipal use.

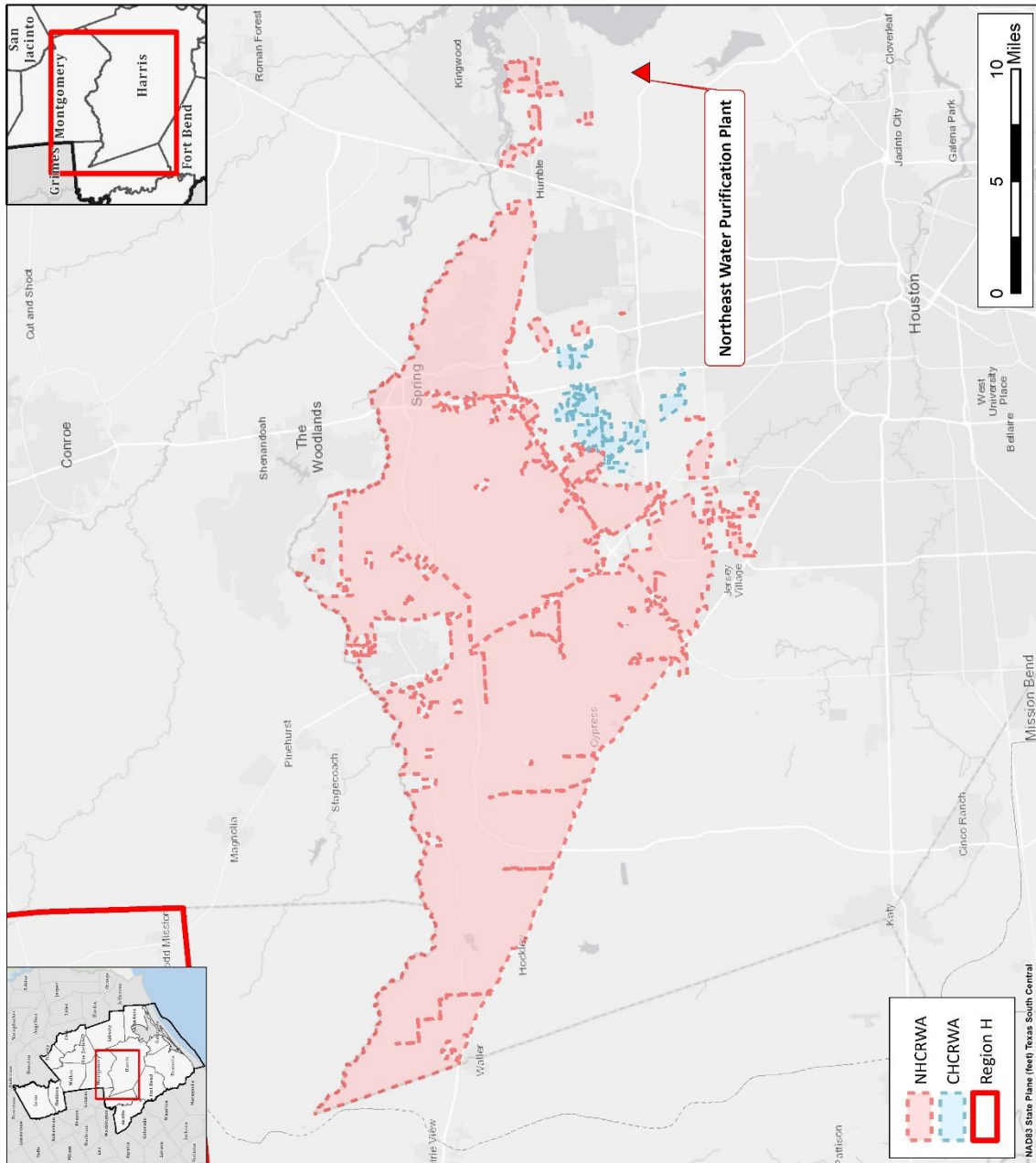
CRITERIA	WUG SUITABILITY
Unit Cost	Adds small amount to unit cost of NHCRWA's surface water conversion process.
Other Factors	Reduces dependence on Gulf Coast Aquifer groundwater.

References

AECOM. *2014 North Harris County Regional Water Authority Groundwater Reduction Plan*, prepared for NHCRWA, June 2014.

Harris-Galveston Subsidence District. *Harris-Galveston Subsidence District 2013 District Regulatory Plan*, May 2013.

Location Map



NHCRWA Transmission Lines Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Pasadena Infrastructure Expansion
Project ID:	CONV-013
Project Type:	Conveyance
Potential Supply Quantity (Rounded):	16,800 ac-ft/yr (15.0 mgd)
Implementation Decade:	2030
Development Timeline:	5 years
Project Capital Cost:	\$103,994,471 (Sept. 2023)
Unit Water Cost (Rounded):	\$669 per ac-ft (during loan period) \$233 per ac-ft (after loan period)

Strategy Description

The City of Pasadena, located in the greater Houston metropolitan area, is the second most populous municipality in Harris County. In addition to directly serving a population of over 150,000 residents, it also acts as a wholesale water provider to the neighboring Cities of Seabrook and Clear Lake and to local industries. Pasadena meets water demands primarily through treated water purchased from the City of Houston (COH), supplemented with self-supplied groundwater. Pasadena's water supply contract with COH provides a potential treated surface water supply of up to 46 mgd (51,520 ac-ft/yr), including 40 mgd from the COH Southeast Water Purification Plant (SEWPP) and 6 mgd from the COH East Water Purification Plant (EWPP).

In 2016, the City completed a comprehensive evaluation of its water system in order to identify potential improvements needed to meet projected water demands and support compliance with local groundwater reduction requirements. It was determined that Pasadena's existing infrastructure, including water plants and pumping and transmission infrastructure connecting take points from the COH system to Pasadena's water plants, lack the capacity to fully utilize contracted supply. Of the 46 mgd of contracted surface water, approximately 25 to 28 mgd is not readily accessible with current infrastructure. In order to meet the water demands of the City and its wholesale customers, Pasadena has identified key infrastructure improvements necessary to access a great portion of contracted supplies.

Strategy Analyses

The project analyses for the Pasadena Infrastructure Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The City of Pasadena is heavily dependent on contractual treated surface water supply from COH in order to meet water demands. However, the City's ability to utilize this supply is limited by infrastructure capacity. Pasadena has identified key infrastructure improvements, with the goal of increasing usable supply from contractual surface water by approximately 15 mgd (16,800 ac-ft/yr).

Key project components include increased water treatment and pumping capacity at the City's Crenshaw Water Plant and Bay Area Water Plant, development of a new pump station at the site of a non-functioning former Coastal Water Authority (CWA) pump station, and major transmission lines to allow the city to receive additional COH supply for conveyance to Pasadena water plants. While the City is also investigating additional conveyance infrastructure, the project concept presented for the Regional Water Plan is limited to components creating new supply and large-capacity transmission, pumping, and treatment infrastructure.

Environmental Considerations

This project will result in minor surface disturbances which may require mitigation, although development primarily in an urbanized and pre-disturbed setting limits environmental and habitat impacts. The project will also result in the crossing of various channels and stream features. The project sponsor has determined that environmental site assessment, wetland delineation, and implementation of Storm Water Pollution Prevention Plans will be necessary for several project infrastructure components. A Phase 1 Environmental Site Assessment and a wetland delineation study have been completed for improvements to the Bay Area Water Plant. Implementation of this water management strategy will increase diversions from surface water sources. However, these diversions will be made from existing water rights currently owned by COH and contracted by the City of Pasadena, and no new water rights permits are required for this project.

Permitting and Development

No new water rights permitting is expected with this project. However, there is expected to be construction permitting, and some permitting will be required from the Harris Galveston Subsidence District (HGSD) for the development of new groundwater wells.

Cost Analysis

Costs were developed for the West University Place Infrastructure Expansion project based on the estimated cost and infrastructure capacity data provided by the project sponsor, in conjunction with standard Regional Water Planning costing procedures and assumptions. Construction, engineering, legal, contingency, environmental, and interest during construction costs were obtained from sponsor data and scaled to a September 2023 equivalent cost using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. Additional costs, including land surveying, annualized debt service, and annual operating costs were developed based on standard assumptions for regional planning. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. A total cost estimate for the Pasadena Infrastructure Expansion project is shown in *Table 1*.

Table 1 – Pasadena Infrastructure Expansion Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$84,167,877	\$84,167,877
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$6,234,080	\$6,234,080
3	LAND AND EASEMENTS	1	LS	\$2,715,940	\$2,715,940
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$1,117,490	\$1,117,490
5	INTEREST DURING CONSTRUCTION	1	LS	\$9,759,084	\$9,759,084
PROJECT CAPITAL COST					\$103,994,471

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$7,317,163	\$7,317,163	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$3,922,643	\$3,922,643	\$3,922,643	\$3,922,643	\$3,922,643	\$3,922,643
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$11,239,806	\$11,239,806	\$3,922,643	\$3,922,643	\$3,922,643	\$3,922,643

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$11,239,806	\$11,239,806	\$3,922,643	\$3,922,643	\$3,922,643	\$3,922,643
2	YIELD	16,800	16,800	16,800	16,800	16,800	16,800
3	UNIT COST	\$669	\$669	\$233	\$233	\$233	\$233
TOTAL UNIT COST		\$379					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$36,692,989	\$36,692,989
2	PIPELINES	1	LS	\$33,015,272	\$33,015,272
3	WATER TREATMENT PLANTS	1	LS	\$14,459,616	\$14,459,616
PROJECT COST					\$84,167,877

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$36,692,989	\$917,325
2	PIPELINES	1.0	%	\$33,015,272	\$330,153
3	WATER TREATMENT PLANTS	1.0	LS	\$2,675,165	\$2,675,165
ANNUAL OPERATION AND MAINTENANCE COST					\$3,922,643

Water Management Strategy Evaluation

Based on the analysis provided above, the Pasadena Infrastructure Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Cost	3	Unit cost of the project, as depicted, is moderate and decreases significantly after debt service.

Criteria	Rating	Explanation
Location	4	Project is located near demand center and includes limited transmission components for delivery to system water plants.
Water Quality	3	No known issues regarding water quality.
Environmental Land and Habitat	4	Limited environmental impacts associated with project development in urbanized, pre-disturbed area.
Environmental Flows		Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.
Local Preference	4	No known significant opposition.
Institutional Constraints		Minimal permitting challenges or opposition expected.
Development Timeline	5	Project development, including permitting, could be accomplished in approximately five years or less.
		The City of Pasadena has identified the project and it is currently in the design phase of development.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization		Serves sponsor entity and a limited number of industrial customers and surrounding municipalities.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

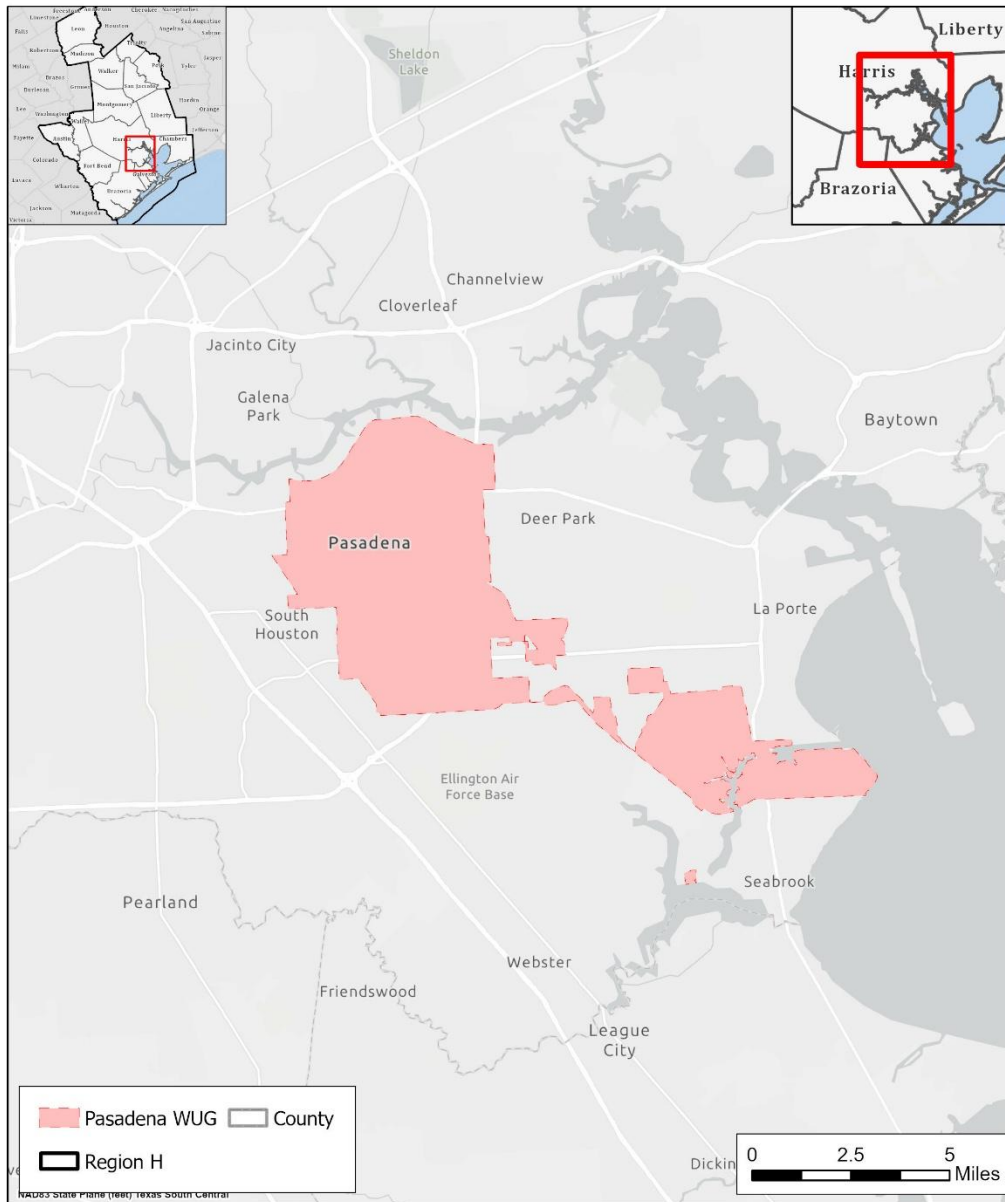
Water User Group Application

The Pasadena Infrastructure Expansion project 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.

Criteria	WUG Suitability
Proximity	Project is located in close proximity to intended points of use.
Size	The capacity of this project is based on demands projected by the project sponsor.
Water Quality	Project provides treated water suitable for municipal use.

Criteria	WUG Suitability
Unit Cost	Near-term and long-term unit costs are reasonable for target uses.
Other Factors	This project is identified for serving the City of Pasadena and surrounding areas.

Location Map



Pasadena Infrastructure Expansion Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	SJRA Highlands System Enhancement
Project ID:	CONV-014
Project Type:	Various
Potential Supply Quantity (Rounded):	30,000 ac-ft/yr (26.8 mgd)
Implementation Decade:	2030 (2028)
Development Timeline:	<5 years
Project Capital Cost:	\$35,197,440 (Sept. 2023)
Unit Water Cost (Rounded):	\$99 per ac-ft (during loan period) \$17 per ac-ft (after loan period)

Strategy Description

The San Jacinto River Authority (SJRA) is a wholesale water provider for an extensive portion of the San Jacinto River Basin. In eastern Harris County, SJRA provides raw water supply from water rights in the San Jacinto and Trinity River Basins to industrial, municipal, and irrigation customers through its Highland Canal System. SJRA's San Jacinto River water right supplies are conveyed by the SJRA Main Canal to the Highlands Reservoir, from which they serve customers through other system canals. SJRA's Trinity River Rights are diverted by the Coastal Water Authority (CWA) through a contractual agreement and conveyed westward through the CWA canal system to the SJRA Highlands Canal System.

While the SJRA Highlands System can currently utilize substantial supplies from its Trinity River Basin Rights to meet water demands, there is a portion of SJRA's water right portfolio in the basin not currently fully utilized. SJRA has identified increased usage from these supplies as a potential option for meeting future water demand for wholesale customers. Accessing the full volume of these supplies would require enhancements to pump station and canal elements to increase conveyance capacity.

Strategy Analyses

The project analyses for SJRA Highlands System Enhancement include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The project concept presented this memorandum is adapted from information provided by SJRA on potential future conveyance capacity increases to allow additional surface water supply to be delivered to SJRA's customers. Major project components are anticipated to include development of

additional pump station capacity and improvements to canal infrastructure to increase conveyance capacity.

While SJRA is authorized to divert the full volume permitted under their existing water rights and through contractual supplies, current infrastructure limits the amount of Trinity River Basin supplies that can be physically conveyed and delivered to customers in the Highlands System. This additional capacity will enable SJRA to divert up to 30,000 ac-ft/year more than is currently possible with existing infrastructure, enabling utilization of raw additional supplies from established water rights. The enhanced infrastructure from this project could also potentially support other future strategies and supplies. The supply volume allocated for this strategy in the Plan reflects modeled source availability for currently utilized sources and annualized use.

Environmental Considerations

The enhanced infrastructure will facilitate an increase in conveyance capacity for the SJRA Highlands system. Impacts on instream flows and bay and estuary flows are anticipated to be minimal, as the proposed project increases usable supply from existing water rights. Infrastructure development may result in some limited surface disturbance from construction; however, this is expected to be minimal as the proposed infrastructure has a limited footprint and will be developed at existing SJRA infrastructure locations.

Permitting and Development

The development of this strategy may require some permitting due to surface disturbance from the development of additional conveyance capacity. This is expected to be minimal, as construction is anticipated to occur at existing SJRA infrastructure locations. Because the supply source is provided by existing water rights and diverted at existing take points, permitting of new water rights or amendment of existing rights will not be required.

Cost Analysis

A preliminary planning-level cost estimate was developed for the SJRA Highlands System Enhancement project based on available sponsor information. Primary infrastructure components include increased pump station capacity and canal improvements to increase conveyance capacity. Additional cost components, including engineering, land, environmental studies and mitigation, interest during construction, annualized debt service, and annualized operations and maintenance costs were assumed using standard Regional Planning costing assumptions. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs are presented in September 2023 dollars in *Table 1*.

Table 1 – SJRA Highlands System Enhancement Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$25,205,334	\$25,205,334
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$8,821,867	\$8,821,867
3	LAND AND EASEMENTS	1	LS	\$7,414	\$7,414
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$59,763	\$59,763
5	INTEREST DURING CONSTRUCTION	1	LS	\$1,103,062	\$1,103,062
PROJECT CAPITAL COST					\$35,197,440

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$2,476,530	\$2,476,530	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$504,107	\$504,107	\$504,107	\$504,107	\$504,107	\$504,107
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$2,980,636	\$2,980,636	\$504,107	\$504,107	\$504,107	\$504,107

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$2,980,636	\$2,980,636	\$504,107	\$504,107	\$504,107	\$504,107
2	YIELD	30,000	30,000	30,000	30,000	30,000	30,000
3	UNIT COST	\$99	\$99	\$17	\$17	\$17	\$17
TOTAL UNIT COST		\$44					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$16,803,556	\$16,803,556
2	CANAL IMPROVEMENT	1	LS	\$8,401,778	\$8,401,778
PROJECT COST					\$25,205,334

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$16,803,556	\$420,089
2	CANAL IMPROVEMENT	1.0	%	\$8,401,778	\$84,018
ANNUAL OPERATION AND MAINTENANCE COST					\$504,107

Water Management Strategy Evaluation

Based on the analysis provided above, the SJRA Highlands System Enhancement project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	The project, while not directly generating supply, allows conveyance with small additional cost.
Location	4	Reflects conveyance infrastructure to demand centers.

Environmental Land and Habitat	5	Limited impacts associated with construction in existing corridors.
Local Preference	3	No known significant opposition.
Development Timeline	5	Project can be developed in a relatively short period of time.
Vulnerability	3	Moderate risk associated with development of a structure in a coastal area.
Impacts on Other WMS	5	Project will increase overall SJRA system flexibility and reliability, positively impacting customer WMS.

Water User Group Application

The SJRA Highlands System Enhancement project 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.

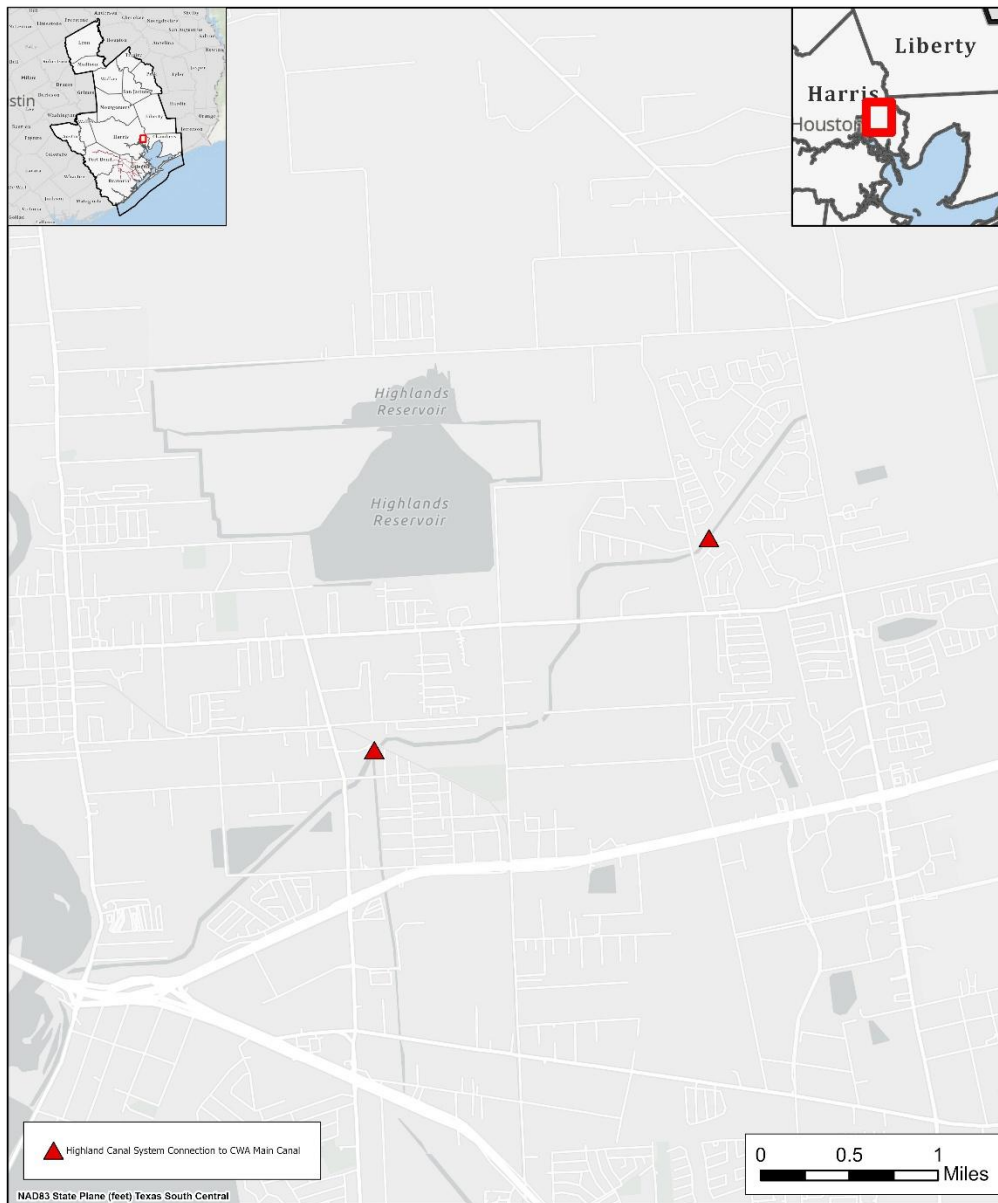
CRITERIA	WUG SUITABILITY
Proximity	This project conveys treated water to industrial and municipal customers in eastern Harris County.
Size	The capacity of this project is based on the customer need and source water supply.
Water Quality	The project is not anticipated to impact water quality. This project will convey raw water, which is suitable for industrial use.
Unit Cost	Adds small amount to unit cost of SJRA's strategies to provide additional water to customers.

CRITERIA	WUG SUITABILITY
Other Factors	This project has been identified for customers within the SJRA Highlands System service area.

References

Freese and Nichols, Inc. 2025. *Raw Water Supply Master Plan*. Prepared for San Jacinto River Authority.

Location Map



SJRA Highlands System Enhancement Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Southeast Transmission Line Improvements
Project ID:	CONV-015
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	39,928 ac-ft/yr (35.65 mgd)
Implementation Decade:	2030
Development Timeline:	5 years
Project Capital Cost:	\$159,151,171 (Sept. 2023)
Unit Water Cost (Rounded):	\$306 per ac-ft (during loan period) \$26 per ac-ft (after loan period)

Strategy Description

The existing Southeast Transmission Line (formerly called the Old Galveston Road line) transmits water from the Southeast Water Purification Plant (SEWPP) to customers of the plant in southeastern Harris County and northwestern Galveston County. In recent years, existing customers have expressed an interest in expanding capacity in the pipeline during a rehabilitation project to be carried out in upcoming years.

Strategy Analyses

The project analyses for Southeast Transmission Line Improvements include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The concept for the project presented in this memorandum is adapted from information from the City of Houston (COH) and the co-participants in the project. COH and the co-participants are currently considering future needs for water from the pipeline. The project is expected to increase available capacity of the pipeline by approximately 36 mgd. The Southeast Transmission Line Improvements will be constructed as 13 segments. The transmission line begins slightly west of the SEWPP at a connection with an existing line, runs southwest and south for almost two miles, then turns southeast and continues for approximately 6.5 miles to the City of Webster. Segments have decreasing diameters along the route as the line reaches delivery points to various customers. Additional segments branch off to the west at a point slightly over a mile from the end of the northwest-to-southeast route. Approximate alignments are shown in the Location Map included with this memorandum.

Environmental Considerations

Environmental issues are expected to be minimal due to the use of existing corridors for development. Further environmental study will be conducted as part of the ongoing study of alternatives and configurations.

Permitting and Development

Permitting issues related to the project will be examined more closely during further phases of study. Infrastructure development may result in some construction disturbance which could require mitigation. However, the development of the project primarily within existing right-of-way in an urbanized setting minimizes potential permitting obstacles.

Cost Analysis

Project costs were provided by COH, including estimated capital costs for engineering, design, real estate acquisition, construction, and contingency. Environmental mitigation costs were assumed to be included in the costs provided by COH. Standard assumptions for regional planning were applied to determine interest during construction, annualized debt service, and annual operating and maintenance costs. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated project costs for the Southeast Transmission Line Improvements project are shown in *Table 1* in September 2023 dollars.

Table 1 – Southeast Transmission Line Improvements Estimated Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$103,855,364	\$103,855,364
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$36,505,301	\$36,505,301
3	LAND AND EASEMENTS	1	LS	\$8,919,395	\$8,919,395
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$9,871,111	\$9,871,111
PROJECT CAPITAL COST					\$159,151,171

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$11,198,048	\$11,198,048	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$1,038,554	\$1,038,554	\$1,038,554	\$1,038,554	\$1,038,554	\$1,038,554
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$12,236,601	\$12,236,601	\$1,038,554	\$1,038,554	\$1,038,554	\$1,038,554

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$12,236,601	\$12,236,601	\$1,038,554	\$1,038,554	\$1,038,554	\$1,038,554
2	YIELD	39,928	39,928	39,928	39,928	39,928	39,928
3	UNIT COST	\$306	\$306	\$26	\$26	\$26	\$26
TOTAL UNIT COST		\$119					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$103,855,364	\$103,855,364
PROJECT COST					\$103,855,364

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES	1.0	%	\$103,855,364	\$1,038,554
ANNUAL OPERATION AND MAINTENANCE COST					\$1,038,554

Water Management Strategy Evaluation

Based on the analysis provided above, the Southeast Transmission Line Improvements project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	The Southeast Transmission Line Improvements, while not directly generating supply, allow conveyance with small additional cost.
Location	4	Reflects conveyance infrastructure from supply to demand centers.

CRITERIA	RATING	EXPLANATION
Water Quality	3	No impacts to water quality.
Environmental Land and Habitat	5	Limited impacts associated with construction within existing corridors.
Environmental Flows	3	No impact to environmental flows.
Local Preference	5	Significant support from co-participants.
Institutional Constraints	3	Property available and limited permitting efforts.
Development Timeline	5	Projected may be implemented within five years.
Sponsorship	5	Sponsors identified and in the process of developing project.
Vulnerability	5	Minimal risk associated with pipeline infrastructure.
Regionalization	3	Transmission line improvements will serve multiple systems who utilize this line.
Impacts on Other WMS	5	Project helps to facilitate the use of treated surface water from the SEWPP.

The Southeast Transmission Line Improvements will include approximately 11.2 miles of pipelines. The majority of this impact will be in urbanized areas with limited impacts to habitat. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

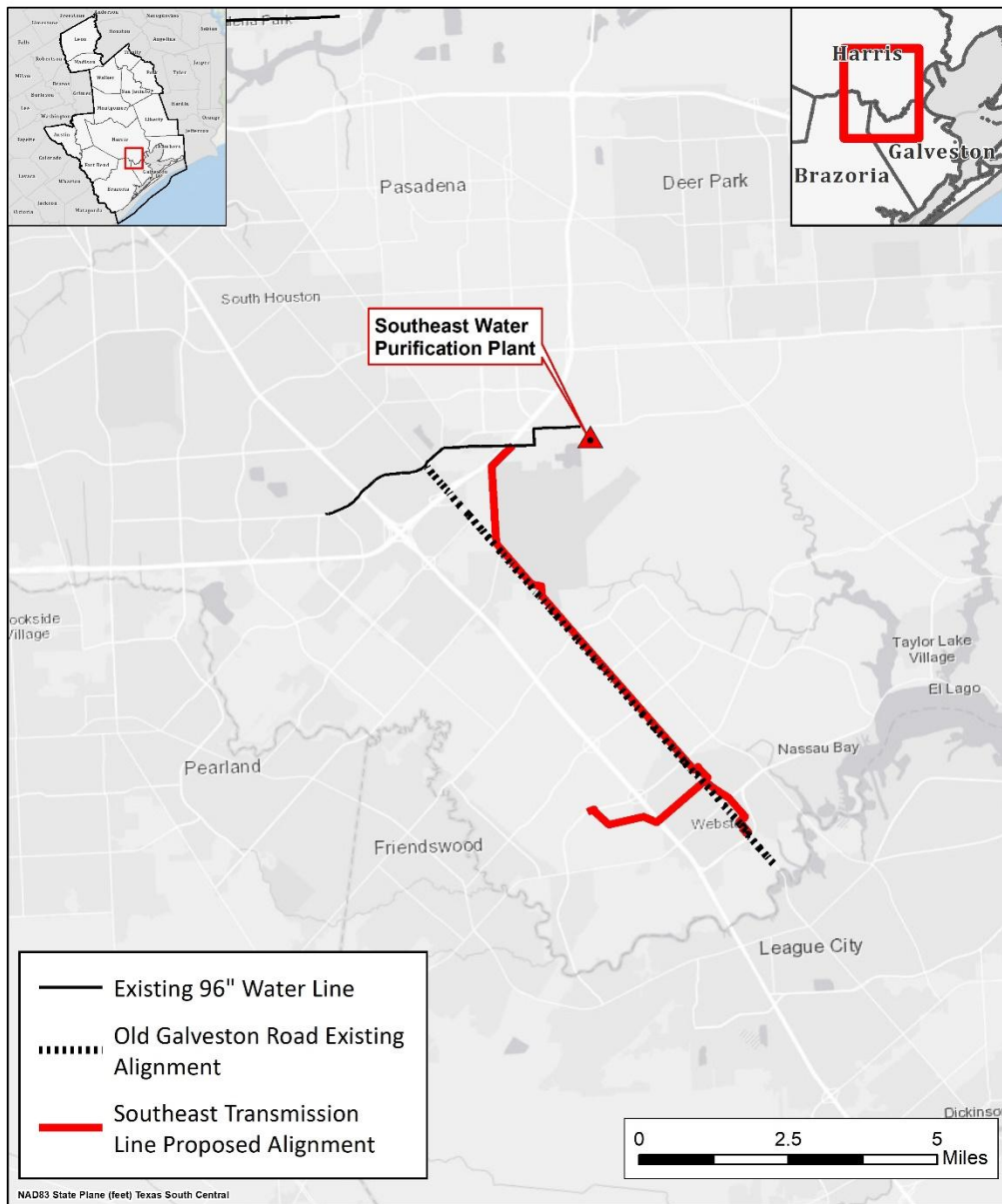
Water User Group Application

The Southeast Transmission Line Improvements project 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.

CRITERIA	WUG SUITABILITY
Proximity	This project is intended to provide water to customers in Harris and Galveston Counties along the Interstate 45 corridor.
Size	The capacity of this project is based on projected need of its specific stakeholders.
Water Quality	This project will convey treated surface water.

CRITERIA	WUG SUITABILITY
Unit Cost	The unit cost for this project is a reasonable price for transmission of treated water for municipal, commercial, or industrial uses.
Other Factors	This project is identified for a few specific co-participants in the vicinity of the SEWPP.

Location Map



Southeast Transmission Line Improvements Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	West University Place Infrastructure Expansion
Project ID:	CONV-016
Project Type:	Conveyance
Potential Supply Quantity (Rounded):	850 ac-ft/yr (0.75 mgd)
Implementation Decade:	2030
Development Timeline:	5 years
Project Capital Cost:	\$6,490,080 (Sept. 2023)
Unit Water Cost (Rounded):	\$695 per ac-ft (during loan period) \$158 per ac-ft (after loan period)

Strategy Description

The City of West University Place is located in the greater Houston metropolitan area in Harris County. The City meets water demands primarily through treated water purchased from the City of Houston (COH), supplemented with self-supplied groundwater and non-potable municipal reuse. Through its system assessment studies, the City has identified the need to expand infrastructure capacity expansions in order to utilize a greater portion of its contractual water supply from COH to meet municipal water demands, including expansion of pumping capacity at the City's Wakeforest and Milton Water Plants.

Strategy Analyses

The project analyses for the West University Place Infrastructure Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The City of West University Place is heavily dependent on contractual treated surface water supply from COH in order to meet water demands. Surface water is received through several connections to the City's system, including at the Wakeforest Water Plant and Milton Water Plant. However, the City's ability to utilize this supply is limited by current water plant capacity, and a need to increase water plant pumping capacity has been identified. Key project components include installation of additional pump capacity and transmission elements. The City plans to install two booster pumps at the Wakeforest Water Plant, increasing pump capacity from 3,000 gpm to 4,000 gpm with minor transmission components included in connecting the booster pumps to the system. This would result in an estimated increase of approximately 850 ac-ft/yr (0.75 mgd) of usable supply from existing contractual sources to be delivered to and utilized by the City.

Environmental Considerations

This project will result in minor surface disturbances which may require mitigation. The project includes the development of underground stormwater detention and site work for construction control. Development of project infrastructure within an urbanized, pre-disturbed setting limits environmental and habitat impacts.

Permitting and Development

Development of expanded water plant infrastructure will cause some degree of surface disturbance, which may require permitting and mitigation. Development of project infrastructure within an urbanized, pre-disturbed setting limits impacts.

Cost Analysis

Costs were developed for the West University Place Infrastructure Expansion project based on the estimated cost and infrastructure capacity data provided by the project sponsor, in conjunction with standard Regional Water Planning costing procedures and assumptions. Construction, engineering, legal, and contingency costs were obtained from sponsor data and scaled to a September 2023 equivalent cost using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. Additional costs, including land, environmental studies and mitigation, interest during construction, annualized debt service, and annual operating costs were developed based on standard assumptions for regional planning. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. A total cost estimate for the West University Place Infrastructure Expansion project is shown in *Table 1*.

Table 1 – West University Place Infrastructure Expansion Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$5,363,391	\$5,363,391
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$487,695	\$487,695
3	LAND AND EASEMENTS	1	LS	\$217,800	\$217,800
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$217,800	\$217,800
5	INTEREST DURING CONSTRUCTION	1	LS	\$203,394	\$203,394
PROJECT CAPITAL COST					\$6,490,080

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$456,649	\$456,649	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$134,085	\$134,085	\$134,085	\$134,085	\$134,085	\$134,085
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$590,734	\$590,734	\$134,085	\$134,085	\$134,085	\$134,085

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$590,734	\$590,734	\$134,085	\$134,085	\$134,085	\$134,085
2	YIELD	850	850	850	850	850	850
3	UNIT COST	\$695	\$695	\$158	\$158	\$158	\$158
TOTAL UNIT COST		\$337					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$5,363,391	\$5,363,391
PROJECT COST					\$5,363,391

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$5,363,391	\$134,085
ANNUAL OPERATION AND MAINTENANCE COST					\$134,085

Water Management Strategy Evaluation

Based on the analysis provided above, the West University Place Infrastructure Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	3	Unit cost of the project, as depicted, is moderate and decreases significantly after debt service.
Location	5	Project is located near demand center and includes limited transmission components for delivery to sponsor.

CRITERIA	RATING	EXPLANATION
Water Quality		No known issues regarding water quality.
Environmental Land and Habitat	4	Limited environmental impacts associated with project development in urbanized, pre-disturbed area.
Environmental Flows	3	Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.
Local Preference	4	No known significant opposition.
Institutional Constraints	3	Minimal permitting challenges or opposition expected.
Development Timeline	5	Project development could be accomplished in approximately five years or less.
Sponsorship	4	The City of West University Place has identified the project and it is currently in the design phase.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	1	Serves sponsor entity.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

Water User Group Application

The West University Place Infrastructure Expansion project 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.

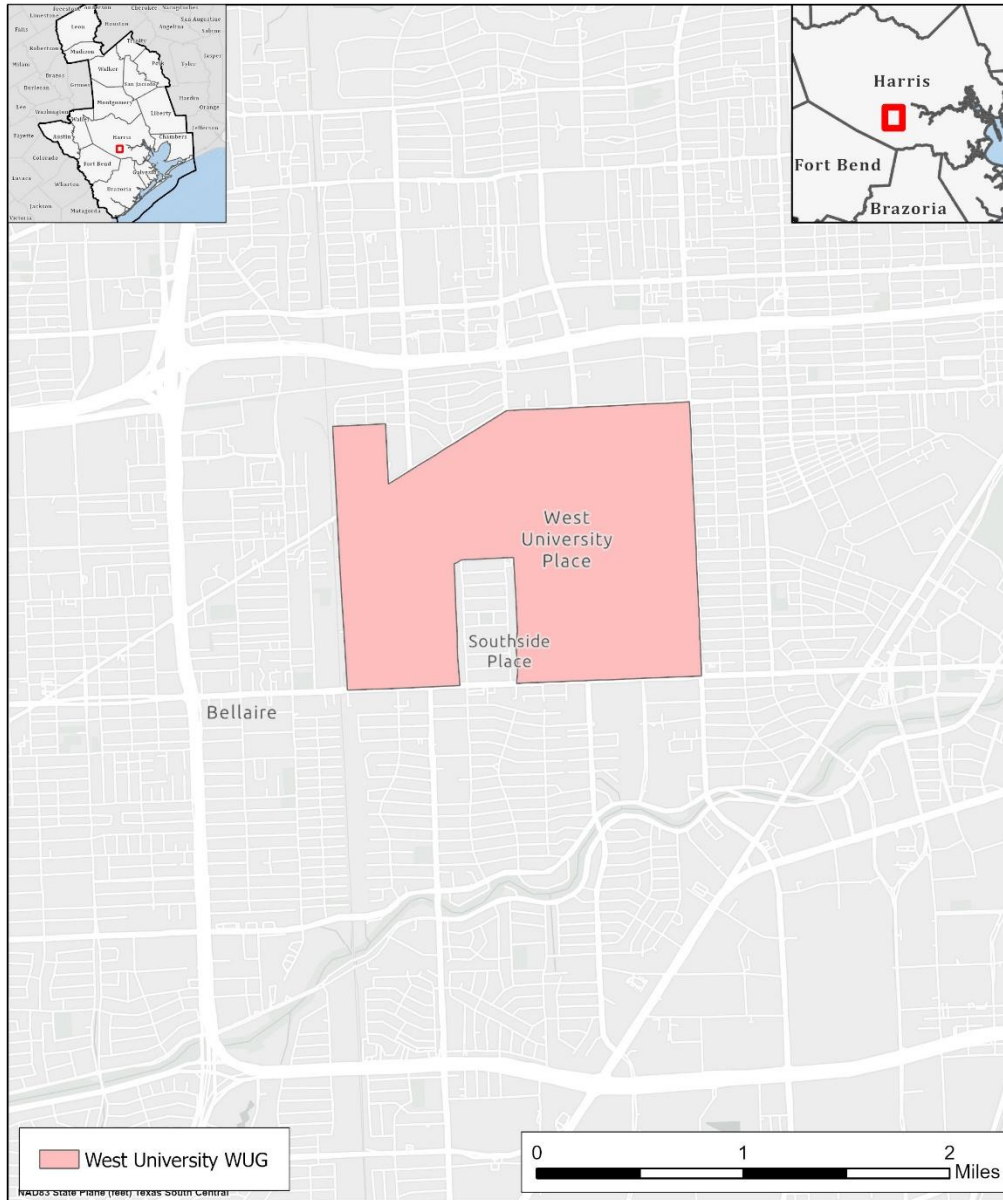
CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use.
Size	Conveyance is sized to convey the requisite amount of source water.
Water Quality	Project provides treated water suitable for municipal use.
Unit Cost	Near-term and long-term unit costs are reasonable for target uses.
Other Factors	This project is identified for serving the City of West University Place.

References

City of West University Place, *2025-2034 Capital Improvement Plan*.

Freese and Nichols. 2021. *City of West University Place Water System Assessment Technical Memorandum*, prepared for West University Place, May 2021.

Location Map



West University Place Infrastructure Expansion Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	West Harris County Regional Water Authority Distribution Expansion
Project ID:	CONV-017
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	92,288 ac-ft/yr (82.4 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	<5 years
Project Capital Cost:	\$391,325,872 (Sept. 2023)
Unit Water Cost (Rounded):	\$334 per ac-ft (during loan period) \$36 per ac-ft (after loan period)

Strategy Description

The Harris-Galveston Subsidence District (HGSD) and Fort Bend Subsidence District (FBSD) have established requirements for entities within their boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the West Harris County Regional Water Authority (WHCRWA) has contracted with the City of Houston (COH) to receive treated surface water. The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH. In order to utilize sufficient supplies to meet future surface water conversion obligations, WHCRWA must expand the distribution infrastructure network through which it supplies its member districts, allowing for greater overall volume to be conveyed and conversion of additional districts to surface water.

Strategy Analyses

The project analyses for WHCRWA Distribution Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH, which is reflected in the Regional Plan as an existing supply. In order to meet future water demands and regulatory conversion obligations, the Authority has continued development and implementation of its GRP

program by increasing its supply reservation from COH and planning for large scale transmission to its service area. WHCRWA will expand its distribution network by 2025, allowing it to provide a greater volume of treated surface water and to convert additional member districts to surface water supply. As with the currently implemented stage of conversion, some entities will remain on groundwater, while others will rely solely on surface water or utilize groundwater only to meet peak demands. WHCRWA anticipates conversion of additional districts by 2035.

Environmental Considerations

Infrastructure development may result in some construction disturbance which could require mitigation. The most significant impact associated with the GRP is the source supply, which requires the interbasin transfer of surface water supplies.

Permitting and Development

WHCRWA is subject to contractual requirements established by COH as well as any relevant permitting required by the State of Texas and HGSD. Development of expanded distribution infrastructure will cause some degree of surface disturbance, which may require permitting and mitigation. Infrastructure development is also likely to require acquisition of additional easements or property.

Cost Analysis

WHCRWA's engineering consultant provided Region H with estimated capital costs for the 2025 and 2035 phases of the WHCRWA Distribution Expansion project. Non-construction capital costs (engineering, land acquisition, and environmental components) were not called out separately and for purposes of the Regional Plan are assumed to be included in the values provided. Interest during construction, debt service, and annual operations and maintenance costs were calculated using standard regional planning procedures, and costs were scaled to a September 2023 equivalent cost in accordance with TWDB guidance. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs are presented in *Table 1*.

Table 1 - WHCRWA Distribution Expansion Project Costs

OPINION OF PROBABLE CONSTRUCTION COST					September 2023	
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL	
PROJECT CAPITAL COST SUMMARY						
1	CONSTRUCTION AND NON-CONSTRUCTION COSTS (ENGINEERING, LAND ACQUISITION, ETC.)	1	LS	\$332,980,000	\$332,980,000	
2	INTEREST DURING CONSTRUCTION	1	LS	\$58,345,872	\$58,345,872	
PROJECT CAPITAL COST					\$391,325,872	

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (2025 Phase)	\$15,831,824	\$15,831,824	\$0	\$0	\$0	\$0
2	DEBT SERVICE (2035 Phase)	\$0	\$11,702,286	\$11,702,286	\$0	\$0	\$0
3	OPERATION AND MAINTENANCE (2025 PHASE)	\$1,914,600	\$1,914,600	\$1,914,600	\$1,914,600	\$1,914,600	\$1,914,600
4	OPERATION AND MAINTENANCE (2035 PHASE)	\$0	\$1,415,200	\$1,415,200	\$1,415,200	\$1,415,200	\$1,415,200
TOTAL ANNUAL COST		\$17,746,424	\$30,863,910	\$15,032,086	\$3,329,800	\$3,329,800	\$3,329,800

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$17,746,424	\$30,863,910	\$15,032,086	\$3,329,800	\$3,329,800	\$3,329,800
2	YIELD	69,216	92,288	92,288	92,288	92,288	92,288
3	UNIT COST	\$256	\$334	\$163	\$36	\$36	\$36
TOTAL UNIT COST		\$139					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES (2025 PHASE)	1	LS	\$191,460,000	\$191,460,000
2	PIPELINES (2035 PHASE)	1	LS	\$141,520,000	\$141,520,000
PROJECT COST					\$332,980,000

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES (2025 PHASE)	1.0	%	\$191,460,000	\$1,914,600
2	PIPELINES (2035 PHASE)	1.0	%	\$141,520,000	\$1,415,200
ANNUAL OPERATION AND MAINTENANCE COST					\$3,329,800

Water Management Strategy Evaluation

Based on the analysis provided above, the WHCRWA Distribution Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	4	The project, while not directly generating supply, provides conveyance with moderately low additional cost.
Location	4	Reflects conveyance infrastructure from major transmission pipelines to demand centers.
	3	No known water quality issues.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	3	Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.
Local Preference	4	Local support. Limited opposition.
Institutional Constraints	3	Permits expected with minimal problems. Property available.
Development Timeline	4	Project to be developed within five years.
Sponsorship	5	Sponsors identified and project is in development.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No known significant impacts to other projects.

The WHCRWA Distribution Expansion includes the construction of several pipeline segments. The majority of this impact will be in urbanized areas with limited impacts to habitat. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The WHCRWA Distribution Expansion project 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 anticipated that the project will only serve WHCRWA, participants of the GRP, and any other wholesale customers that WHCRWA provides with water supply.

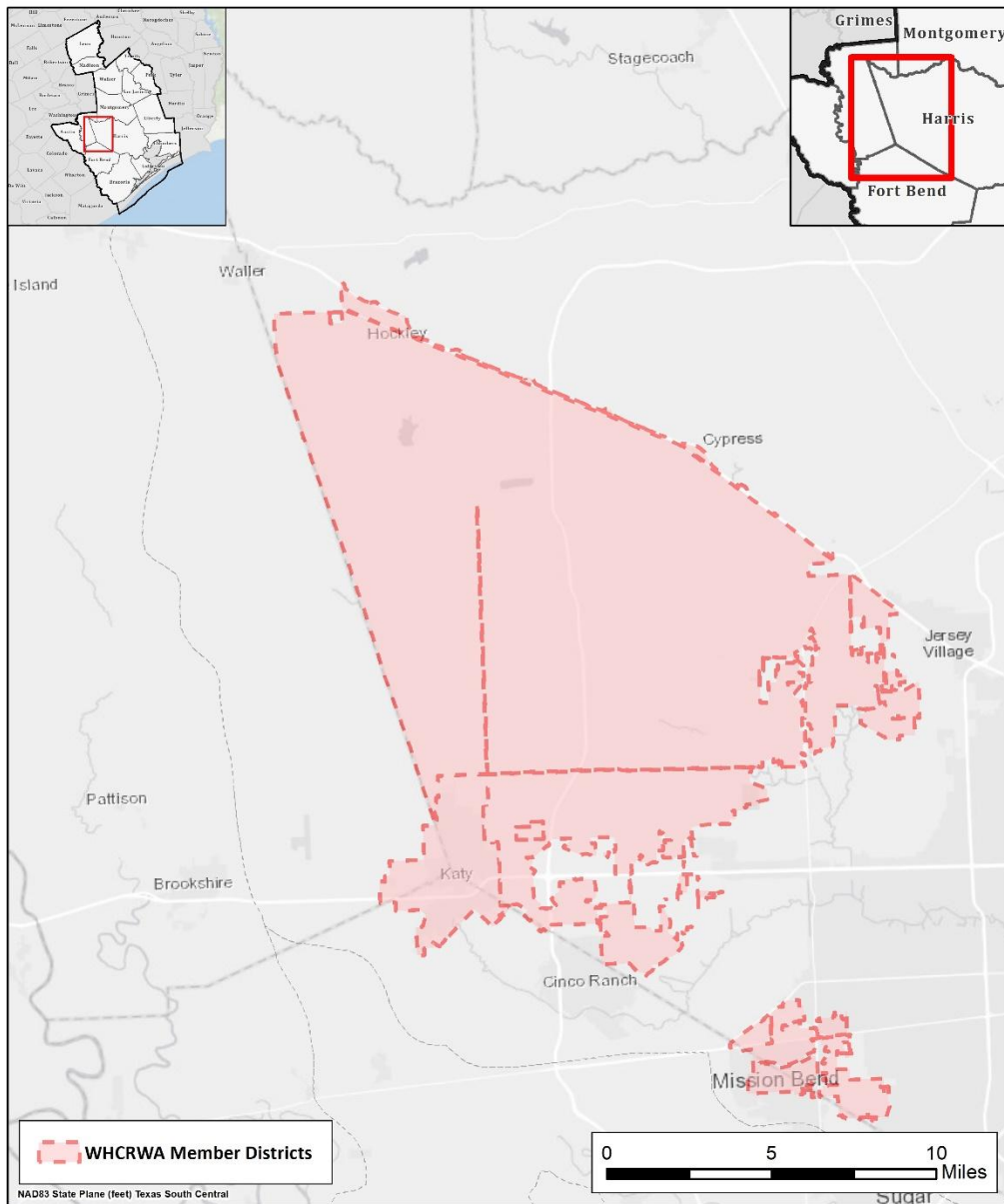
CRITERIA	WUG SUITABILITY
Proximity	Conveyance infrastructure from major transmission pipelines to demand centers.
Size	Conveyance is sized to convey the requisite amount of source water.
Water Quality	Conveys treated water of quality appropriate for municipal use.
Unit Cost	Adds small amount to unit cost of WHCRWA's surface water conversion process.
Other Factors	Reduces dependence on Gulf Coast Aquifer groundwater.

References

Dannenbaum Engineering Corporation. *West Harris County Regional Water Authority Groundwater Reduction Plan*, prepared for WHCRWA, June 2014.

Harris-Galveston Subsidence District. *Harris-Galveston Subsidence District 2013 District Regulatory Plan*, May 2013.

Location Map



WHCRWA Distribution Expansion Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	WHCRWA/NFBWA Transmission Line
Project ID:	CONV-018
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	169,030 ac-ft/yr (150.9 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	<5 years
Project Capital Cost:	\$622,459,204 (Sept. 2023)
Unit Water Cost (Rounded):	\$297 per ac-ft (during loan period) \$38 per ac-ft (after loan period)

Strategy Description

The Harris-Galveston Subsidence District (HGSD) and Fort Bend Subsidence District (FBSD) have established requirements for entities within their boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the North Fort Bend Water Authority (NFBWA) and West Harris County Regional Water Authority (WHCRWA) have contracted with the City of Houston (COH) to receive treated surface water. Both Authorities have already developed transmission and distribution infrastructure to meet their initial obligations for reducing groundwater demand and are receiving water from COH. In order to utilize sufficient supplies to meet future surface water conversion obligations, the Authorities are jointly sponsoring the development of additional large-scale transmission infrastructure referred to by the sponsors as the Surface Water Supply Project (formerly the Second Source Transmission Line) from the COH Northeast Water Purification Plant (NEWPP) to the Authority distribution areas.

Strategy Analyses

The project analyses for WHCRWA/NFBWA Transmission Line include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

WHCRWA and NFBWA have acquired capacity in the COH Luce Bayou Interbasin Transfer Project and Northeast Water Purification Plant (NEWPP) Expansion to provide treated surface water supply which will be conveyed through the WHCRWA/NFBWA Transmission Line project infrastructure to the Authority service areas. NFBWA and WHCRWA have increased their contracted supply reservation

with COH. In order to convey these supplies, the Authorities are jointly developing shared transmission pipeline infrastructure to convey treated surface water supplies from the NEWPP to the Authority distribution areas. The transmission infrastructure consists of various pipeline segments, beginning with a 96-inch pipeline running from the NEWPP to a repump station just east of Highway 290, where the transmission line transitions to an 84-inch pipeline which continues west to a central pump station in the vicinity of Fry Road. A 66-inch segment continues from the central pump station to a meter station near Katy, TX to serve the southwest portion of WHCRWA and the northern portion of NFBWA. A smaller pipeline, primarily 42-inch diameter, also branches from the 84-inch line slightly west of Beltway 8 and travels south to the NFBWA Bellaire pump station. Construction of the shared transmission project infrastructure is anticipated to be completed by 2025.

Environmental Considerations

The WHCRWA/NFBWA Transmission Line project is required under a nationwide permit to obtain a mitigation site, primarily due to the destruction of forested wetlands. The most significant impact associated with the project is the source supply, which requires the interbasin transfer of surface water supplies.

Permitting and Development

The project sponsors have sought funding through the State Water Implementation Fund for Texas (SWIFT) program. SWIFT loan obligations require that environmental clearance for this project be obtained from appropriate regulatory agencies including the United States Army Corps of Engineers, Texas Parks and Wildlife Department, local floodplain managers, Harris County, Texas Historical Commission, and others. Development of expanded transmission infrastructure will cause some degree of surface disturbance, which may require permitting and mitigation. Infrastructure development is also likely to require acquisition of additional easements or property.

Cost Analysis

Planning level cost estimates were developed for the Region H Plan based on available information from WHCRWA and NFBWA. WHCRWA and NFBWA plan to cover approximately 55% and 45% of the total project cost, respectively. Capital costs were scaled to a September 2023 equivalent cost in accordance with TWDB guidance. Other cost components not included in the available data, such as interest during construction, annualized debt service, and annualized operations and maintenance costs, were assumed using standard Regional Planning costing assumptions. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs are presented in *Table 1*.

Table 1 – WHCRWA/NFBWA Transmission Line Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$500,794,635	\$500,794,635
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$26,768,209	\$26,768,209
3	LAND AND EASEMENTS	1	LS	\$1,667,628	\$1,667,628
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$421,361	\$421,361
5	INTEREST DURING CONSTRUCTION	1	LS	\$92,807,371	\$92,807,371
PROJECT CAPITAL COST					\$622,459,204

ITEM DESCRIPTION		ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$43,796,900	\$43,796,900	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$6,346,068	\$6,346,068	\$6,346,068	\$6,346,068	\$6,346,068	\$6,346,068
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$50,142,968	\$50,142,968	\$6,346,068	\$6,346,068	\$6,346,068	\$6,346,068

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$50,142,968	\$50,142,968	\$6,346,068	\$6,346,068	\$6,346,068	\$6,346,068
2	YIELD	169,030	169,030	169,030	169,030	169,030	169,030
3	UNIT COST	\$297	\$297	\$38	\$38	\$38	\$38
TOTAL UNIT COST							\$124

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$89,208,104	\$89,208,104
2	PIPELINES	1	LS	\$395,156,531	\$395,156,531
3	OTHER	1	LS	\$16,430,000	\$16,430,000
PROJECT COST					\$500,794,635

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$89,208,104	\$2,230,203
2	PIPELINES	1.0	%	\$395,156,531	\$3,951,565
3	OTHER	1.0	%	\$16,430,000	\$164,300
ANNUAL OPERATION AND MAINTENANCE COST					\$6,346,068

Water Management Strategy Evaluation

Based on the analysis provided above, the WHCRWA/NFBWA Transmission Line project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may

be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	The shared transmission pipeline will provide conveyance at a moderate additional cost which will decrease substantially after completion of debt services.
Location	4	Reflects conveyance infrastructure from major transmission pipelines to demand centers.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	3	Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.
Local Preference	4	Local support. Limited opposition.
Institutional Constraints	3	Permits expected with minimal problems. Property available.
Development Timeline	4	Project to be developed within five years.
Sponsorship	5	Sponsors identified and project is in development.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	5	Provides conveyance of treated water from the Northeast Water Purification Plant Expansion project to demand centers and to other major transmission projects.

WHCRWA/NFBWA Transmission Line improvements include up to 57 miles of pipelines. The majority of this impact will be in urbanized areas with limited impacts to habitat or agricultural land or production. The project will not directly impact environmental flows.

Water User Group Application

The WHCRWA/NFBWA Transmission Line project 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.

CRITERIA	WUG SUITABILITY
Proximity	Conveyance infrastructure from major transmission pipelines to demand centers.
Size	Conveyance is sized to convey the requisite amount of source water.
Water Quality	Conveys treated water of quality appropriate for municipal use.
Unit Cost	Adds a moderate amount to unit cost of surface water conversion process.
Other Factors	Reduces dependence on Gulf Coast Aquifer groundwater.

References

Dannenbaum Engineering Corporation. *WHCRWA Groundwater Reduction Plan*, prepared for WHCRWA, June 2014.

Harris-Galveston Subsidence District. *HGSD 2013 District Regulatory Plan*, May 2013.



WHCRWA/NFBWA Transmission Line Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Aquifer Storage and Recovery
Project ID:	GWDV-001
Project Type:	Existing Groundwater Source
Potential Supply Quantity (Rounded):	Approximately 9,426 ac-ft/yr (varies by application) (8.4 mgd)
Implementation Decade:	2080
Development Timeline:	20-25 years
Project Capital Cost:	\$379,102,115 (Sept. 2023; varies by application)
Unit Water Cost (Rounded):	\$4,116 per ac-ft (during loan period) \$1,287 per ac-ft (after loan period)

Strategy Description

Hydrology in southeast Texas is defined by intervals of high rainfall and extended periods of drought. Traditionally, storage solutions such as reservoirs have been used to capture flows during high-flow events, store water for prolonged periods, and convert what would be an interruptible flow to a reliable, firm water supply that can be utilized throughout periods of drought. However, reservoirs often pose difficulties in development due to their substantial cost and project footprint. Additionally, evaporation from a reservoir can reduce yield, especially in the wide, shallow basins that are typical in this part of the state.

One alternative to the development of a reservoir is the use of aquifer storage and recovery (ASR) to provide firm yield storage. In an ASR concept, water from a variety of sources including surface water, reclaimed water, stormwater, or even other sources of groundwater, may be captured, treated to an appropriate extent to meet the standards of local groundwater, and injected into a groundwater formation for storage. Later, this water can be recovered from the aquifer and used to meet water demands. This approach provides similar benefits to a reservoir by utilizing underground storage.

The concept of ASR has been implemented in a number of locations throughout Texas including the San Antonio Water System (SAWS) Twin Oaks ASR Facility and the City of Kerrville. These projects utilize storage in the Carrizo-Wilcox and Trinity Aquifers, respectively. To date, no successful project has been implemented in the Gulf Coast Aquifer, which is the principal groundwater-bearing formation within Region H. A test well was constructed in Texas City to examine the potential for such a strategy, but this effort was discontinued when the project was met with water quality challenges related to blending of water sources.

A study by the Harris-Galveston Subsidence District (HGSD), *Assessment of Subsidence and Regulatory Considerations for Aquifer Storage and Recovery in the Evangeline and Chicot Aquifers*, examined two potential alternatives for implementing an ASR project in the Gulf Coast Aquifer: (1) a project to provide industrial water supply during a drought of record (DOR) and (2) a project to provide for an annual municipal summer peaking water supply. Each scenario was modeled using MODFLOW to

estimate subsidence that may occur as a result of the injection and withdrawal operations of these conceptual projects located in the Gulf Coast Aquifer. The results of this modeling study indicated the potential for compaction resulting from the withdrawal of water during the production phases of ASR well operation, although the rate of compaction was lower than for projects producing an equivalent volume of water without injection. The study then recommended ways in which impacts of a project could be minimized including maximizing well spacing, decreasing recovery rates, decreasing recovery duration prior to the next recharge cycle, and targeting layers with low clay content and high transmissivity for development.

Strategy Analyses

The Region H Water Planning Group (RHWPG) has designated a value of 25,000 ac-ft/yr as the threshold for significant identified water needs across the region in any given planning decade. This threshold was exceeded in all decades on a region-wide level, as described in **Chapter 4**. Thus, as required by Texas Water Code §16.053(e)(10), the RHWPG has conducted a concept-level analysis of ASR. For this cycle of regional planning, environmental and cost aspects of this high-level analysis were focused on a specific project location due to the presence of high need, unappropriated interruptible surface water availability, and potentially viable subsurface conditions. A project site adjacent to Lake Conroe in Montgomery County was chosen to represent the ASR project. This location benefits from interruptible surface water supplies available at Lake Conroe and from Lake Creek, south of Lake Conroe, as well as the opportunity to expand treatment capacity at the SJRA Surface Water Facility (SWF) to prepare water for injection into the groundwater system. Although concepts and costs were analyzed specifically for this alternative, this example provides a range of costs that may represent the potential for such strategies in other similar locations in Region H. The project analyses for ASR include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

A study was performed to evaluate aquifer characteristics within the vicinity of the proposed project, chiefly in the area east of Lake Conroe and northwest of the City of Conroe. Aquifer parameters from existing large capacity public supply wells were used to estimate the transmissivity and pumping rates utilized in the ASR analytical simulations. Based on this analysis, average transmissivity values for the Jasper and Catahoula Aquifers were found to be 37,500 and 22,500 gpd/ft, respectively. The coefficient of storage in the Jasper formation was adapted from the Houston Area Groundwater Model and was found to be 0.00040. In the Catahoula formation, the coefficient of storage was found to be approximately 0.00030 based on a separate evaluation specific to Montgomery County. Well spacings were determined to be 2,000 feet for a pattern layout or 1,500 feet for a line layout within the Jasper, while a line spacing of 5,280 feet was assumed for the Catahoula. The resulting injection rates for the Jasper and Catahoula aquifers based on these parameters were estimated to be 1,125 gpm (1.6 mgd) and 375 gpm (0.5 mgd), respectively. It should be noted that this modeling was focused on operation of the potential ASR project and did not consider the risk of subsidence related to long-term injection and withdrawal from the aquifers. However, based on this analysis, the Jasper Aquifer was identified as the most likely target formation for development of an ASR project in this area.

A conceptual model was developed to examine the potential firm supply made available through an ASR project. This is based on availability of source water such as an interruptible surface water supply, the capacity of infrastructure to temporarily store, treat, and inject the source water into the aquifer,

losses associated with aquifer storage, and the recovery schedule for supply. Environmental flow needs were considered through the use of the Texas Commission on Environmental Quality (TCEQ) WAM Run 3 scenario, which includes Senate Bill 3 environmental flow criteria, as the basis for interruptible supply availability for input to the ASR conceptual model. The model is capable of projecting the growth of the available storage “bubble” over time and how this supply might be drawn down over the historic drought of record. The firm yield for the proposed project was considered to be the annual depletions that could be made during the historic hydrology that did not result in either the depletion of storage or the inability of the project to end with an equal or greater level of storage than the beginning of the simulation period. Various concepts were considered with the following assumptions and variations:

- Lake Conroe Diversions
 - Alternatives considered with and without source water from excess flows from Lake Conroe
- Lake Creek Diversions
 - Alternatives considered with and without source water from excess flows from Lake Creek
 - Pump station capacities to divert excess flows from Lake Creek of 10, 20, 50, 75, 100, 150, and 200 mgd
 - Off-channel reservoir for temporary storage of diverted surface water prior to treatment and injection with 1,000, 2,000, and 4,000 acre-feet of storage capacity
- ASR Concept and Operation
 - Injection well capacity of 1.6 mgd based on evaluation of the Jasper Aquifer in the vicinity of Lake Conroe Dam
 - Total number of injection wells numbering either 10 or 20
 - Annual loss from ASR storage of 1% of the total volume injected (long-term recovery percentage would vary based on configuration, site, and years of storage development)
 - Total number of years of storage developed before ASR operation of either 10 or 20 years

A total of 109 separate simulations were conducted to evaluate the sensitivity of the project cost per unit volume of supply. From this analysis, no clear trends emerged related to the effect of various assumptions on project costs. This implies the scalability of the strategy based on the investment in infrastructure as well as the sensitivity of the concept to its operation. The most significant factor identified was the volume of temporary storage provided to capture interruptible flows from Lake Creek prior to treatment and injection, with larger capacities supporting a larger volume of injectable water. However, this benefit drops when temporary storage greatly exceeds the capacity of the ASR system to convert this water to underground storage. Additional information related to cost development is included below.

The concept selected for consideration Region H Regional Water Plan (RWP) utilizes captured interruptible surface water supplies from both Lake Conroe and Lake Creek to produce firm supply. A 100-mgd pump station and a 4,000-acre-foot reservoir are used to make water available from Lake Creek. This water is treated using a surface water treatment facility and the water injected through

ten 1.6-mgd wells. The resulting firm yield of this concept was estimated to be 9,426 ac-ft/yr.

Environmental Considerations

Environmental impacts related to the proposed ASR concept include the diversion of surface water for injection and the footprint of pump station, storage, pipeline, treatment, and well infrastructure required to execute the project. Unlike surface water reservoirs, ASR does not require a substantial footprint related to the inundation of land for water storage.

For the analysis of ASR for the RWP, instream environmental flow needs were considered through the use of the TCEQ WAM Run 3 scenario, which includes Senate Bill 3 environmental flow criteria, as the basis for interruptible supply availability for input to the Region H ASR conceptual model. The WAM was utilized to identify monthly unappropriated and regulated flows at various points of interest rather than to model the strategy diversions directly, and therefore the post-modeling analysis results for the model used to inform the ASR analysis would be the same as for the base WAM. Due to the nature of the strategy, including a pre-diversion storage period, and the large number of potential operational and magnitude scenarios, the WAM is not optimal for direct modeling of the strategy. Any environmental flow impacts of an ASR strategy would be dependent on the specific set of operational parameters identified by a potential future sponsor.

Permitting and Development

Since the enactment of House Bill 655 by the Texas Legislature in 2015, permitting for ASR projects is conducted through the TCEQ. This is conducted through TCEQ's Class V Underground Injection Control (UIC) Program and can be performed through general permit, individual permit, or permit-by-rule. The decision to authorize an ASR well depends upon:

- Compliance with the Safe Drinking Water Act,
- The ability to recover the injected volume,
- Impacts on existing wells, and
- Impacts on native groundwater quality.

Local Groundwater Conservation Districts (GCDs) do not have authority to regulate production from ASR wells unless production exceeds the volume of water deemed recoverable from the injected volume. For the purpose of this strategy concept, it is assumed that production from the project is limited to recoverable injected volumes.

In addition to the permitting of the ASR well, local registration of the well must be conducted through the local GCD or subsidence district even in the absence of production of native groundwater. Furthermore, the unique mission of the subsidence districts may require specific consideration of subsidence factors in TCEQ's decision to grant an ASR permit in Fort Bend, Harris, or Galveston County. It would be expected that this will involve careful coordination between TCEQ and HGSD or Fort Bend Subsidence District (FBSD) throughout the process.

Cost Analysis

Costs were developed for the proposed ASR configuration consisting of a 100-mgd pump station at Lake Creek, a 4,000-ac-ft off-channel reservoir for temporary surface water storage, and ten 1.6-mgd ASR wells. Pipeline and treatment infrastructure were sized appropriately to accommodate the key surface water development and ASR infrastructure required. These costs are shown below in *Table 1*.

Table 1 – Aquifer Storage and Recovery Project Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$274,126,720	\$274,126,720
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$92,009,339	\$92,009,339
3	LAND AND EASEMENTS	1	LS	\$605,128	\$605,128
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$480,147	\$480,147
5	INTEREST DURING CONSTRUCTION	1	LS	\$11,880,781	\$11,880,781
PROJECT CAPITAL COST					\$379,102,115

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$26,674,033	\$26,674,033	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$9,508,637	\$9,508,637	\$9,508,637	\$9,508,637	\$9,508,637	\$9,508,637
3	PUMPING ENERGY COSTS	\$2,617,999	\$2,617,999	\$2,617,999	\$2,617,999	\$2,617,999	\$2,617,999
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$38,800,669	\$38,800,669	\$12,126,636	\$12,126,636	\$12,126,636	\$12,126,636

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$38,800,669	\$38,800,669	\$12,126,636	\$12,126,636	\$12,126,636	\$12,126,636
2	YIELD	-	9,426	9,426	9,426	9,426	9,426
3	UNIT COST	\$0	\$4,116	\$1,287	\$1,287	\$1,287	\$1,287
TOTAL UNIT COST							\$2,676

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$62,955,598	\$62,955,598
2	PIPELINES	1	LS	\$78,700,270	\$78,700,270
3	WATER TREATMENT PLANTS	1	LS	\$95,752,351	\$95,752,351
4	OFF-CHANNEL RESERVOIRS	1	LS	\$15,578,892	\$15,578,892
5	WELL FIELDS	1	LS	\$21,139,609	\$21,139,609
PROJECT COST					\$274,126,720

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$62,955,598	\$1,573,890
2	PIPELINES	1.0	%	\$78,700,270	\$787,003
3	WATER TREATMENT PLANTS	1.0	LS	\$6,702,665	\$6,702,665
4	OFF-CHANNEL RESERVOIRS	1.5	%	\$15,578,892	\$233,683
5	WELL FIELDS	1.0	%	\$21,139,609	\$211,396
ANNUAL OPERATION AND MAINTENANCE COST					\$9,508,637

Water Management Strategy Evaluation

Based on the analysis provided above, the Aquifer Storage and Recovery project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Costs are generally high but decline after debt service.
Location	5	Project can provide supply in close proximity to needs.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Limited environmental impacts expected.
Environmental Flows	2	Project develops water from excess surface water.
Local Preference	3	Project has local interest.
Institutional Constraints	2	Project requires a permitting process that is relatively untested. Some property acquisition required.
Development Timeline	3	Project will require 10-15 years of development and ten years to develop storage volume.
Sponsorship	4	Project is included in SJRA Raw Water Supply Master Plan.
Vulnerability	4	Some risks associated with this project.
Regionalization	3	Project would be anticipated to serve multiple water systems.
Impacts on Other WMS	3	No major impacts to other projects identified.

Aquifer Storage and Recovery is not anticipated to affect vulnerable species or to impact agricultural land or production. This project may reduce instream flows during periods of excess flow availability.

Water User Group Application

The Aquifer Storage and Recovery project 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.

CRITERIA	WUG SUITABILITY
Proximity	Project located near center of significant future water needs.
Size	Project provides a significant water supply.
Water Quality	This strategy would provide water of quality similar to native groundwater.
Unit Cost	Costs are high but comparable for many late-term water strategies.
Other Factors	Availability dependent upon future hydrology.

References

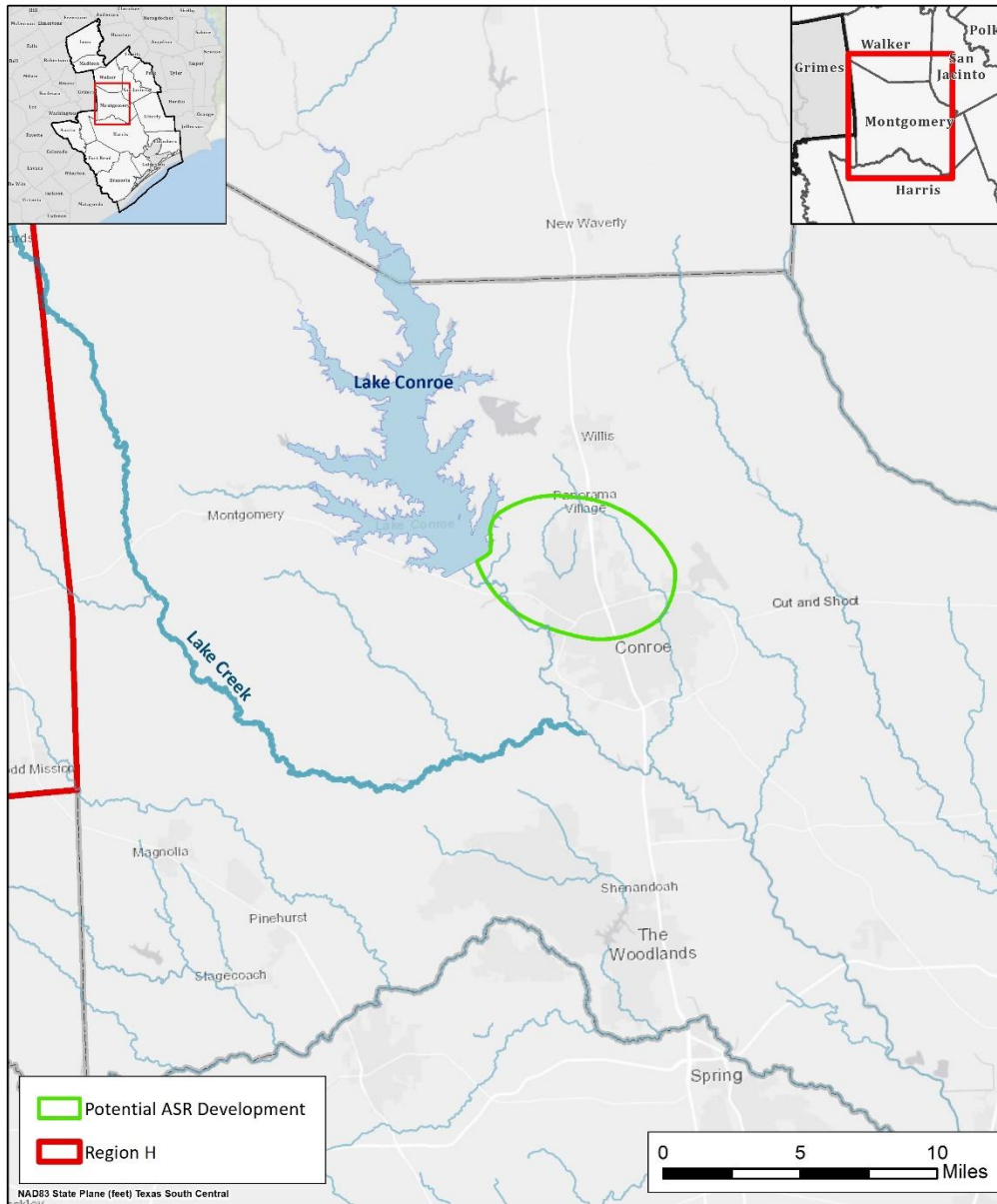
Freese and Nichols, Inc. 2018. *Raw Water Supply Master Plan*. Prepared for San Jacinto River Authority.

INTERA, Inc. 2019. *Assessment of Subsidence and Regulatory Considerations for Aquifer Storage and Recovery in the Evangeline and Chicot Aquifers*. Prepared for Harris-Galveston Subsidence District.

Kasmarek, M.C. 2012. *Hydrogeology and simulation of groundwater flow and land-surface subsidence in the northern part of the Gulf Coast aquifer system, Texas, 1891–2009 (ver. 1.1, December 2013)*. U. S. Geological Survey Scientific Investigations Report 2012–5154.

LBG-Guyton Associates. 2012. *Catahoula Aquifer Characterization and Modeling Evaluation in Montgomery County*. Prepared for Lone Star Groundwater Conservation District.

Location Map



Aquifer Storage and Recovery Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Brackish Groundwater Development and Groundwater Blending
Project ID:	GWDV-002
Project Type:	Existing Groundwater Source
Potential Supply Quantity	Varies
Implementation Decade:	Varies
Development Timeline:	1-2 years
Project Capital Cost:	Varies by specific project
Unit Water Cost (Rounded):	\$689 to 11,024 per ac-ft (during loan period) \$320 to 7,107 per ac-ft (after loan period)

Strategy Description

As growth occurs throughout Region H there is a need to provide alternative supplies to a number of WUGs that may not be within close proximity to conventional water supply sources. In addition, regulatory requirements by groundwater conservation districts (GCDs) and subsidence districts in Region H restrict the use of fresh groundwater in some areas, encouraging the development of unconventional sources of water. Brackish groundwater may be a viable source of water in some areas. In Montgomery County, the Catahoula Aquifer is considered by the Lone Star GCD to be an acceptable alternative water supply source to the commonly developed aquifers in the Gulf Coast Aquifer System. Studies have also shown potential for brackish groundwater development in Brazoria, Fort Bend, and Harris Counties. Additionally, the cost of brackish groundwater desalination is far less than seawater desalination. In some cases, raw brackish groundwater may be blended with conventional supplies to produce an acceptable supply without advanced treatment. Within Region H, several communities within Montgomery County have successfully employed this project for water supplies and it is also being investigated in other parts of the region. This memorandum describes the potential for Brackish Groundwater Development and Groundwater Blending as water supply strategies in Region H. However, due to regulatory constraints and limited interest by potential sponsors, this water management strategy (WMS) is currently only recommended to meet needs of water user groups (WUGs) that have already developed supplies in fresh to slightly brackish aquifers.

Strategy Analyses

The project analyses for Brackish Groundwater Development and Groundwater Blending include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The 2016 Region H Regional Water Plan (RWP) included a review of aquifer conditions within Region

H in order to identify potential areas of brackish groundwater development. Water of quality ranging from 1,000 to 3,000 mg/l of Total Dissolved Solids (TDS) is generally considered slightly brackish, and water of 3,000 to 10,000 mg/l of TDS is considered brackish water. An update to the study of brackish groundwater development and a review of the potential for groundwater blending has primarily focused on the Gulf Coast Aquifer System, which includes the Chicot, Evangeline, Jasper, and Catahoula Aquifers. Water quality varies with depth and geography within the same geologic formations, so brackish groundwater sources are typically found in the deeper portions of a formation that is also used for freshwater supplies in other areas. In the Gulf Coast Aquifer System, which is a major source of fresh groundwater in Region H, as individual formations dip from outcrops in the northwest toward the coast in the southeast, these formations increase in depth, thickness, and generally in TDS. Thus, more brackish or slightly brackish water typically occurs in the southeastern extent of individual Gulf Coast aquifers. The estimated extent of brackish groundwater availability in each aquifer is illustrated in the exhibits attached to this memorandum. Available information on potential brackish groundwater supplies are provided below, based on the studies by the Region H Water Planning Group (RHWPG) in the previous and current regional planning cycles.

- **Simsboro Aquifer:** The Simsboro outcrops north of Region H. Brackish water supplies may be found in the downdip extent of this aquifer across Madison County where the quality ranges from 1,000 mg/l of TDS to 10,000 mg/l.
- **Carrizo-Wilcox Aquifer:** The outcrop of the Carrizo Wilcox in Region H occurs in the northwestern portion of Leon County. The downdip portion approaches saline conditions in southern Madison County with quality transitioning to approximately 3,000 mg/l of TDS at the Madison and Walker County line. A thin band of water between 3,000 and 10,000 mg/l of TDS can be found extending approximately five miles into northwestern Walker County.
- **Sparta Aquifer:** The outcrop of the Sparta Aquifer in Region H occurs in Leon County. Saline portions of the aquifer occur in Walker County north of Huntsville and central Trinity County along a line between the cities of Trinity and Groveton.
- **Chicot Aquifer of the Gulf Coast Aquifer System:** The Chicot Aquifer is the shallowest aquifer within the Gulf Coast Aquifer System and outcrops in a wide band from Austin County toward southern Polk County. Supplies are generally fresh except close to the coast where water quality quickly declines from fresh water to brackish within a span of approximately ten miles. Future wells in the brackish zone of the Chicot Aquifer are estimated to be capable of producing from 500 gpm to more than 1,000 gpm. Current development of brackish supplies in the Chicot Aquifer is limited to an ongoing project by the Brazosport Water Authority, which is detailed in a separate technical memorandum.
- **Evangeline Aquifer of the Gulf Coast Aquifer System:** The Evangeline Aquifer lies beneath the Chicot Aquifer and outcrops in Montgomery, Walker, San Jacinto, and Polk Counties within Region H. Water quality remains fresh throughout most of the region. However, water from the aquifer is slightly brackish to brackish except in these areas: the northern portion of Brazoria County, most of Galveston County, the northwest portion of Chambers County, and the southeastern portion of Liberty County. This segment contains water of varying salinity until reaching the coast, where TDS climbs well above 10,000 mg/l. Little to no development has occurred in the brackish portion of the Evangeline Aquifer. It is estimated that well production rates in the slightly brackish and brackish zones could range from 500 to more than 1,200 gpm.
- **Jasper Aquifer of the Gulf Coast Aquifer System:** The outcrop of the Jasper Aquifer in Region

H crosses northern Austin County and cuts through central Walker County and around the junction of Trinity, Polk, and San Jacinto Counties. This aquifer lies beneath the Evangeline and is a source of fresh water for Austin and Waller Counties, northern Harris County, and northward. A band of brackish water reaches its greatest width across almost the entirety of Fort Bend County with the majority of that supply being in the 3,000 to 10,000 mg/l of TDS range. Brackish groundwater in the Jasper Aquifer is also found in the southern portions of Harris County and the central portion of Liberty County. A public water supplier in northern Fort Bend County has drilled a test well in the slightly brackish zone of the Jasper Aquifer and plans to blend this water with an existing fresh groundwater source. Otherwise, development of brackish water from the Jasper has been limited, and a 2018 study has indicated that such development could pose a subsidence risk. Although pumping rates are highly dependent on local conditions, it is estimated that pumping rates of approximately 1,000 to 1,500 gpm could be obtained in the slightly brackish and brackish zones of the Jasper Aquifer in Fort Bend County.

- **Catahoula Aquifer of the Gulf Coast Aquifer System:** The outcrop of the Catahoula Aquifer in Region H occurs in Walker, Trinity, and Polk Counties, and water quality in the down dip maintains freshwater conditions as far south as central Montgomery, San Jacinto, and Polk Counties. Water of slightly brackish to brackish quality extends southward in a band that reach the Woodlands in Montgomery County, crosses south of Coldspring and Livingston to the northeast and south of Hempstead and Bellville to the southwest, making it available as a potential supply in Austin, Waller, Montgomery, San Jacinto, and Polk Counties. This aquifer is currently being developed as a supply in Montgomery County, and a study by the RHWPG indicates that additional wells in that county could likely produce between 1,000 and 2,000 gpm in the slightly brackish zone of the aquifer.

Typically, the depth of the brackish portions of these aquifers is far greater than the more commonly developed aquifers. However, these confined systems often have shallow static water levels that are far above the top of the aquifer, making pumping costs more consistent with other groundwater supplies, although capital costs to develop deep wells are correspondingly higher than for typical groundwater applications.

The brackish supplies identified in these areas are relatively undocumented compared to the typical supply aquifers in Region H. Therefore, the question of long-term availability will remain uncertain until the level of use increases to the point that adequate information can be collected to fully evaluate these resources. However, it is known that pumpage in these aquifers may alter the geographic distribution of brackish water. For example, four public supply wells in the freshwater portion of the Catahoula Aquifer in Montgomery County have experienced increases in the TDS of produced water over a relatively short lifetime of less than ten years, such that produced water is approaching the slightly brackish threshold of 1,000 mg/l of TDS. Therefore, the location of waters of various qualities may change over time. Developed groundwater supplies in these aquifers that are initially fresh or only slightly brackish may eventually need additional treatment or even be deemed unreliable as a long-term supply without adequate blending or treatment.

Direct use of brackish or slightly brackish groundwater as a supply source requires treatment through a reverse osmosis (RO) process to reduce TDS to at least the TCEQ-defined secondary contaminant level (SCL) of 1,000 mg/l. Some utilities which have begun producing water from the Catahoula Aquifer or Jasper Aquifer have experienced high levels of customer complaints for TDS levels above 500 mg/l. To alleviate treatment costs, water providers may also consider a blending strategy, in which a slightly brackish source water is blended with a higher quality water source to increase total

supply volume without exceeding the TCEQ drinking water standard. For source waters with TDS concentrations only slightly over 1,000 mg/L, this strategy has the potential to provide a supply of acceptable quality without additional treatment. Alternately, blending fresh water with a lower quality brackish water may produce a blended supply that requires some treatment but is still more economical to treat than a strictly brackish supply.

Environmental Considerations

In general, environmental concerns for development of brackish groundwater are site-specific and similar to the concerns associated with conventional groundwater projects. Additional concern may arise from the disposal of brine concentrate from RO treatment processes, which are used to lower the levels of TDS in the produced water stream. Disposal may be performed through deep well injection, which forces the brine into deep aquifers away from environmentally sensitive features, such as fish and wildlife habitat resources. In some cases, conditions permitting, this disposal may be alternately discharged into a natural water course. However, surface water discharge may only be performed in cases where the receiving water body already experiences high levels of TDS (such as in coastal areas) or where species and habitat would not be impacted. Surface water discharge of brine concentrate would require study of impacts, permitting effort, and potentially mitigation or management through permit conditions, flow and water quality monitoring, or operational procedures related to salinity, flow regimes, or other parameters of interest.

In the Gulf Coast area and particularly in Region H, concerns regarding subsidence are critical to all decisions made in groundwater development. A 2018 study by the Harris-Galveston Subsidence District (HGSD) and Fort Bend Subsidence District (FBSD) found that substantial groundwater development in the Jasper Aquifer, which contains brackish water in most of Harris and Fort Bend Counties, would likely result in subsidence. While additional studies and data collection have been recommended, this study indicates that pumpage from deeper aquifers of the Gulf Coast Aquifer System may pose a similar risk for subsidence as that of over-pumping in the shallower aquifers, which may limit the potential for the development of brackish groundwater projects in this part of the region.

Permitting and Development

In Region H, permitting of groundwater supplies may be managed by a Groundwater Conservation District (GCD) or one of the subsidence districts. Each of these entities has a different means to address the availability and development of brackish groundwater, so it is important to address these issues on a project by project basis. Furthermore, many brackish groundwater resources are encompassed within the extent of traditional supply aquifers throughout the region. For those aquifers which have a Desired Future Condition (DFC) adopted by the local Groundwater Management Area (GMA), availability for the purposes of regional water planning is limited to the Modeled Available Groundwater (MAG) for that aquifer, plus any additional availability provided by the application of a MAG Peak Factor. If the current use of fresh groundwater from these aquifers is already equal to the defined source availability, the regional plan may not allocate any additional brackish groundwater supplies from that aquifer.

Currently, the Catahoula Aquifer does not have a DFC in any county. The Lone Star GCD in Montgomery County permits pumping from this aquifer. Groundwater development in Fort Bend, Galveston, and Harris Counties is subject to subsidence district regulations, which currently limit pumping from any aquifer to a percentage of demand. Thus, brackish groundwater is a feasible supply

option in these counties but must still be used in conjunction with non-groundwater sources. In Brazoria County, pumping is not currently limited by Brazoria County GCD rules; however, source availability for regional planning purposes is limited due to the existence of DFCs for both readily accessible aquifers in this county (Chicot and Evangeline Aquifers).

In addition to the production well, permitting is also required for the development of an injection well typically used for brine disposal associated with the RO treatment process. In most cases, this is a matter of permitting a Class I non-hazardous injection well with the Texas Commission on Environmental Quality (TCEQ). This process typically takes a year to complete.

Cost Analysis

In addition to well construction and development, it may be necessary to treat water from fresh to slightly brackish aquifers in order to reduce the TDS to a level considered acceptable by end users. This may be performed through RO desalination. In addition to the cost of treatment, the cost of brine disposal must also be considered. This is typically performed through deep well injection which deposits the concentrated brine in a deep layer that is safely separated from water sources. Alternatively, disposal to surface water may be performed when conditions warrant such an arrangement.

Unit cost analyses were based on the development of a single 1,000-gpm production well. Three cost scenarios were developed to pump and treat brackish groundwater of 1,000, 2,000, and 3,000 mg/l TDS. RO treatment was assumed to remove 99 percent of the influent TDS and reject 25 percent of the overall input stream as concentrated brine. A blending approach was employed such that a portion of the brackish water supply would be treated and then blended with the remaining brackish water to produce a finished water with a TDS concentration of 500 mg/l. These planning level cost estimates assume the development of one brackish well and one injection well for disposal of RO concentrate.

In addition, a planning level cost estimate was developed for a scenario in which blending with existing fresh water sources was a viable alternative. This option only included the cost for development of a single well in a brackish aquifer and the construction of collection lines to receive water from the well site. This scenario assumes that the freshwater source is of sufficient quality and quantity that no RO treatment would be required for the blended supply.

Costs for all four scenarios assume drilling a 2,000-ft deep supply well that would be in operation 80% of the year and would have a peaking factor of 1.5. All cost estimates are based on standard regional planning cost estimation assumptions. A summary of costs is shown below in *Table 1*.

Table 2, Table 3, and Table 4 contain detailed cost information for the three scenarios requiring treatment, and the blending option is shown in *Table 5*. Costs for these scenarios are intended to be representative of a typical well at various potential TDS levels. RWP costing for individual WUG-level brackish groundwater projects applies a similar methodology for WUG-specific TDS and well sizing. For WUG-specific brackish groundwater projects utilizing blending without RO treatment, costs are calculated in the same manner as the Region H Expanded Use of Groundwater WMS and vary by WUG type and size of project.

Table 1 – Cost Summary for Brackish Groundwater Development and Groundwater Blending Options

Supply Well Capacity (gpm)	Brackish Water Quality (mg/l TDS)	Percent Treated in RO Process	Finished Water Quality (mg/l TDS)	Capital Cost (Sept. 2023 \$)	Unit Cost During Debt Service (Sept. 2023 \$)	Long Term Unit Cost (Sept. 2023 \$)
1,000	1,000	50.0%	504	\$31,141,750	\$7,959	\$5,037
1,000	2,000	75.5%	501	\$38,556,795	\$10,038	\$6,421
1,000	3,000	84.0%	499	\$41,753,756	\$11,024	\$7,107
1,000				\$3,937,418	\$689	\$320

Table 2 – One Well and Treatment at 1,000 mg/l Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$22,320,108	\$22,320,108
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$7,802,205	\$7,802,205
3	LAND AND EASEMENTS	1	LS	\$21,222	\$21,222
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$22,256	\$22,256
5	INTEREST DURING CONSTRUCTION	1	LS	\$975,959	\$975,959
PROJECT CAPITAL COST					\$31,141,750

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$2,191,167	\$2,191,167	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$3,512,998	\$3,512,998	\$3,512,998	\$3,512,998	\$3,512,998	\$3,512,998
3	PUMPING ENERGY COSTS	\$265,049	\$265,049	\$265,049	\$265,049	\$265,049	\$265,049
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$5,969,213	\$5,969,213	\$3,778,046	\$3,778,046	\$3,778,046	\$3,778,046

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$5,969,213	\$5,969,213	\$3,778,046	\$3,778,046	\$3,778,046	\$3,778,046
2	YIELD	750	750	750	750	750	750
3	UNIT COST	\$7,959	\$7,959	\$5,037	\$5,037	\$5,037	\$5,037
TOTAL UNIT COST		\$6,011					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$196,662	\$196,662
2	WATER TREATMENT PLANTS	1	LS	\$18,731,538	\$18,731,538
3	WELL FIELDS	1	LS	\$3,391,908	\$3,391,908
PROJECT COST					\$22,320,108

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES	1.0	%	\$196,662	\$1,967
2	WATER TREATMENT PLANTS	1.0	LS	\$3,477,112	\$3,477,112
3	WELL FIELDS	1.0	%	\$3,391,908	\$33,919
ANNUAL OPERATION AND MAINTENANCE COST					\$3,512,998

Table 3 – One Well and Treatment at 2,000 mg/l Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$27,638,757	\$27,638,757
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$9,663,732	\$9,663,732
3	LAND AND EASEMENTS	1	LS	\$22,524	\$22,524
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$23,440	\$23,440
5	INTEREST DURING CONSTRUCTION	1	LS	\$1,208,342	\$1,208,342
PROJECT CAPITAL COST					\$38,556,795

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$2,712,898	\$2,712,898	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$4,525,887	\$4,525,887	\$4,525,887	\$4,525,887	\$4,525,887	\$4,525,887
3	PUMPING ENERGY COSTS	\$289,642	\$289,642	\$289,642	\$289,642	\$289,642	\$289,642
TOTAL ANNUAL COST		\$7,528,427	\$7,528,427	\$4,815,530	\$4,815,530	\$4,815,530	\$4,815,530

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$7,528,427	\$7,528,427	\$4,815,530	\$4,815,530	\$4,815,530	\$4,815,530
2	YIELD	750	750	750	750	750	750
3	UNIT COST	\$10,038	\$10,038	\$6,421	\$6,421	\$6,421	\$6,421
TOTAL UNIT COST		\$7,626					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$196,662	\$196,662
2	WATER TREATMENT PLANTS	1	LS	\$23,694,011	\$23,694,011
3	WELL FIELDS	1	LS	\$3,748,084	\$3,748,084
PROJECT COST					\$27,638,757

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES	1.0	%	\$196,662	\$1,967
2	WATER TREATMENT PLANTS	1.0	LS	\$4,486,440	\$4,486,440
3	WELL FIELDS	1.0	%	\$3,748,084	\$37,481
ANNUAL OPERATION AND MAINTENANCE COST					\$4,525,887

Table 4 – One Well and Treatment at 3,000 mg/l Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$29,929,899	\$29,929,899
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$10,465,632	\$10,465,632
3	LAND AND EASEMENTS	1	LS	\$24,477	\$24,477
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$25,216	\$25,216
5	INTEREST DURING CONSTRUCTION	1	LS	\$1,308,532	\$1,308,532
PROJECT CAPITAL COST					\$41,753,756

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$2,937,839	\$2,937,839	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$5,032,402	\$5,032,402	\$5,032,402	\$5,032,402	\$5,032,402	\$5,032,402
3	PUMPING ENERGY COSTS	\$297,840	\$297,840	\$297,840	\$297,840	\$297,840	\$297,840
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$8,268,081	\$8,268,081	\$5,330,242	\$5,330,242	\$5,330,242	\$5,330,242

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$8,268,081	\$8,268,081	\$5,330,242	\$5,330,242	\$5,330,242	\$5,330,242
2	YIELD	750	750	750	750	750	750
3	UNIT COST	\$11,024	\$11,024	\$7,107	\$7,107	\$7,107	\$7,107
TOTAL UNIT COST		\$8,413					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$196,662	\$196,662
2	WATER TREATMENT PLANTS	1	LS	\$25,866,429	\$25,866,429
3	WELL FIELDS	1	LS	\$3,866,808	\$3,866,808
PROJECT COST					\$29,929,899

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES	1.0	%	\$196,662	\$1,967
2	WATER TREATMENT PLANTS	1.0	LS	\$4,991,767	\$4,991,767
3	WELL FIELDS	1.0	%	\$3,866,808	\$38,668
ANNUAL OPERATION AND MAINTENANCE COST					\$5,032,402

Table 5 – One Well for Blending Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$2,816,854	\$2,816,854
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$976,066	\$976,066
3	LAND AND EASEMENTS	1	LS	\$9,501	\$9,501
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$11,601	\$11,601
5	INTEREST DURING CONSTRUCTION	1	LS	\$123,396	\$123,396
PROJECT CAPITAL COST					\$3,937,418

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$277,041	\$277,041	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$28,169	\$28,169	\$28,169	\$28,169	\$28,169	\$28,169
3	PUMPING ENERGY COSTS	\$211,760	\$211,760	\$211,760	\$211,760	\$211,760	\$211,760
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$516,970	\$516,970	\$239,929	\$239,929	\$239,929	\$239,929

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$516,970	\$516,970	\$239,929	\$239,929	\$239,929	\$239,929
2	YIELD	750	750	750	750	750	750
3	UNIT COST	\$689	\$689	\$320	\$320	\$320	\$320
TOTAL UNIT COST		\$443					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$196,662	\$196,662
2	WELL FIELDS	1	LS	\$2,620,193	\$2,620,193
PROJECT COST					\$2,816,854

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES	1.0	%	\$196,662	\$1,967
2	WELL FIELDS	1.0	%	\$2,620,193	\$26,202
ANNUAL OPERATION AND MAINTENANCE COST					\$28,169

Water Management Strategy Evaluation

Based on the analysis provided above, the Brackish Groundwater Development and Groundwater Blending project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Cost	3	The costs of this project vary greatly from one application to another. Cost is primarily dependent upon the quality of local supplies and the opportunity to blend with fresh sources.
Location	5	Where water is available, it may be developed in the immediate vicinity of demand.
Water Quality	3	When treated or blended responsibly, there are no known issues related to water quality.
Environmental Land and Habitat	4	Minimal impacts related to development of well sites and treatment facilities.
Environmental Flows	4	The project produces return flows from deep groundwater supplies.
Local Preference	3	No local preference identified.
Institutional Constraints	3	Regulation varies by specific application. However, where supply development is within the limits of the regulating authority, pathways are available for development.
Development Timeline	5	Projects may be identified and implemented in a short period of time.
Sponsorship	3	Sponsorship varies by specific application. Some WUGs are proceeding with development and others have had the project applied through the planning process.
Vulnerability	4	Supplies are generally more drought-tolerant than surface water resources and have limited risk from human impacts.
Regionalization	1	Typically implemented at the individual water system level or for a small number of interconnected systems.
Impacts on Other WMS	4	Slight increase in return flows associated with groundwater development.

Brackish Groundwater Development and Groundwater Blending projects are not anticipated to affect acreage or vulnerable species. However, certain approaches to brine disposal, should they be pursued, may impact water quality. The projects may increase return flows to streams by approximately 50 percent of the project yield through municipal return flows. This strategy is not anticipated to impact agricultural land or production.

Water User Group Application

The Brackish Groundwater Development and Groundwater Blending project 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.

Criteria	WUG Suitability
Proximity	This project may be developed as a supply in the vicinity of brackish groundwater zones identified in this technical memorandum.
Size	This project is scalable to fit local demands. However, little is known regarding the long-term sustainability of these brackish supplies and availability may be limited through physical constraints or regulation in the future.
Water Quality	Supplies from this project can be developed in such a way to provide water at a number of quality levels.
Unit Cost	The unit cost for the project varies based on magnitude and the specifics of each application. Generally, the range of costs limit the application of brackish groundwater development projects to municipal and industrial applications, but the use of brackish groundwater in a blended supply may be an affordable option.
Other Factors	Brackish groundwater supplies are currently in use from the Catahoula Aquifer in Montgomery County and are being developed in the Chicot Aquifer in Brazoria County.

References

Harris-Galveston Subsidence District and Fort Bend Subsidence District. (2018). *Investigation of the Brackish Groundwater Resources in the Gulf Coast Aquifer and the Determination of Potential Subsidence Risk Due to Resource Development*. Prepared by INTERA, Ewing, T. E., Banerji, D., LBG-Guyton & Associates / WSP, Sheng, Z., and HDR.

Lone Star Groundwater Conservation District. (2019). Montgomery County Catahoula Aquifer Pumping and Permitting Data.

Smith, David K. *Brazosport Water Authority Brackish Groundwater Development*. Texas Desalinization Association, Texas Desal 2017 Conference, 23 September 2017, Hyatt Regency, Austin, TX.

Texas Commission on Environmental Quality Texas Drinking Water Watch.
<https://dww2.tceq.texas.gov/DWW/>

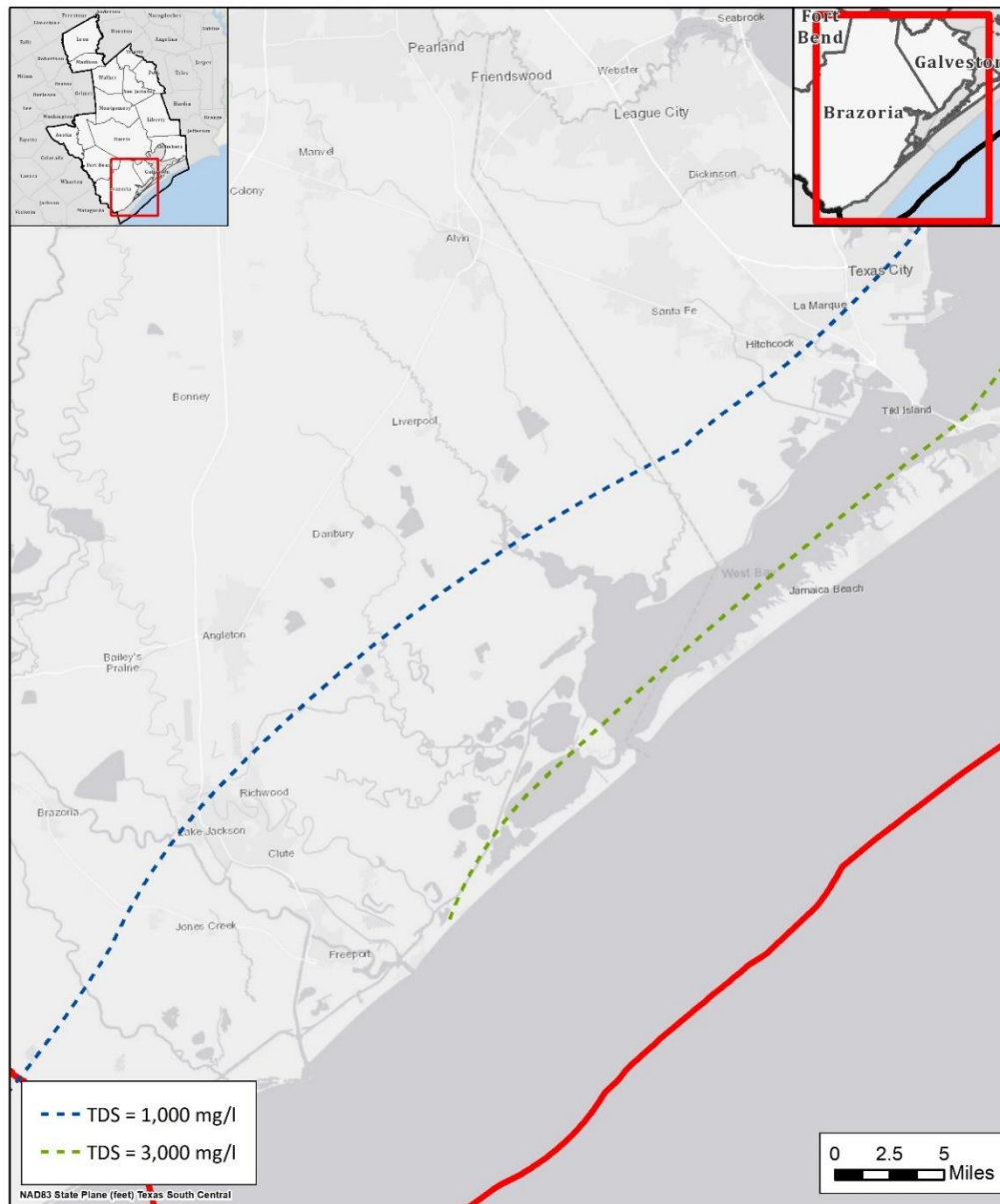
Texas Water Development Board Groundwater Database.
<http://www.twdb.texas.gov/groundwater/data/gwdbbrpt.asp>

Texas Water Development Board. (2016). *Final Report: Identification of Potential Brackish Groundwater Production Areas – Gulf Coast Aquifer System*. Prepared by TWDB, INTERA, Ewing, T. E., and Banerji, D.

United States Geological Survey. *USGS Groundwater Data for Texas*.

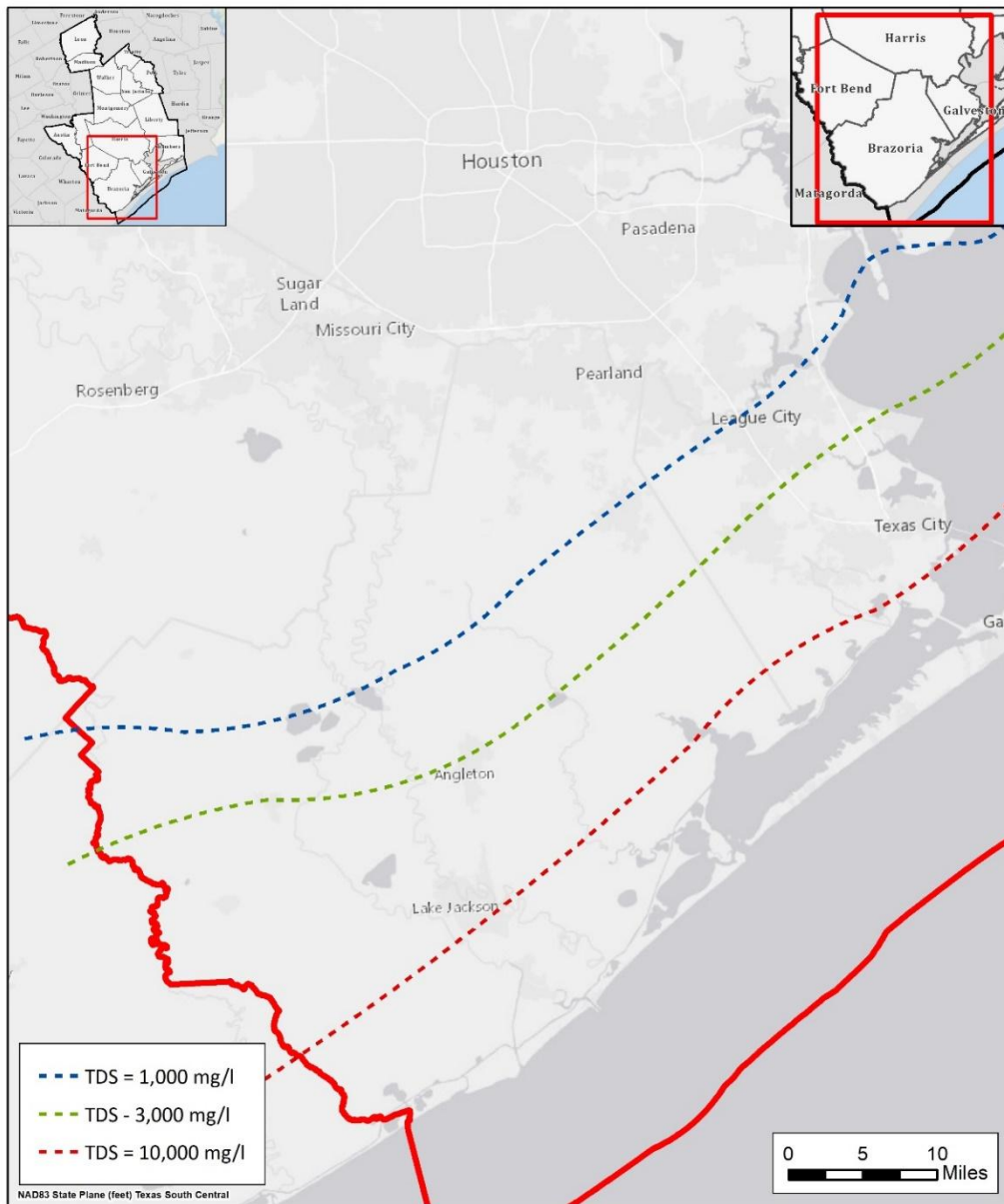
<https://waterdata.usgs.gov/tx/nwis/gw>

Exhibits



Chicot Aquifer Estimated Delineation of Fresh to Brackish Groundwater

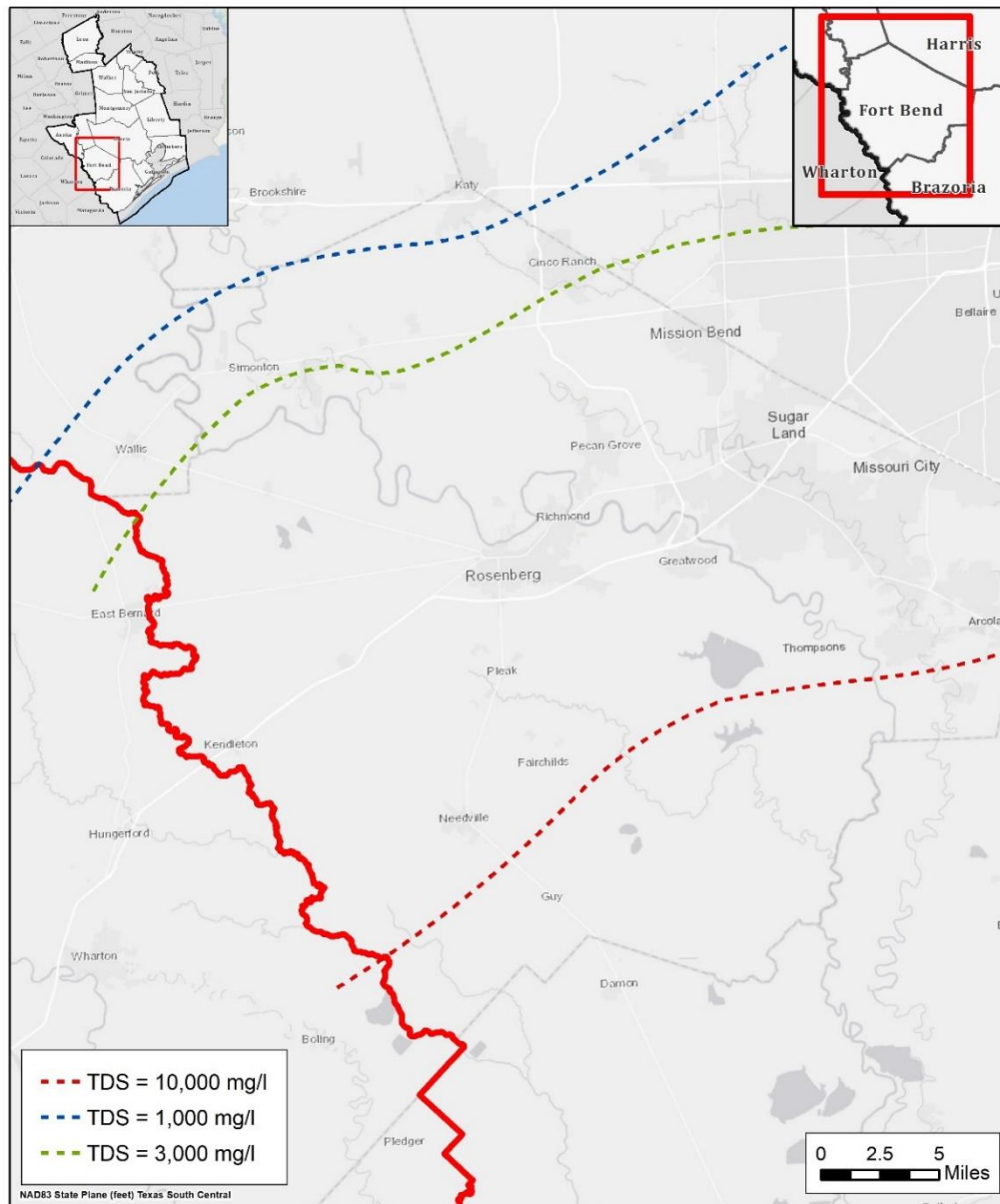




Evangeline Aquifer Estimated Delineation of Fresh to Brackish Groundwater

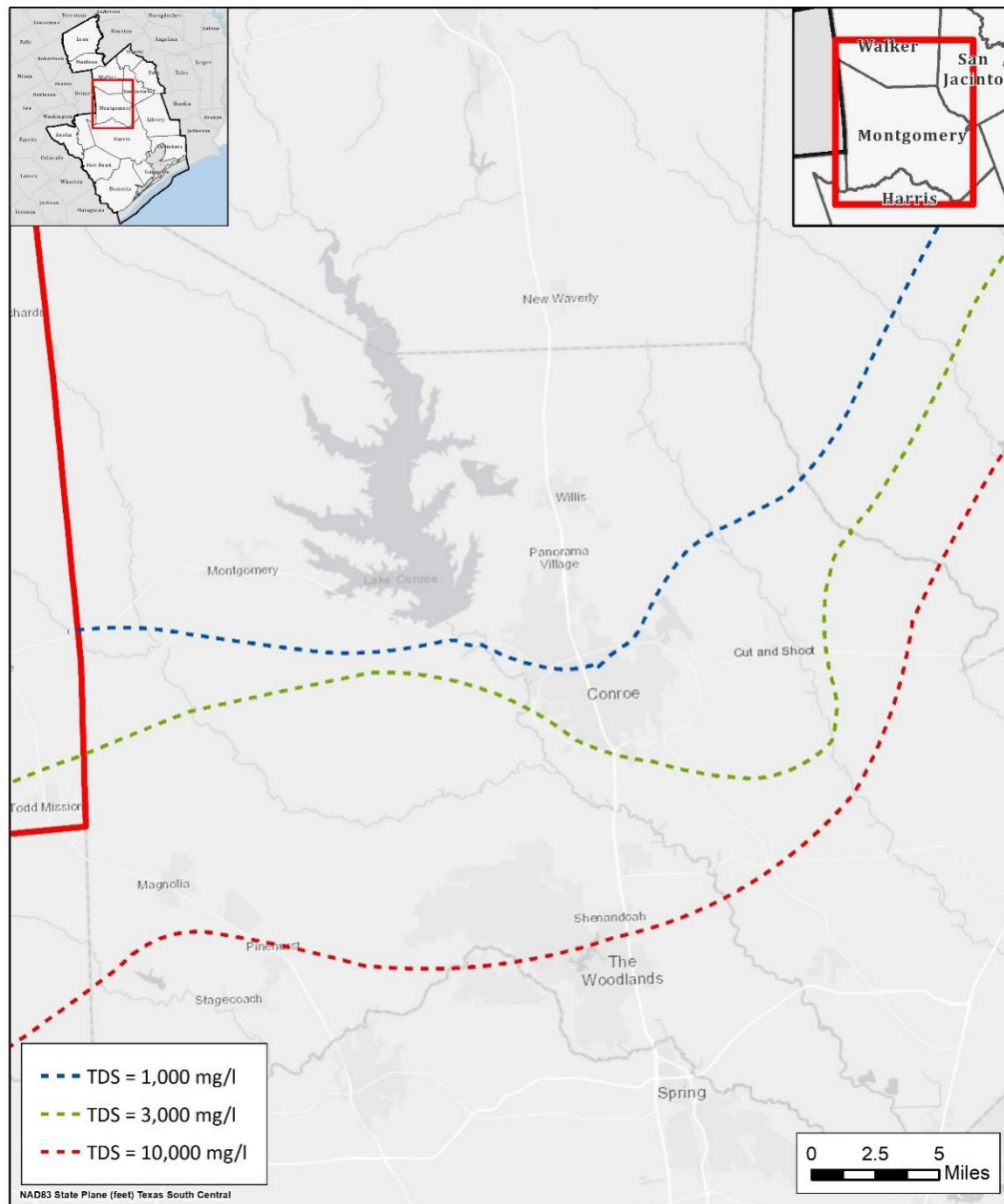


Texas



Jasper Aquifer Fort Bend County Estimated Delineation of Fresh to Brackish Groundwater





Catahoula Aquifer Estimated Delineation of Fresh to Brackish Groundwater



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Brazosport Water Authority Brackish Groundwater Development
Project ID:	GWDV-003
Project Type:	New Groundwater Source
Potential Supply Quantity (Rounded):	13,440 ac-ft/yr (peak) (12 mgd)
Implementation Decade:	2030
Development Timeline:	2 years
Project Capital Cost:	\$74,055,688 (Sept. 2023)
Unit Water Cost (Rounded):	\$830 per ac-ft (during loan period) \$442 per ac-ft (after loan period)

Strategy Description

The Brazosport Water Authority (BWA) serves seven communities in the southern Brazoria County area and provides potable service to Dow Inc. and two Texas Department of Criminal Justice (TDCJ) units, as well as the City of Rosenberg. In December of 2013, BWA concluded a Texas Water Development Board (TWDB) Regional Facility Planning Grant study to examine the potential for serving the current BWA service area as well as other portions of Brazoria County in the future. The study included several recommendations including the development of a reverse osmosis (RO) water treatment plant (WTP) at the site of the current BWA surface water treatment plant to be fed by a brackish groundwater well field in the vicinity of the current plant site. The RO WTP would function in two basic modes:

1. When the Brazos River has sufficient flow, including Harris and Brazoria Reservoir diversions, the RO WTP would provide a minimal baseline potable water flow, supplementing the primary, lower cost potable water from the BWA surface water treatment plant.
2. When the Brazos River has insufficient flow, the RO WTP would operate up to its peak capacity to meet the potable water demands.

Strategy Analyses

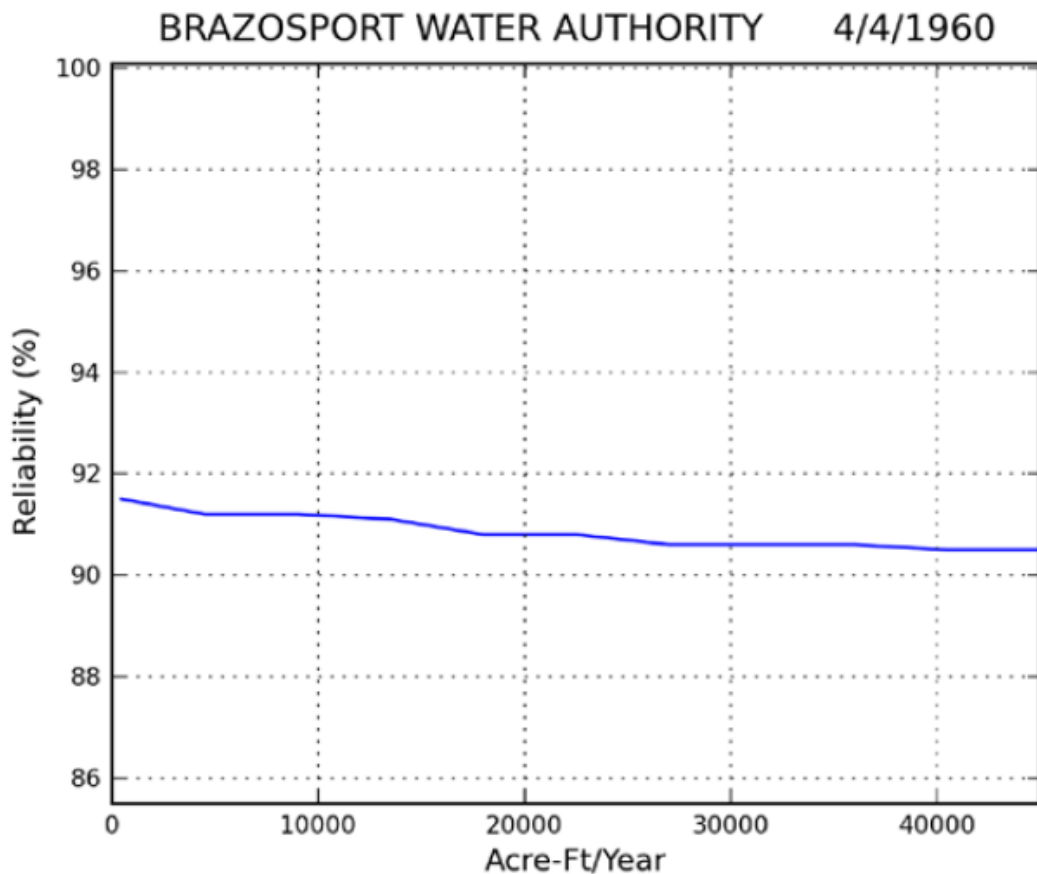
The project analyses for BWA Brackish Groundwater Development include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Existing surface water supplies were evaluated using the Texas Commission on Environmental Quality (TCEQ) Brazos River Basin and San Jacinto-Brazos Coastal Basin Water Availability Model (WAM). For

the purposes of this exercise, the full authorization version of the model (bwam3) was employed to evaluate availability from BWA's water right, 5366. As shown in *Figure 1*, this right of 45,000 ac-ft/yr was found to have a time reliability of approximately 90.5 percent. That is, 100 percent of the diversion target is available in 90.5 percent of the monthly simulation periods. *Figure 1* also shows that even a dramatically reduced target of only one percent of the permit value has limited improvement in reliability. In effect, the WAM indicates that availability for this right is subject to dramatic swings in river conditions resulting in conditions where either the entirety of or none of the right is available for diversion at any given time. This reliability is depicted below in *Figure 1*.

Figure 1 – Simulated Reliability of BWA Water Right 5366



As part of the regional study, various approaches were considered to close the water supply gap. These include the purchase of surface water from wholesale providers in the Brazos River Basin, brackish groundwater desalination, and seawater desalination. Brackish groundwater desalination was selected as the preferred alternative for meeting supply shortages in supply due to availability and cost of water considerations.

Although the RO WTP's initial phase capacity is rated at 6 mgd, actual operation of the facility would result in a lower long-term average rate of production. The study indicates that Phase 1 of the facility will operate at peak capacity (6.0 mgd) ten percent of the time to mitigate shortages in surface water supply. The plant would normally operate at just 2.0 mgd 90 percent of the time. This results in an average rate of production of 2.40 mgd. In order to produce the peak rate of 6.0 mgd a feed rate of 6.7 mgd is anticipated. This is based on blending 4.0 mgd of membrane permeate with 2.0 mgd of bypass flow. Similar permeate and bypass blending for the 2.40 mgd average flow will require a long-

term groundwater production rate of 2.7 mgd or approximately 3,000 ac-ft/yr. The proposed brackish groundwater facilities would consist of three closely located wells and collection lines ranging from 12-in. to 36-in. diameter. The WTP would provide cartridge filter pretreatment, chemical additives, and final treatment through three RO membrane racks.

Phase 2 of the strategy includes an increase of 6 mgd peak capacity, bringing the facility to an overall peak capacity of 12 mgd. An additional two wells will be incorporated into the overall well field to reach the Phase 2 capacity of 12 mgd connected by additional 12-in. and 36-in. piping. Pretreatment will be accomplished in the same manner as Phase 1.

It should be noted that the 12 mgd (13,440 ac-ft/yr) project supply presented in this memorandum reflects peak planned infrastructure capacity. Volumes shown as allocated strategy supply in the TWDB Regional Water Planning database and related summaries include additional considerations for source water availability, short term groundwater peaking, and other factors and may vary from the peak capacity.

Environmental Considerations

Construction within the vicinity of the Waters of the U.S. found along the Brazos River may be subject to Section 404 of the Clean Water Act (CWA) and crossing of the Brazos River to install collection line to the remote well across the river would be subject to a Section 10 permit from the U.S. Army Corps of Engineers. These issues may be covered under Nationwide Permit (NWP) 39 assuming certain conditions are met such as limitation of disturbance to no more than 0.5 acres. Also, construction of a pipeline across the CR 2004 bridge would be considered a bridge under Section 9 of the River and Harbors Act and require authorization.

The Brazos River in the project vicinity is a State-owned riverbed. Any activity within or beneath the confines of the Brazos River would require an easement from the GLO prior to proceeding with construction.

The development of groundwater production may potentially increase the risk of subsidence and saltwater intrusion, especially for sites near the coast. To address these concerns, BWA has performed investigations into the potential for subsidence and drawdown occurring in the vicinity of the well field. To accomplish this, BWA utilized both the Houston Area Groundwater Model (HAGM) and the Lower-Colorado River Basin (LCRB) Groundwater Flow Model, both of which models simulate flow in formations of the Gulf Coast Aquifer System. Maximum incremental subsidence was determined for various scenarios. In a scenario similar to the proposed well field configuration, the subsidence predicted by the HAGM reached a maximum of 1.25 feet at the well field under a constant pumping scenario of 4,000 gpm (5.76 mgd) between 2005 and 2050. A scenario splitting pumpage stratigraphically across the Beaumont and Lissie formations in the LCRB demonstrated subsidence of 0.43 feet between the same time period. Note that this pumping rate of 5.76 mgd is greater than the anticipated long-term average pumping rates for Phases 1 and 2 discussed above. In addition to this desktop analysis, BWA has installed subsidence monitoring equipment for use in tracking long-term trends in proximity of the well field.

RO concentrate disposal to the Brazos River will be accomplished in a way to minimize potential environmental impacts. Discharge is anticipated to occur below State Highway (SH) 332 where there is no limit set for Total Dissolved Solids (TDS). At this point, the salinity of RO concentrate is expected to be below the ambient levels of the Brazos River. Similar discharge strategies have been employed for other projects in the Brazos River Basin. This discharge will require permitting under the Texas Pollutant Discharge Elimination System (TPDES).

Permitting and Development

The groundwater well components of this project will require permitting through the Brazoria County Groundwater Conservation District (BCGCD) to drill and operate the planned wells. Brine discharge from the facility will also require permitting through TCEQ. Additional permitting activities may be required to facilitate construction activities, as described above.

Cost Analysis

Costs for the proposed project were estimated based upon information provided by BWA in conjunction with detailed infrastructure and operation and maintenance cost projections. Sponsor costs were scaled to September 2023 equivalent cost in accordance with TWDB guidance. Other components such as interest during construction and annualized debt service were estimated using standard regional planning assumptions. Costs for Phases 1 and 2 of the project have been combined into one overall capital cost as it is expected that both phases will be developed in the 2030 planning period. These costs are summarized below in *Table 1*.

Table 1 – BWA Brackish Groundwater Development Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023	
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL	
PROJECT CAPITAL COST SUMMARY						
1	CONSTRUCTION COST	1	LS	\$60,000,000	\$60,000,000	
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$9,399,360	\$9,399,360	
3	LAND AND EASEMENTS	1	LS	\$16,120	\$16,120	
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$47,016	\$47,016	
5	INTEREST DURING CONSTRUCTION	1	LS	\$4,593,193	\$4,593,193	
PROJECT CAPITAL COST					\$74,055,688	

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$5,210,638	\$5,210,638	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$5,090,768	\$5,090,768	\$5,090,768	\$5,090,768	\$5,090,768	\$5,090,768
3	PUMPING ENERGY COSTS	\$852,000	\$852,000	\$852,000	\$852,000	\$852,000	\$852,000
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$11,153,406	\$11,153,406	\$5,942,768	\$5,942,768	\$5,942,768	\$5,942,768

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$11,153,406	\$11,153,406	\$5,942,768	\$5,942,768	\$5,942,768	\$5,942,768
2	YIELD	13,440	13,440	13,440	13,440	13,440	13,440
3	UNIT COST	\$830	\$830	\$442	\$442	\$442	\$442
TOTAL UNIT COST		\$571					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	WATER TREATMENT PLANTS	1	LS	\$60,000,000	\$60,000,000
PROJECT COST					\$60,000,000

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	WATER TREATMENT PLANTS	1.0	LS	\$5,090,768	\$5,090,768
ANNUAL OPERATION AND MAINTENANCE COST					\$5,090,768

Water Management Strategy Evaluation

Based on the analysis provided above, the BWA Brackish Groundwater Development project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	3	Relatively low project cost for a desalination alternative.
Location	3	Conveyance required to provide water to diverse BWA service area.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Environmental impacts may be easily mitigated.
Environmental Flows	4	Slight increase in instream flows due to brine return to stream course.
Local Preference	4	Local support from BWA customers.
Institutional Constraints	5	Permits have been granted and project is progressing to pilot development stage.
Development Timeline	5	Project can be implemented in a relatively short time period.
Sponsorship	5	Project is under development.
Vulnerability	4	No substantial risk from natural and man-made disasters. Potential for subsidence being monitored to prevent detrimental impacts.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	5	Project works in conjunction with BWA surface water rights to provide a reliable water supply.

The BWA Brackish Groundwater Development project is not anticipated to affect vulnerable species and will not reduce instream flows. This project is not anticipated to impact agricultural land or production.

Water User Group Application

The BWA Brackish Groundwater Development project 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

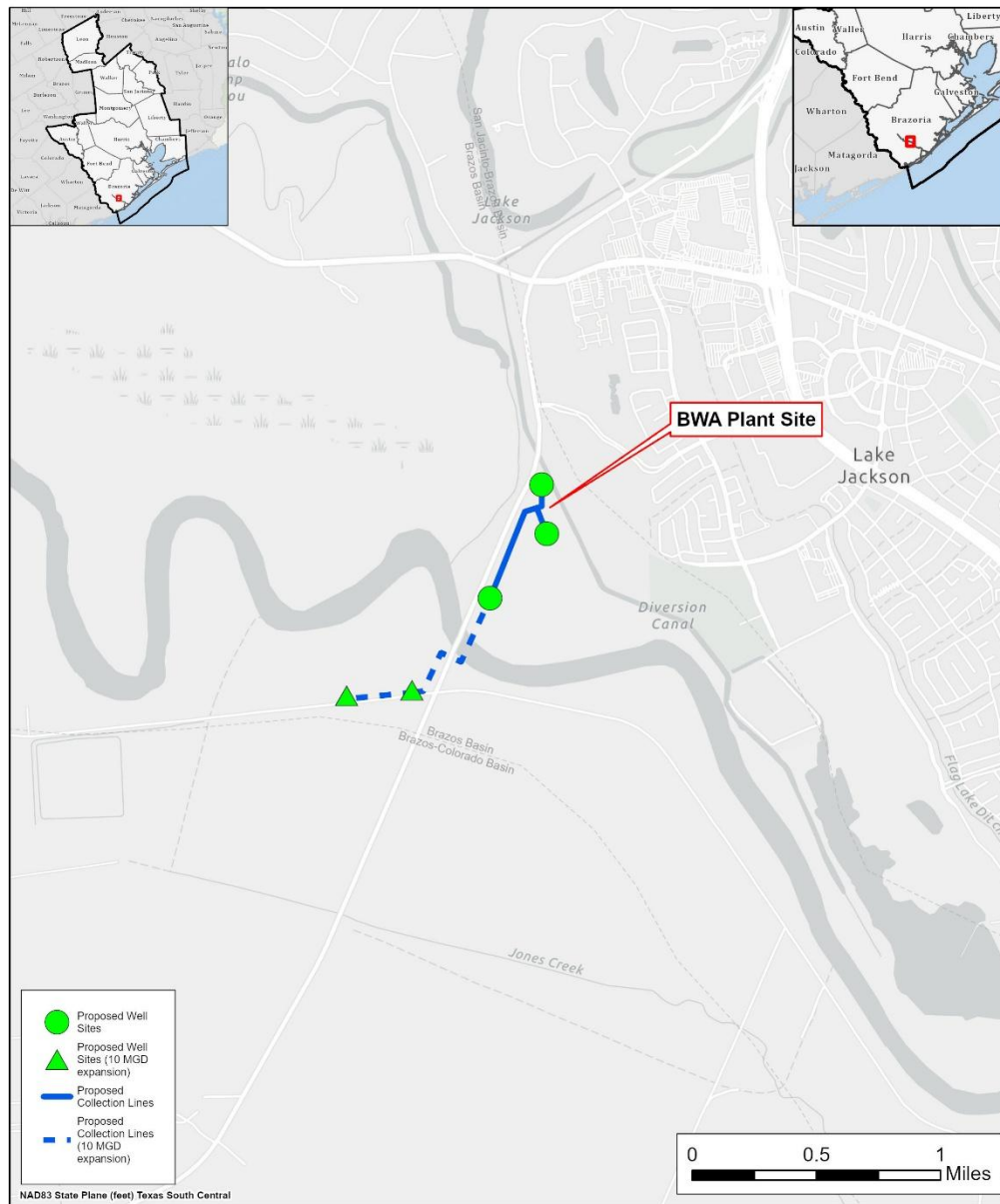
the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served.

CRITERIA	WUG SUITABILITY
Proximity	Project is positioned to provide water within the current BWA customer service area.
Size	Project is sized to provide adequate dry-year supply for BWA customer use.
Water Quality	Project will provide treated water for potable municipal and industrial use.
Unit Cost	Unit cost is suited to use in municipal supply. Long-term costs are also mitigated by use of traditionally treated surface water supplies when available.
Other Factors	Project is identified for BWA service area.

References

CDM-Smith. *Brazoria County Regional Water Facility Study*. May 2013.

Location Map



Brazosport Water Authority Brackish Groundwater Development Location Map



Texas

THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	City of Houston Area 2 Groundwater Infrastructure
Project ID:	GWDV-004
Project Type:	Existing Groundwater Source
Potential Supply Quantity (Rounded):	50,400 ac-ft/yr (45 mgd)
Implementation Decade:	2030
Development Timeline:	<5 years
Project Capital Cost:	\$150,754,783 (Sept. 2023)
Unit Water Cost (Rounded):	\$482 per ac-ft (during loan period) \$271 per ac-ft (after loan period)

STRATEGY DESCRIPTION

The Harris-Galveston Subsidence District (HGSD) has established requirements for entities within its boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer. Within HGSD Regulatory Area 2, groundwater production is limited to 20 percent of total water use for a water system or for an aggregation of systems under a common Groundwater Reduction Plan (GRP). The City of Houston (COH) has identified a need to develop additional well capacity within Area 2 in order to utilize its estimated future allowable groundwater capacity within the regulatory limits established by HGSD. Remaining demands beyond allowable groundwater production will be met by alternate sources. The project also supports the City's One Water Houston approach to integrated, sustainable management of water resources.

STRATEGY ANALYSES

The project analyses for COH Area 2 Groundwater Infrastructure include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

SUPPLY DEVELOPMENT

In order to meet the requirements of the HGSD, the COH has used its surface water rights and treatment capacity to provide an alternative to groundwater pumpage for the city itself as well as other entities in a broad geographic area. The COH has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is developing multiple infrastructure projects related to the treatment and distribution of surface water to facilitate continued compliance as water demands grow in the future. While groundwater makes up only a limited percentage of the overall supply portfolio, the COH has determined that its existing groundwater infrastructure capacity within HGSD Regulatory Area 2 is below the projected allowable

production amount based on HGSD regulation and anticipated water demand. In order to better utilize groundwater resources within the limits established by HGSD, the COH has identified the need to develop an additional 45 mgd in groundwater production capacity within Area 2.

ENVIRONMENTAL CONSIDERATIONS

Development of this project may impact environmental conditions in the immediate vicinity of the well field or fields and associated conveyance infrastructure. While some surface disturbance is likely for construction of groundwater infrastructure, due to the urbanized nature of the COH within Area 2, construction impacts would be expected to occur primarily within previously disturbed areas. Groundwater production in the greater Houston area has been associated with historical subsidence; however, the supplies associated with the COH Area 2 Groundwater Infrastructure project are within the regulatory allowable production limits of the HGSD. Groundwater levels and subsidence are both monitored throughout Harris County by HGSD. It is also noted that well pumping may increase return flows to surface water bodies and to the Galveston Bay system.

PERMITTING AND DEVELOPMENT

Development of the project would be required to comply with the HGSD rules regarding permitting, production, well spacing, and other factors. Infrastructure development may also require minor construction permitting related to surface disturbance for well field, treatment, and pipeline infrastructure.

COST ANALYSIS

A preliminary planning-level cost estimate was developed for the COH Area 2 Groundwater Infrastructure project based on standard regional planning assumptions. Construction costs were estimated for groundwater production and treatment capacity as well as associated storage. Interest during construction, annualized debt service, pumping energy costs, and costs of operation and maintenance were also estimated using standard assumptions for Region H. Costs are presented in September 2023 equivalent costs in *Table 1*.

Table 1 – City of Houston Area 2 Groundwater Infrastructure Estimated Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$88,560,481	\$88,560,481
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$30,996,168	\$30,996,168
3	LAND AND EASEMENTS	1	LS	\$2,406,690	\$2,406,690
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$24,066,900	\$24,066,900
5	INTEREST DURING CONSTRUCTION	1	LS	\$4,724,544	\$4,724,544
PROJECT CAPITAL COST					\$150,754,783

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$10,607,269	\$10,607,269	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$7,107,466	\$7,107,466	\$7,107,466	\$7,107,466	\$7,107,466	\$7,107,466
3	PUMPING ENERGY COSTS	\$6,553,116	\$6,553,116	\$6,553,116	\$6,553,116	\$6,553,116	\$6,553,116
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$24,267,851	\$24,267,851	\$13,660,582	\$13,660,582	\$13,660,582	\$13,660,582

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$24,267,851	\$24,267,851	\$13,660,582	\$13,660,582	\$13,660,582	\$13,660,582
2	YIELD	50,400	50,400	50,400	50,400	50,400	50,400
3	UNIT COST	\$482	\$482	\$271	\$271	\$271	\$271
TOTAL UNIT COST		\$341					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	WATER TREATMENT PLANTS	1	LS	\$19,443,317	\$19,443,317
2	WATER STORAGE TANKS	1	LS	\$15,271,826	\$15,271,826
3	WELL FIELDS	1	LS	\$53,845,339	\$53,845,339
PROJECT COST					\$88,560,481

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	WATER TREATMENT PLANTS	1.0	LS	\$6,416,294	\$6,416,294
2	WATER STORAGE TANKS	1.0	%	\$15,271,826	\$152,718
3	WELL FIELDS	1.0	%	\$53,845,339	\$538,453
ANNUAL OPERATION AND MAINTENANCE COST					\$7,107,466

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the City of Houston Area 2 Groundwater Infrastructure project was evaluated across 12 different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

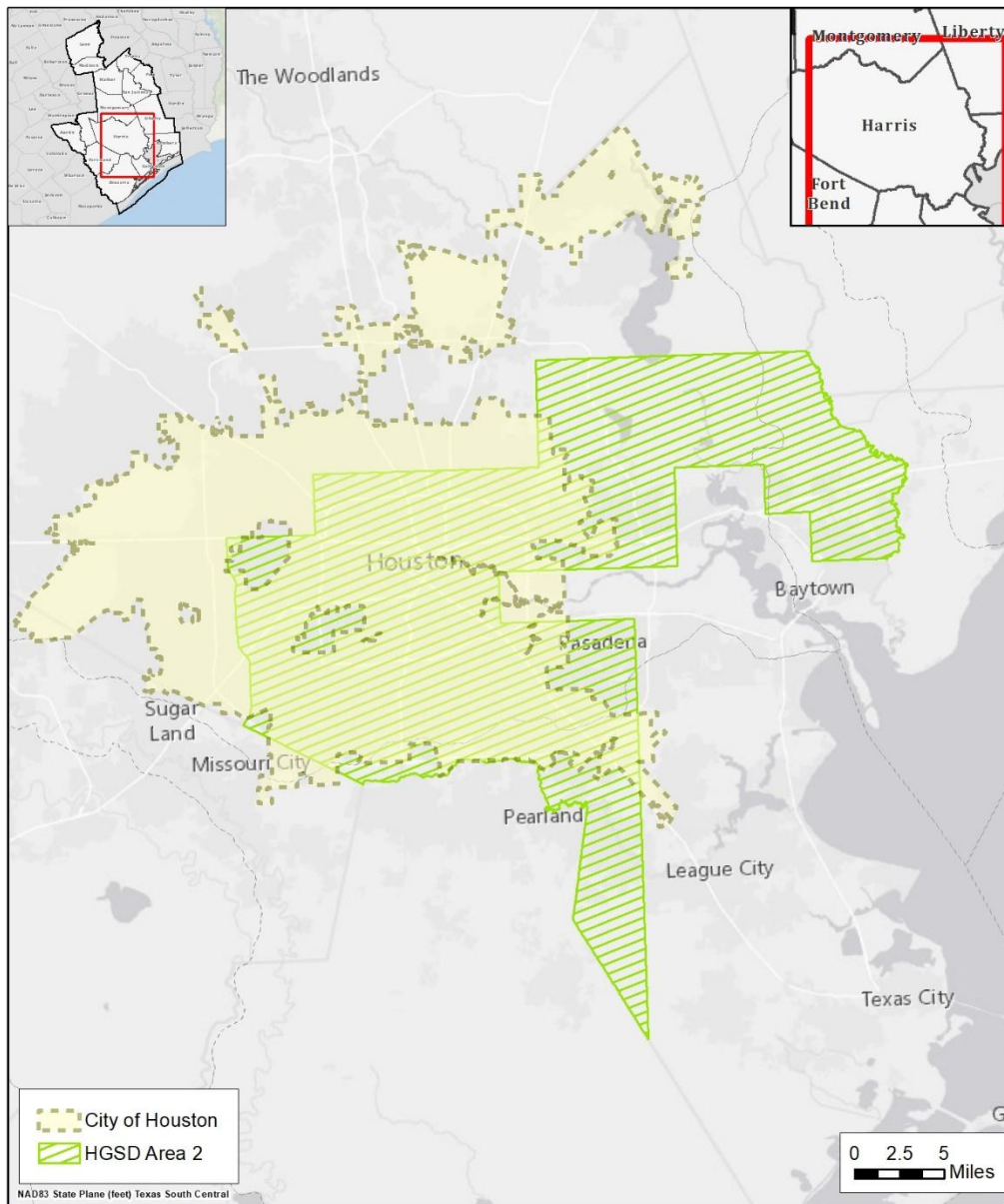
CRITERIA	RATING	EXPLANATION
Cost	4	Costs are moderately low and decline considerably after debt service.
Location	5	Well development would be located near points of use or in the vicinity of the City of Houston's existing water distribution system.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Limited concerns. Environmental impacts can be avoided or mitigated.
Environmental Flows	4	Potential increases to instream flows.
Local Preference	4	Project expected to encounter minimal opposition.
Institutional Constraints	3	Minimal permitting challenges anticipated.
Development Timeline	5	Project can be developed in a relatively short period of time.
Sponsorship	5	Sponsor has identified project and intends to develop infrastructure over time.
Vulnerability	4	No substantial risk from natural and man-made disasters. Potential for subsidence is limited by compliance with HGSD regulation and conversion of large portions of Area 2 to surface water sources.
Regionalization	3	Serves primarily the sponsor and limited number of customers directly but provides indirect support and diversification to existing regional supply systems.
Impacts on Other Projects	3	Project is not expected to impact other water management strategies.

The COH Area 2 Groundwater Infrastructure project is not anticipated to affect vulnerable species and may increase return flows to streams. The project is not anticipated to impact agricultural land or production.

WATER USER GROUP APPLICATION

The COH Area 2 Groundwater Infrastructure project 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 project as well as other factors that may relate to the suitability of the project to the WUGs served.

CRITERIA	WUG SUITABILITY
Proximity	Wells or well field infrastructure would be located near points of use within the City of Houston service area or in close proximity to the existing water distribution system.
Size	The project sizing is consistent with allowable groundwater production under HGSD regulation.
Water Quality	Water generated by the project is anticipated to be of good quality and suitable for multiple uses within the City of Houston service area.
Unit Cost	Project unit costs are moderately low during debt service and decline after debt service.
Other Factors	Availability constrained by relevant local groundwater regulations.

LOCATION MAP

**COH Area 2
Groundwater Infrastructure
Location Map**



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	City of Houston Repump and Groundwater Plant Improvements
Project ID:	GWDV-005
Project Type:	Existing Groundwater Source
Potential Supply Quantity (Rounded):	97,440 ac-ft/yr (87 mgd)
Implementation Decade:	2030
Development Timeline:	<10 years
Project Capital Cost:	\$173,600,899 (Sept. 2023)
Unit Water Cost (Rounded):	\$287 per ac-ft (during loan period) \$45 per ac-ft (after loan period)

STRATEGY DESCRIPTION

The City of Houston (COH) provides water supply to its own extensive service area as well as to a number of contract customers and regional partners. While COH predominantly utilizes surface water sources, groundwater production within applicable regulatory limits remains an important element of its supply portfolio and provides operational flexibility during periods of peak demand. The City of Houston is planning capacity expansions and other enhancements at multiple groundwater plants and repump stations to help address water demands and support compliance with Texas Commission on Environmental Quality (TCEQ) regulations. COH is also investigating redevelopment of its IAH 3 Ground Water Plant into a repump station that will reliably supply surface water and adequate water pressure to the George Bush Intercontinental Airport. The project also supports the City's One Water Houston approach to integrated, sustainable management of water resources.

STRATEGY ANALYSES

The project analyses for COH Repump and Groundwater Plant Improvements include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

SUPPLY DEVELOPMENT

The COH Repump and Groundwater Plant Improvements project is in the conceptual study phase. For the purposes of the 2026 Region H Regional Water Plan (RWP), the capacity increase associated with the IAH 3 facility conversion to a repump role is estimated at 7 mgd (7,840 ac-ft/yr), with completion estimated by 2030. Other upgrades and enhancements to groundwater and repump facilities are estimated to increase system conveyance and production capacity by up to 80 mgd (89,600 ac-ft/yr) by 2035.

ENVIRONMENTAL CONSIDERATIONS

Infrastructure development may result in some construction disturbance which could require mitigation. Due to the highly urbanized nature of much of the COH area, construction impacts would be expected to occur primarily within previously disturbed areas.

PERMITTING AND DEVELOPMENT

The project primarily involves expansions and enhancements for existing facilities, reducing the need for land acquisition or extensive permitting. Infrastructure development may require minor construction permitting related to surface disturbance.

COST ANALYSIS

A preliminary planning-level cost estimate was developed for the COH Repump and Groundwater Plant Improvements project. Capital costs were based upon data provided by COH; for purposes of the 2026 RWP, these estimates were assumed to be inclusive of all capital cost components including engineering, land acquisition, environmental studies and mitigation, and interest during construction. Annual costs including annualized debt service, pumping energy costs, and costs of operation and maintenance were estimated using standard regional planning assumptions. Costs are presented in September 2023 equivalent costs in *Table 1*.

Table 1 – COH Repump and Ground Water Enhancement Total Estimated Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJEC >					
1	CONSTRUCTION AND NON-CONSTRUCTION COSTS (ENGINEERING, LAND ACQUISITION, ETC.)	1	LS	\$173,600,899	\$173,600,899
PROJECT CAPITAL COST					\$173,600,899

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (IAH 2030)	\$1,660,585	\$1,660,585	\$0	\$0	\$0	\$0
2	DEBT SERVICE (Repump GW 2040)	\$0	\$10,554,162	\$10,554,162	\$0	\$0	\$0
3	OPERATION AND MAINTENANCE (IAH 2030)	\$590,022	\$590,022	\$590,022	\$590,022	\$590,022	\$590,022
4	OPERATION AND MAINTENANCE (Repump GW 2040)	\$0	\$3,750,000	\$3,750,000	\$3,750,000	\$3,750,000	\$3,750,000
5	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
6	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$2,250,607	\$16,554,769	\$14,894,184	\$4,340,022	\$4,340,022	\$4,340,022

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$2,250,607	\$16,554,769	\$14,894,184	\$4,340,022	\$4,340,022	\$4,340,022
2	YIELD	7,840	97,440	97,440	97,440	97,440	97,440
3	UNIT COST	\$287	\$170	\$153	\$45	\$45	\$45
TOTAL UNIT COST							\$94

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS (IAH 2030)	1	LS	\$23,600,899	\$23,600,899
2	PUMP STATIONS (Repump GW 2040)	1	LS	\$150,000,000	\$150,000,000
PROJECT COST					\$173,600,899

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS (IAH 2030)	2.5	%	\$23,600,899	\$590,022
2	PUMP STATIONS (Repump GW 2040)	2.5	%	\$150,000,000	\$3,750,000
ANNUAL OPERATION AND MAINTENANCE COST					\$4,340,022

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the COH Repump and Groundwater Plant Improvements project was evaluated across twelve different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below. The project is not anticipated to impact agricultural land or production.

CRITERIA	RATING	EXPLANATION
Cost	5	Project increases system supply and conveyance capacity at a low additional unit cost.

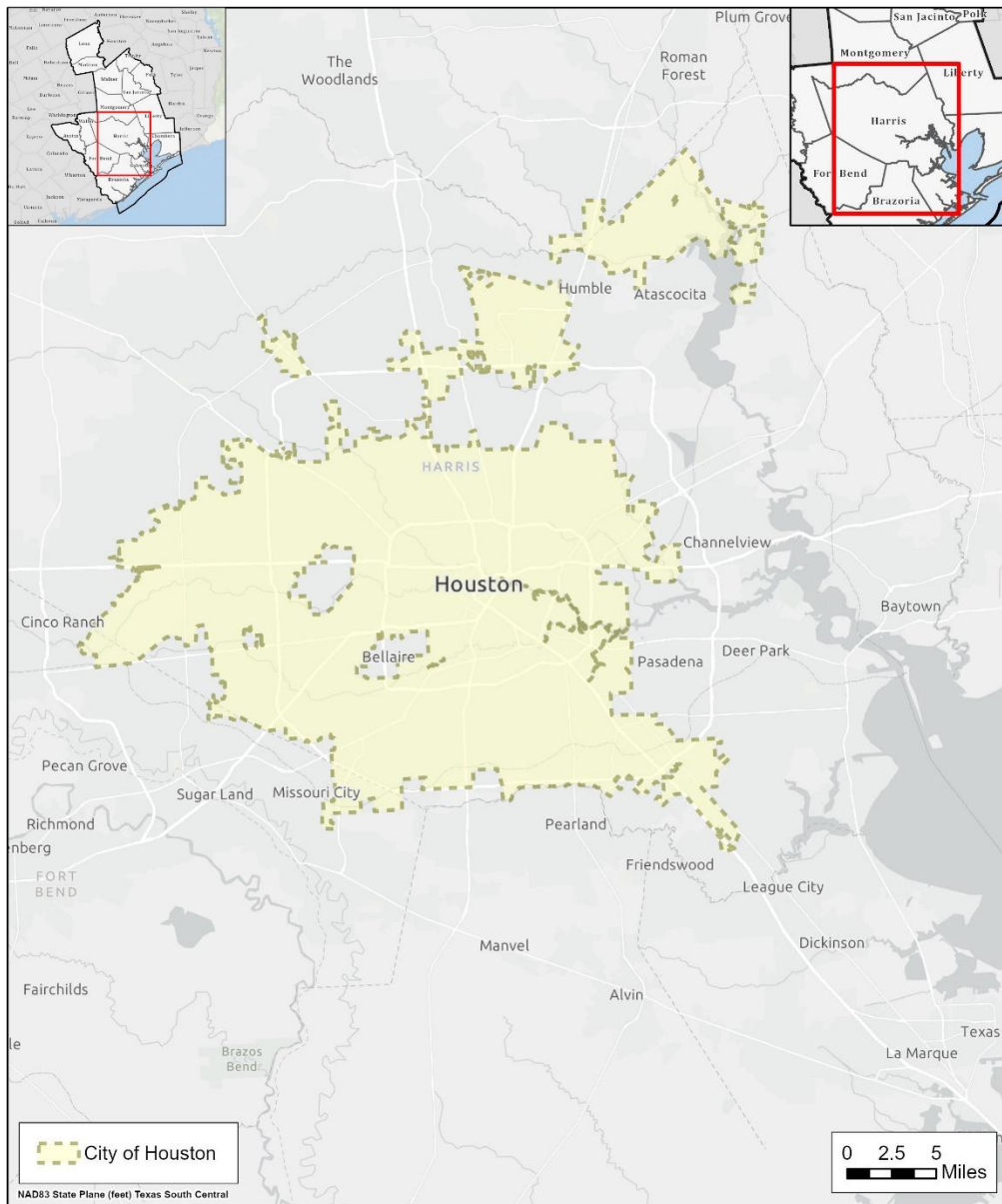
CRITERIA	RATING	EXPLANATION
Location	5	Project development would be located near points of use or in the vicinity of the City of Houston's existing water distribution system.
Water Quality		No known water quality issues.
Environmental Land and Habitat	4	Limited concerns. Environmental impacts can be avoided or mitigated as upgrades will occur at facilities already constructed.
Environmental Flows	3	Project is not anticipated to significantly impact environmental flows.
Local Preference	3	Limited opposition expected.
Institutional Constraints	3	Permits expected with minimal problems.
Development Timeline	5	Project can be developed within five years per phase.
Sponsorship	3	The project sponsor, COH, has identified the project and is engaged in concept studies.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	3	Serves primarily the sponsor and limited number of customers directly but provides indirect support and diversification to existing regional supply systems.
Impacts on Other WMS	3	Project is not expected to impact other water management strategies.

WATER USER GROUP APPLICATION

The COH Repump and Groundwater Plant Improvements project 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is positioned to provide more reliable supply at various locations around Houston.
Size	The project is sized in accordance with the needed improvements in the system which will increase deliverable supply.

CRITERIA	WUG SUITABILITY
Water Quality	Project is not anticipated to impact water quality.
Unit Cost	Project cost is low relative to a number of other projects.
Other Factors	Project increases delivery capacity and overall system reliability and supports adequate delivery and system pressures.

LOCATION MAP

**City of Houston
Repump and Groundwater
Plant Improvements
Location Map**



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Expanded Use of Groundwater
Project ID:	GWDV-006
Project Type:	Existing Groundwater Source
Potential Supply Quantity (Rounded):	Approximately 15,000 – 43,200 ac-ft/yr (13.4 – 38.6 mgd)
Implementation Decade:	2030 (varies by WUG)
Development Timeline:	<5 years
Project Capital Cost:	Varies by WUG type and projected need
Unit Water Cost (Rounded):	Varies by WUG type and projected need

STRATEGY DESCRIPTION

A number of Water User Groups (WUGs) within Region H, particularly those with limited access to other supply sources, will likely meet a portion of their projected needs by developing or expanding infrastructure to utilize available groundwater within the limits established by groundwater conservation district (GCD) and subsidence district (SD) rules or local water quality concerns.

STRATEGY ANALYSES

The project analyses for Expanded Use of Groundwater include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

SUPPLY DEVELOPMENT

The Region H Water Plan anticipates the continued use of available groundwater to meet demands, unless such use is limited by GCD or SD rules or local water quality concerns. By utilizing this supply, a number of WUGs with projected needs would be able to defer or avoid implementation of more costly and logistically difficult options. Groundwater use from the Gulf Coast, Carrizo-Wilcox, Sparta, Queen City, and Yegua-Jackson Aquifers is projected to increase in certain counties during the planning period. Due to GCD and SD regulations or low remaining groundwater availability, the Expanded Use of Groundwater project was generally not applied in Brazoria, Fort Bend, Galveston, Harris, or Montgomery Counties; there are a limited number of exceptions, which generally reflect increased production by entities exempt from regulations limiting groundwater production (portions of County-Other and other WUGs reflecting small private household wells, water for oil and gas production, etc.). For the remaining counties within Region H, remaining groundwater availability was assigned to WUGs which already utilize groundwater or have limited other options.

ENVIRONMENTAL CONSIDERATIONS

Environmental impacts of developing additional groundwater infrastructure are dependent on the project location, source aquifer, and project size. Generally, in the locations in Region H where Expanded Use of Groundwater is feasible and allowable under groundwater district and subsidence district regulations, it is not anticipated to have significant negative environmental impacts. Portions of Region H have been subject to land surface subsidence due to long-term excessive groundwater withdrawals, which should be considered when developing groundwater infrastructure in or near these areas. Groundwater within the region is generally of good quality and available at or near the point of use. Some surface disturbance is likely for construction of groundwater infrastructure but would be expected to occur primarily on previously disturbed areas. Site-specific evaluations of wildlife habitats, wetlands (including mitigation by wetlands offsets) and cultural resources must be considered in the overall development plan. There are no major springs in Region H, but well pumping supplies return flows to all river basins within the region, and ultimately to Galveston Bay. These flows will increase proportionally with the increased groundwater use.

PERMITTING AND DEVELOPMENT

Permitting requirements will vary with the location and intended use of groundwater development. In areas within the jurisdiction of a GCD or SD, projects would be required to comply with the appropriate District rules regarding permitting, registration, production, well spacing, and other factors. Some groundwater development projects may also require minor construction permitting related to surface disturbance for well field, treatment facility, and pipeline infrastructure.

COST ANALYSIS

Costs for WUGs to implement Expanded Use of Groundwater vary by WUG type and size of project. Costs for each WUG were calculated using a set of standardized assumptions by use type (Sept. 2023 equivalent cost). Agricultural wells, which are typically shallower than municipal wells and are normally used heavily for a small portion of the year, tended to have lower costs than municipal wells. Similarly, municipal and industrial wells in rural areas tended to be shallower and lower cost than wells developed in more urbanized areas. Typical capital costs estimated for agricultural groundwater development range from \$443,938 for a 100 ac-ft/yr supply to \$10,586,276 for a 6,000 ac-ft/yr supply. Estimates for municipal wells ranged from \$3,294,122 for a 100 ac-ft/yr rural supply to \$54,435,387 for an 10,000 ac-ft/yr urban supply. Representative costs for a 500 ac-ft/yr project for various user categories are shown in **Tables 1** through **3**. It should be noted that the annualized supply volume for a particular well size may vary by usage type due to differences in duty cycles and demand peaking.

Table 1 – 1,000 gpm Agricultural Well Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$715,436	\$715,436
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$250,403	\$250,403
3	LAND AND EASEMENTS	1	LS	\$592	\$592
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$31,267	\$31,267
PROJECT CAPITAL COST					\$997,698

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$70,199	\$70,199	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$7,154	\$7,154	\$7,154	\$7,154	\$7,154	\$7,154
3	PUMPING ENERGY COSTS	\$35,504	\$35,504	\$35,504	\$35,504	\$35,504	\$35,504
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$112,857	\$112,857	\$42,658	\$42,658	\$42,658	\$42,658

ITEM DESCRIPTION		ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$112,857	\$112,857	\$42,658	\$42,658	\$42,658	\$42,658
2	YIELD	500	500	500	500	500	500
3	UNIT COST	\$226	\$226	\$85	\$85	\$85	\$85
TOTAL UNIT COST		\$132					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	WELL FIELDS	1	LS	\$715,436	\$715,436
PROJECT COST					\$715,436

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	WELL FIELDS	1.0	%	\$715,436	\$7,154
ANNUAL OPERATION AND MAINTENANCE COST					\$7,154

Table 2 – 1,000 gpm Municipal (Urban) Well Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$3,633,887	\$3,633,887
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$1,251,835	\$1,251,835
3	LAND AND EASEMENTS	1	LS	\$77,412	\$77,412
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$49,499	\$49,499
5	INTEREST DURING CONSTRUCTION	1	LS	\$162,175	\$162,175
PROJECT CAPITAL COST					\$5,174,807

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$364,105	\$364,105	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$420,601	\$420,601	\$420,601	\$420,601	\$420,601	\$420,601
3	PUMPING ENERGY COSTS	\$42,010	\$42,010	\$42,010	\$42,010	\$42,010	\$42,010
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$826,716	\$826,716	\$462,611	\$462,611	\$462,611	\$462,611

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$826,716	\$826,716	\$462,611	\$462,611	\$462,611	\$462,611
2	YIELD	500	500	500	500	500	500
3	UNIT COST	\$1,653	\$1,653	\$925	\$925	\$925	\$925
TOTAL UNIT COST		\$1,168					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$400,515	\$400,515
2	WATER TREATMENT PLANTS	1	LS	\$1,200,819	\$1,200,819
3	WATER STORAGE TANKS	1	LS	\$1,128,579	\$1,128,579
4	WELL FIELDS	1	LS	\$903,974	\$903,974
PROJECT COST					\$3,633,887

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES	1.0	%	\$400,515	\$4,005
2	WATER TREATMENT PLANTS	1.0	LS	\$396,270	\$396,270
3	WATER STORAGE TANKS	1.0	%	\$1,128,579	\$11,286
4	WELL FIELDS	1.0	%	\$903,974	\$9,040
ANNUAL OPERATION AND MAINTENANCE COST					\$420,601

Table 3 – 1,000 gpm Municipal (Rural) Well Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$4,138,679	\$4,138,679
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$1,418,376	\$1,418,376
3	LAND AND EASEMENTS	1	LS	\$2,848,272	\$2,848,272
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$1,284,338	\$1,284,338
5	INTEREST DURING CONSTRUCTION	1	LS	\$313,492	\$313,492
PROJECT CAPITAL COST					\$10,003,157

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$703,833	\$703,833	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$425,649	\$425,649	\$425,649	\$425,649	\$425,649	\$425,649
3	PUMPING ENERGY COSTS	\$64,792	\$64,792	\$64,792	\$64,792	\$64,792	\$64,792
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$1,194,274	\$1,194,274	\$490,441	\$490,441	\$490,441	\$490,441

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$1,194,274	\$1,194,274	\$490,441	\$490,441	\$490,441	\$490,441
2	YIELD	500	500	500	500	500	500
3	UNIT COST	\$2,389	\$2,389	\$981	\$981	\$981	\$981
TOTAL UNIT COST		\$1,450					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$603,245	\$603,245
2	WATER TREATMENT PLANTS	1	LS	\$1,200,819	\$1,200,819
3	WATER STORAGE TANKS	1	LS	\$1,128,579	\$1,128,579
4	WELL FIELDS	1	LS	\$1,206,037	\$1,206,037
PROJECT COST					\$4,138,679

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES	1.0	%	\$603,245	\$6,032
2	WATER TREATMENT PLANTS	1.0	LS	\$396,270	\$396,270
3	WATER STORAGE TANKS	1.0	%	\$1,128,579	\$11,286
4	WELL FIELDS	1.0	%	\$1,206,037	\$12,060
ANNUAL OPERATION AND MAINTENANCE COST					\$425,649

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Expanded Use of Groundwater project was evaluated across 12 different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Costs are generally high but decline considerably after debt service. Agricultural groundwater production is less expensive than that for municipal use.

CRITERIA	RATING	EXPLANATION
Location	5	Typically located near points of use.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	4	Limited environmental impacts expected.
Environmental Flows	4	Minor increases to instream flows.
Local Preference	4	Projects typically encounter minimal opposition.
Institutional Constraints	3	Minimal permitting challenges anticipated.
Development Timeline	5	Typically <5 years.
Sponsorship	3	Level of sponsor commitment unknown for most WUGs.
Vulnerability	5	Minimal risks associated with this project.
Regionalization	1	Typically implemented at the individual water system level or for a small number of interconnected systems.
Impacts on Other Projects	3	No major impacts to other projects identified.

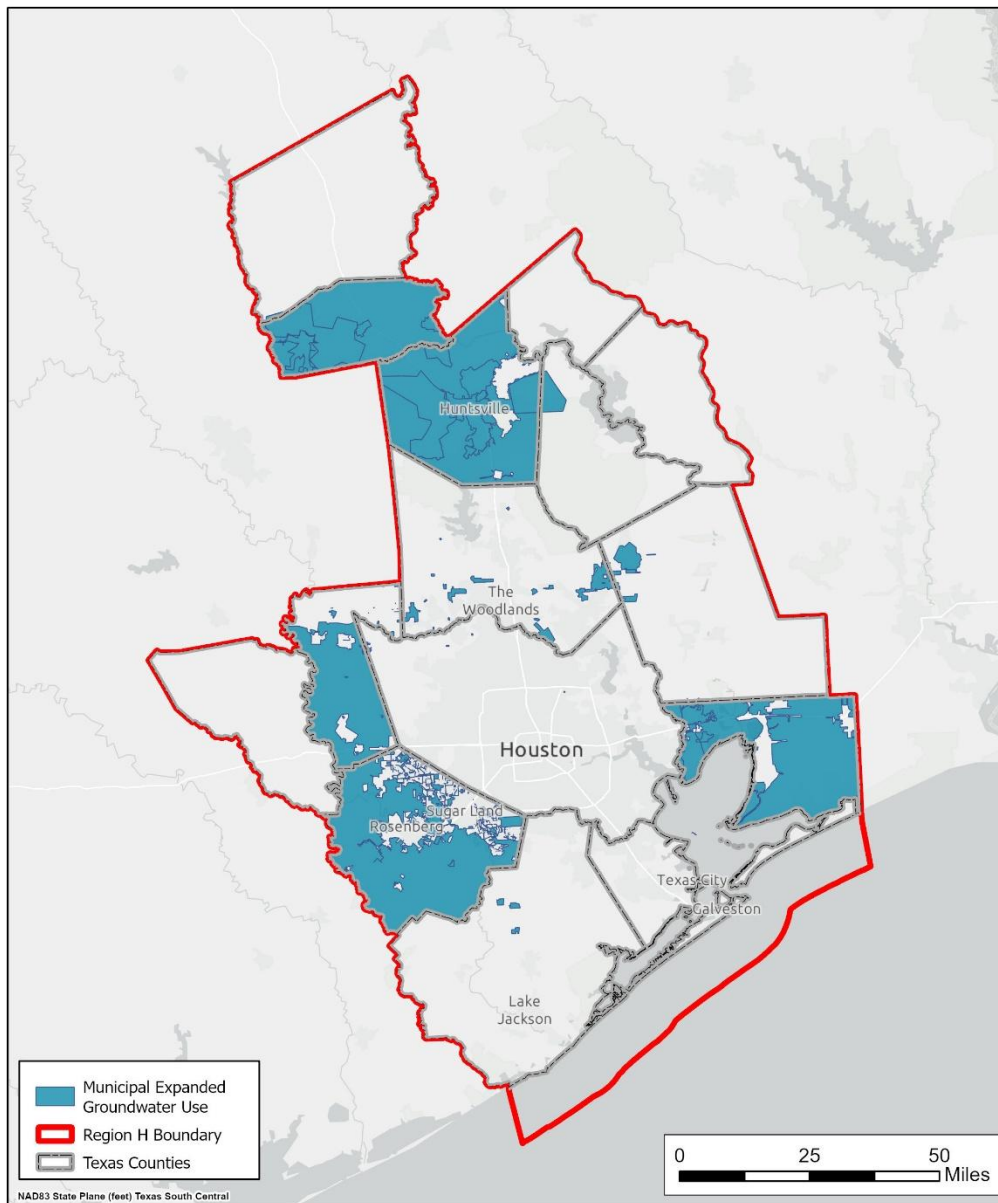
Expanded Use of Groundwater is not anticipated to affect vulnerable species and may increase return flows to streams. The projects are not anticipated to impact agricultural land or production.

WATER USER GROUP APPLICATION

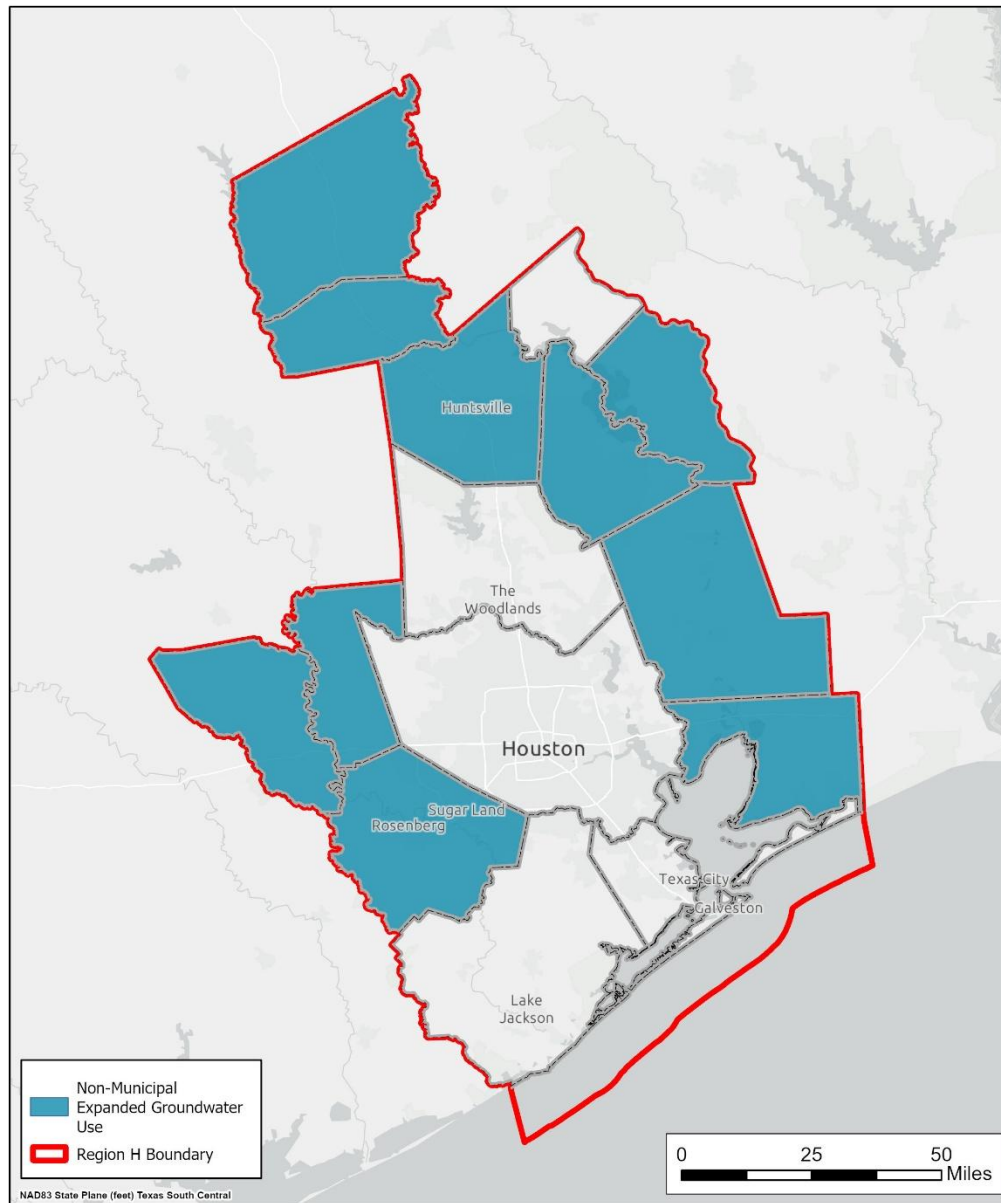
The Expanded Use of Groundwater project was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided,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

CRITERIA	WUG SUITABILITY
Proximity	Wells fields typically collocated with or near to demand centers.
Size	Projects sized for sponsoring community.
Water Quality	Typically good in most areas of Region H.
Unit Cost	Costs are generally high for municipal use and smaller projects but decline considerably after debt service.

CRITERIA	WUG SUITABILITY
Other Factors	Availability constrained by relevant local groundwater regulations.

LOCATION MAP – MUNICIPAL USE**Municipal Expanded
Use of Groundwater
Location Map**

LOCATION MAP – NON-MUNICIPAL USE



Non-Municipal Expanded Use of Groundwater Location Map



Texas

THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Fairchild's Supply Infrastructure
Project ID:	GWDV-007
Project Type:	Existing Groundwater Source
Potential Supply Quantity (Rounded):	2,128 ac-ft/yr (1.9 MGD)
Implementation Decade:	2030
Development Timeline:	<5 years
Project Capital Cost:	\$103,900,000 (Sept. 2023)
Unit Water Cost (Rounded):	\$4,298 per ac-ft (during loan period) \$862 per ac-ft (after loan period)

Strategy Description

The Village of Fairchild's is located in the south-central Fort Bend County. While historically a predominantly rural community, the village and surrounding areas have experienced recent growth as part of the rapid population expansion of Fort Bend County. In light of this growth, the Village of Fairchild's has identified the need to develop regional water treatment and wholesale transmission infrastructure to address future development within its existing boundary as well as other adjacent areas of what are currently unincorporated Fort Bend County. The project is intended to be developed in a manner which would allow for future expansion of both treatment and transmission capacity, and would support the needs of a rapidly developing area in an efficient and resilient manner.

Strategy Analyses

The project analyses for the Fairchild's Supply Infrastructure project include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The Village of Fairchild's anticipates developing regional supply infrastructure in a phased manner. The first phase, estimated for development by 2030, includes a 0.4 mgd (448 ac-ft/yr) water treatment plant and pipeline infrastructure to serve approximately 525 acres of new development. The second phase, anticipated by 2035, would add an additional 1.5 mgd (1,680 ac-ft/yr) of treatment capacity and pipeline conveyance for approximately 2,370 acres of additional future development. Initial supplies are anticipated to be sourced from local groundwater, with supplies produced within the regulatory framework established by the Fort Bend Subsidence District (FBSD).

Environmental Considerations

Development of this project may impact environmental conditions in the immediate vicinity of the well field and associated treatment and conveyance infrastructure through disturbance of habitat. Treatment and production infrastructure would likely occur in currently developed areas, reducing overall project impacts.

Permitting and Development

The development of this strategy may require some permitting due to surface disturbance from the construction of infrastructure. The groundwater well components of this project will require permitting through the FBSD.

Cost Analysis

Planning level capital cost estimates for this strategy are estimated based upon values provided by the project sponsor; for purposes of the 2026 RWP, these estimates were assumed to be inclusive of all capital cost components including engineering, land acquisition, environmental studies and mitigation, and interest during construction. Annual costs including annualized debt service, pumping energy costs, and costs of operation and maintenance were estimated using standard assumptions for Region H. Estimated costs are presented in *Table 1* and are shown in September 2023 dollars in accordance with TWDB guidance.

Table 1 – Fairchild's Supply Infrastructure Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023	
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL	
PROJECT CAPITAL COST SUMMARY						
1	FAIRCHILDS REGIONAL WATER TREATMENT AND TRANSMISSION (PHASE 1)	1	LS	\$17,400,000	\$17,400,000	
2	FAIRCHILDS REGIONAL WATER TREATMENT AND TRANSMISSION (PHASE 2)	1	LS	\$86,500,000	\$86,500,000	
PROJECT CAPITAL COST					\$103,900,000	

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (PHASE 1)	\$1,224,283	\$1,224,283	\$0	\$0	\$0	\$0
2	DEBT SERVICE (PHASE 2)	\$0	\$6,086,233	\$6,086,233	\$0	\$0	\$0
3	OPERATION AND MAINTENANCE (PHASE 1)	\$260,498	\$260,498	\$260,498	\$260,498	\$260,498	\$260,498
4	OPERATION AND MAINTENANCE (PHASE 2)	\$0	\$1,103,184	\$1,103,184	\$1,103,184	\$1,103,184	\$1,103,184
5	PUMPING ENERGY COSTS	\$10,183	\$471,222	\$471,222	\$471,222	\$471,222	\$471,222
6	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$1,494,963	\$9,145,419	\$7,921,136	\$1,834,903	\$1,834,903	\$1,834,903

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$1,494,963	\$9,145,419	\$7,921,136	\$1,834,903	\$1,834,903	\$1,834,903
2	YIELD	448	2,128	2,128	2,128	2,128	2,128
3	UNIT COST	\$3,337	\$4,298	\$3,722	\$862	\$862	\$862
TOTAL UNIT COST		\$2,170					

Water Management Strategy Evaluation

Based on the analysis provided above, the Fairchild's Supply Infrastructure project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

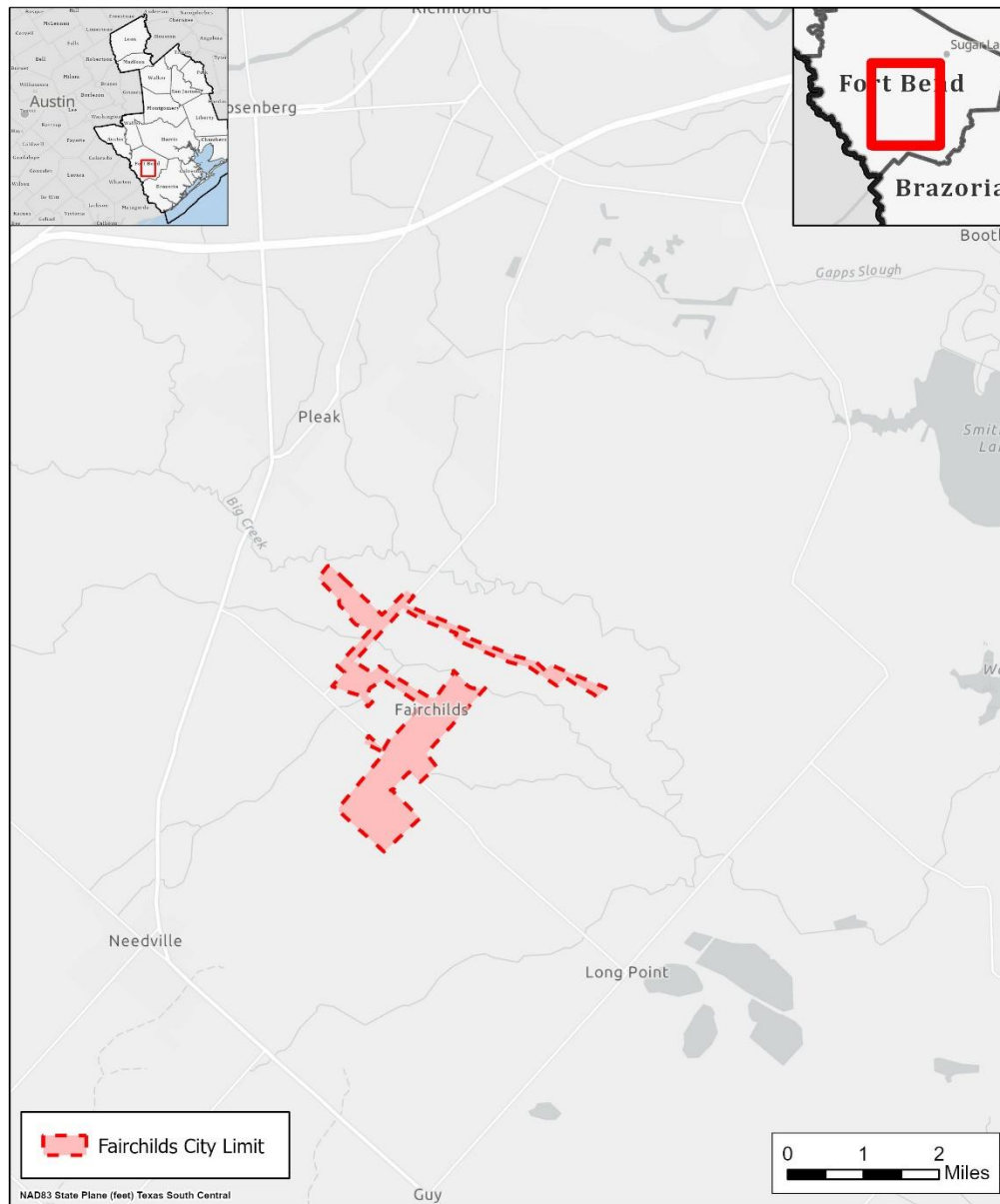
CRITERIA	RATING	EXPLANATION
Cost	1	Initial costs are high due but decrease significantly after debt service.
Location	4	Some conveyance infrastructure required to deliver supply to future development.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Limited concerns. Environmental impacts can be avoided or mitigated.
Environmental Flows	4	Minor increases to instream flows.
Local Preference	4	No known significant opposition.
Institutional Constraints	3	Minimal permitting challenges anticipated.
Development Timeline	5	Project can be developed in a relatively short period of time.
Sponsorship	4	Sponsor is actively engaged in project planning activities.
Vulnerability	4	No substantial risk from natural and man-made disasters. Potential for subsidence is limited by compliance with FBSD regulation.
Regionalization	3	Would potentially serve multiple future water systems or preclude the need for smaller separate systems through regionalization.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

Water User Group Application

The Fairchild's Supply Infrastructure project 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use.
Size	The project is sized in accordance with the treatment and conveyance infrastructure needs identified by the project sponsor.
Water Quality	Water generated by the project is anticipated to be of good quality and suitable for municipal use.
Unit Cost	Costs are relatively high during debt service, but the project provides a coordinated supply solution to a growing area with few current strategy options.
Other Factors	This project meets demands in a growing area and provides a more efficient solution through a regional facility.

Location Map



Fairchild's Supply Infrastructure Location Map



Texas

THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Gulf Coast Water Authority Groundwater Well Development
Project ID:	GWDV-008
Project Type:	Existing Groundwater Source
Potential Supply Quantity (Rounded):	Up to 35,840 ac-ft/yr (32 mgd)
Implementation Decade:	2040
Development Timeline:	<5 years
Project Capital Cost:	\$37,515,741 (Sept. 2023)
Unit Water Cost (Rounded):	\$137 per ac-ft (during loan period) \$63 per ac-ft (after loan period)

STRATEGY DESCRIPTION

Gulf Coast Water Authority (GCWA) supplies a number of industrial and agricultural customers in Brazoria and Galveston Counties with surface water from the Brazos River Basin and San Jacinto-Brazos Coastal Basin. GCWA holds several water rights in these basins and supplies its customers with surface water from these rights as well as contractual supplies purchased from the Brazos River Authority (BRA). In order to meet continually increasing customer demands, GCWA is considering developing groundwater wells to pump from the Gulf Coast Aquifer in the San Jacinto-Brazos Coastal Basin in Brazoria County to provide additional supply, as well as developing groundwater production capacity for the City of Galveston, one of GCWA's major municipal customers within the region.

STRATEGY ANALYSES

The project analyses for GCWA Groundwater Well Development include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

SUPPLY DEVELOPMENT

GCWA is investigating options for two groundwater production projects within its service area to meet the needs of current and future customers. The first, located in Brazoria County and anticipated for completion in the early 2030s, would develop up to 20 mgd (22,400 ac-ft/yr) of groundwater production capacity. It is anticipated that well field facilities would be developed in close proximity to GCWA's canal system, which provides service to multiple GCWA customers. The second project would include development of up to 12 mgd (13,440 ac-ft/yr) of groundwater production capacity on behalf of the City of Galveston, with completion in approximately 2035. Production from these City of Galveston wells would be in compliance with regulatory limits for Harris-Galveston Subsidence

District (HGSD) Area 1, which allow water systems or aggregated groups of systems to meet up to ten percent of their demand from groundwater.

It should be noted that the 32 mgd (35,840 ac-ft/yr) project supply presented in this memorandum reflects planned infrastructure capacity. Volumes shown as allocated strategy supply in the TWDB Regional Water Planning database and related summaries include additional considerations for source water availability, short term groundwater peaking, and other factors and may vary from the infrastructure capacity.

ENVIRONMENTAL CONSIDERATIONS

Development of this project may impact environmental conditions in the immediate vicinity of the well field and associated conveyance infrastructure through disturbance of habitat. Due to the nature of the project, surface disturbance is expected to be limited. Brazoria County infrastructure is anticipated to be developed in close proximity to the GCWA canal system, limiting disturbances associated with transmission development. Wells developed for the City of Galveston would be developed within an already urbanized setting, limiting construction impacts. The development of groundwater production may potentially increase the risk of subsidence and saltwater intrusion, especially for sites near the coast. Installation of subsidence monitoring equipment to track long-term trends may be required as part of permitting or developed in conjunction with Brazoria County Groundwater Conservation District (BCGCD) or the HGSD. Groundwater production developed by GCWA for the City of Galveston would be within the allowable regulatory pumping limits specified by HGSD and is therefore not currently anticipated to cause substantial subsidence impacts.

PERMITTING AND DEVELOPMENT

The groundwater well components of this project will require permitting through the BCGCD to drill and operate the planned Brazoria County wells. Additional permitting activities may be required to facilitate construction activities. Development of wells in Galveston County will require permitting through HGSD.

COST ANALYSIS

Costs were developed for the project based on the estimated cost and infrastructure capacity data provided by the project sponsor, in conjunction with standard Regional Water Planning costing procedures and assumptions. Costs for mitigation are anticipated to be minimal and were assumed to be included in the costs provided by the sponsor. Annualized debt service, pumping energy costs, and costs of operation and maintenance were estimated using standard assumptions for Region H. Costs are presented in September 2023 equivalent costs in *Table 1* for well development in Brazoria County and in *Table 2* for development in the City of Galveston.

Table 1 – GCWA Brazoria County Well Development Estimated Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$21,040,000	\$21,040,000
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$8,836,800	\$8,836,800
3	LAND AND EASEMENTS	1	LS	\$200,000	\$200,000
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$1,683,200	\$1,683,200
PROJECT CAPITAL COST					\$31,760,000

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$2,234,668	\$2,234,668	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$210,400	\$210,400	\$210,400	\$210,400	\$210,400
3	PUMPING ENERGY COSTS	\$0	\$1,408,689	\$1,408,689	\$1,408,689	\$1,408,689	\$1,408,689
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$0	\$3,853,756	\$3,853,756	\$1,619,089	\$1,619,089	\$1,619,089

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$3,853,756	\$3,853,756	\$1,619,089	\$1,619,089	\$1,619,089
2	YIELD	-	22,400	22,400	22,400	22,400	22,400
3	UNIT COST	\$0	\$172	\$172	\$72	\$72	\$72
TOTAL UNIT COST							\$112

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	WELL FIELDS	1	LS	\$21,040,000	\$21,040,000
PROJECT COST					\$21,040,000

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	WELL FIELDS	1.0	%	\$21,040,000	\$210,400
ANNUAL OPERATION AND MAINTENANCE COST					\$210,400

Table 2 – GCWA City of Galveston Well Development Estimated Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$3,085,000	\$3,085,000
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$2,313,750	\$2,313,750
3	LAND AND EASEMENTS	1	LS	\$0	\$0
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$356,991	\$356,991
PROJECT CAPITAL COST					\$5,755,741

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$404,980	\$404,980	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$30,850	\$30,850	\$30,850	\$30,850	\$30,850
3	PUMPING ENERGY COSTS	\$0	\$608,501	\$608,501	\$608,501	\$608,501	\$608,501
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$0	\$1,044,331	\$1,044,331	\$639,351	\$639,351	\$639,351

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$1,044,331	\$1,044,331	\$639,351	\$639,351	\$639,351
2	YIELD	-	13,440	13,440	13,440	13,440	13,440
3	UNIT COST	\$0	\$78	\$78	\$48	\$48	\$48
TOTAL UNIT COST							\$60

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	WELL FIELDS	1	LS	\$3,085,000	\$3,085,000
PROJECT COST					\$3,085,000

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	WELL FIELDS	1.0	%	\$3,085,000	\$30,850
ANNUAL OPERATION AND MAINTENANCE COST					\$30,850

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the GCWA Groundwater Well Development project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below. The project is not anticipated to impact agricultural land or production.

Criteria	Rating	Explanation
Cost	5	Project cost is low relative to a number of other projects.
Location	4	Project is positioned to provide water within the current GCWA customer service area.

Criteria	Rating	Explanation
Water Quality	3	No known water quality issues. Ultimate location of well field could result in production of slightly brackish water.
Environmental Land and Habitat	3	Limited concerns. Environmental impacts can be avoided or mitigated.
Environmental Flows	4	Utilization of groundwater may allow for reduced surface water diversions and increased instream flows.
Local Preference	3	Limited opposition expected.
Institutional Constraints	2	Project will require permitting with BCGCD and HGSD and may entail minor land acquisition.
Development Timeline	5	Project can be developed in a relatively short period of time.
Sponsorship	4	The project sponsor, GCWA, has identified and is pursuing the project.
Vulnerability	4	No substantial risk from natural and man-made disasters. Potential for subsidence.
Regionalization	3	Project would support the City of Galveston and multiple GCWA customers in Brazoria County.
Impacts on Other WMS	3	Project is not expected to impact other water management strategies.

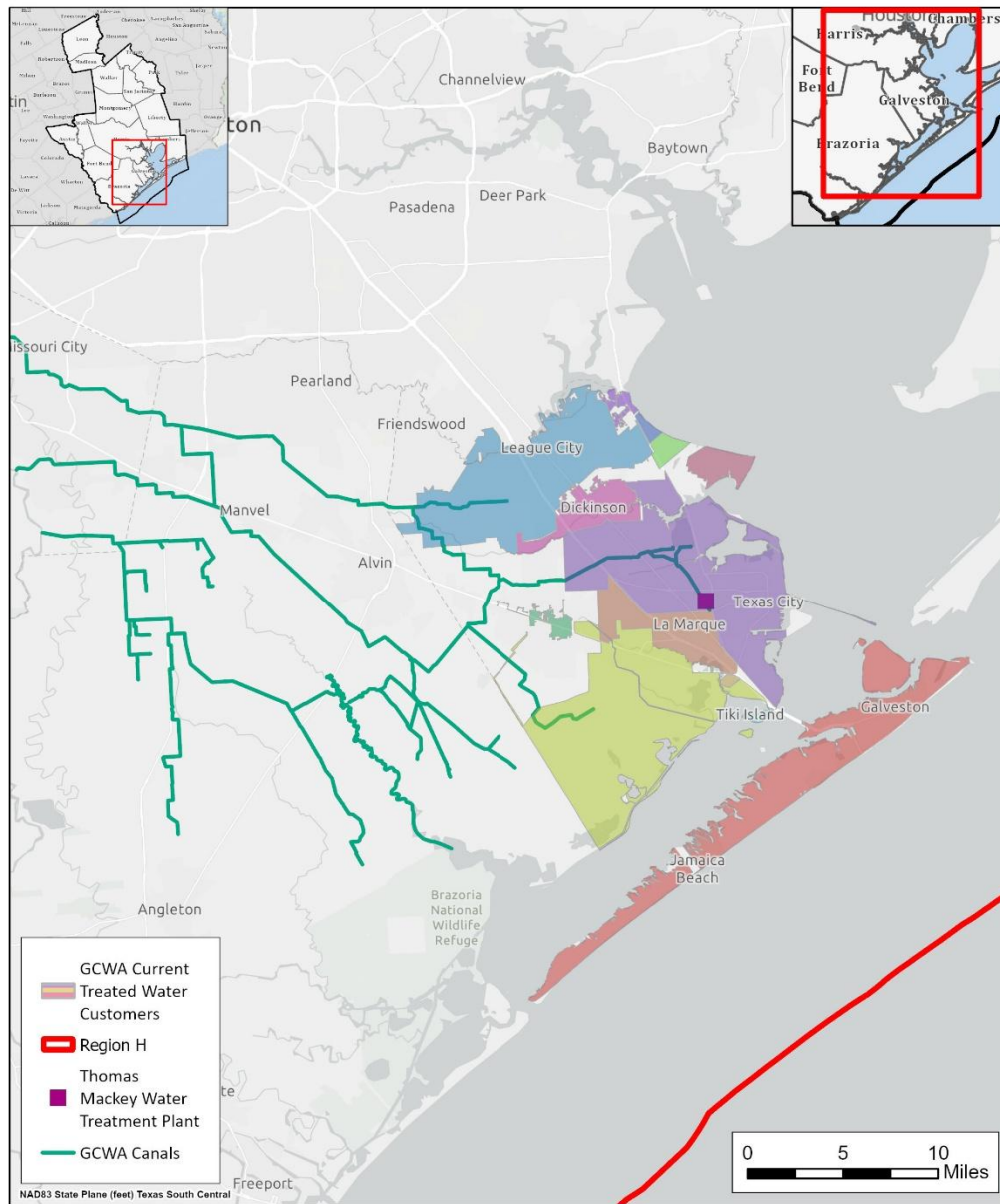
WATER USER GROUP APPLICATION

The GCWA Groundwater Well Development project 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.

Criteria	WUG Suitability
Proximity	Project is positioned to provide water within the current GCWA customer service area.
Size	The project is sized in accordance with customer needs.
Water Quality	Water quality is not expected to dramatically change the quality of existing GCWA sources it is blended with.
Unit Cost	Project cost is low relative to a number of other projects.

Criteria	WUG Suitability
Other Factors	Project supply is subject to BCGCD and GMA 14 Desired Future Conditions for the Gulf Coast Aquifer and HGSD regulation.

LOCATION MAP



GCWA Groundwater Well Development Location Map



THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	SJRA Catahoula Aquifer Supplies
Project ID:	GWDV-009
Project Type:	New Groundwater Source
Potential Supply Quantity (Rounded):	10,500 ac-ft/yr (9.4 mgd)
Implementation Decade:	2080
Development Timeline:	<5 years
Project Capital Cost:	\$22,386,712 (Sept. 2023)
Unit Water Cost (Rounded):	\$486 per ac-ft (during loan period) \$336 per ac-ft (after loan period)

Strategy Description

The San Jacinto River Authority (SJRA) is a wholesale water provider for various municipal, industrial, mining, and irrigation retail customers in the San Jacinto River Basin, including numerous customers in Montgomery County. In order to address demand growth and protect groundwater resources, SJRA has implemented surface water infrastructure to meet a portion of customer needs. Projected future demand growth in Montgomery County is anticipated to require the introduction of additional water strategy alternatives before the end of the planning horizon.

One potential alternative supply exists in the form of groundwater from the Catahoula aquifer. The Catahoula aquifer underlays and is not considered part of the Gulf Coast aquifer system which includes the Chicot, Evangeline, and Jasper layers. Water from the Catahoula aquifer has significant variations in salinity. The aquifer is currently being used by a small number of public water systems near Lake Conroe through blending with fresher sources.

Alternative sources, such as the Catahoula aquifer, may be used in conjunction with the existing Lake Conroe supply as an alternative to Gulf Coast aquifer supplies. This project considers the use of the Catahoula aquifer to provide an alternative groundwater supply for meeting Montgomery County needs.

Strategy Analyses

The project analyses for SJRA Catahoula Aquifer Supplies include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

As part of the development of the SJRA Raw Water Supply Master Plan (RWSMP, 2025), various options were considered for the development of groundwater wells in the Catahoula aquifer in Montgomery County. Some approaches to the development of this supply require implementation by SJRA customers within the county, while others require active participation by SJRA. For the

purposes of the 2026 Region H RWP, one option has been recommended based on cost-effectiveness and total yield. In the selected approach, Catahoula aquifer supplies are developed by SJRA. Groundwater pumped from the Catahoula aquifer would be conveyed through a pipeline for discharge directly into Lake Conroe, becoming blended with raw surface water prior to treatment.

Supply Development

The proposed project considers installing four wells in the Catahoula aquifer near but outside of the Sam Houston National Forest. The concentration of total dissolved solids (TDS) found in the Catahoula aquifer is lower near the Sam Houston National Forest than in other parts of the county to the south and east, so locating wells in this area is expected to minimize the impact on the water quality of the receiving body due to the discharge of Catahoula groundwater into Lake Conroe. Additionally, the depth to water is less in the vicinity of the national forest, allowing for shallower wells. It is assumed that SJRA can produce 10,500 ac-ft/yr from the Catahoula aquifer.

In order to produce the assumed available yield of 10,500 ac-ft/yr, two production wells have been sited on the east side of Lake Conroe and two wells on the west side. The wells were located in close proximity to Lake Conroe to minimize the transmission required to discharge the aquifer supplies into the lake. Given that the volumes of available groundwater are substantially less than the capacity of Lake Conroe, the rate at which Catahoula water is blended with the raw surface water was not considered to be of concern. Groundwater would be directly discharged into the lake with minimal transmission needs. An additional benefit of discharging into Lake Conroe is that this approach addresses the issue of the heat load of the Catahoula groundwater, precluding the need for cooling towers or other water quality infrastructure.

Environmental Considerations

Development of this project may impact environmental conditions in the immediate vicinity of the wells and associated conveyance infrastructure. While some surface disturbance is likely for construction of groundwater infrastructure, due to the suburbanized nature of the project area, construction impacts would be expected to occur primarily within previously disturbed areas. Use of short pipeline conveyance directly to Lake Conroe rather than more remote well development and bed-and-banks conveyance through intervening streams avoids impacts to streamflow regimes and stream water chemistry.

Permitting and Development

To develop Catahoula aquifer supplies, permits must be sought from the Lone Star Groundwater Conservation District to allow for drilling a test bore in the Catahoula formation and then to permit the production from any completed wells. A bed and banks permit from the Texas Commission on Environmental Quality (TCEQ) is needed for direct blending of Catahoula water with Lake Conroe. A Texas Pollutant Discharge Elimination System permit from TCEQ may also be required.

Due the presence of streams, wetlands and ponds that could be deemed Waters of the United States (WOTUS) and jurisdictional to Section 404 of the Clean Water Act (CWA) throughout distribution system alignments, acquiring a permit(s) through the U.S. Army Corps of Engineers (USACE) would be required prior to beginning construction activities. Pending the level of potential WOTUS impacts, project activities could likely be covered by a Nationwide Permit. Nationwide Permits are typically obtained within 45 to 60 calendar days, but acquiring an Individual Permit typically requires a

minimum of 180 calendar days and a public comment period.

If no federal funding or assistance would be used for construction of the proposed project, the need to complete a National Environmental Policy Act (NEPA) process would not be required. However, coordination with the USACE to obtain a CWA Section 404 permit, particularly an Individual Permit, could trigger the need to comply with the NEPA review process.

Cost Analysis

A preliminary planning-level cost estimate was prepared for the SJRA Catahoula Aquifer Supplies project using default costing methods for regional plan development. Estimated costs for the installation and annual operation and maintenance of four wells in the Catahoula aquifer are presented in *Table 1*.

Table 1 – SJRA Catahoula Aquifer Supplies Project Costs

OPINION OF PROBABLE CONSTRUCTION COST					September 2023	
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL	
PROJECT CAPITAL COST SUMMARY						
1	CONSTRUCTION COST	1	LS	\$15,988,985	\$15,988,985	
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$5,596,145	\$5,596,145	
3	LAND AND EASEMENTS	1	LS	\$0	\$0	
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$100,000	\$100,000	
5	INTEREST DURING CONSTRUCTION	1	LS	\$701,583	\$701,583	
PROJECT CAPITAL COST					\$22,386,712	

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$0	\$0	\$0	\$0	\$1,575,153
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$0	\$0	\$0	\$0	\$159,890
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$3,364,044
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$0	\$0	\$0	\$0	\$0	\$5,099,087

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$0	\$0	\$0	\$0	\$5,099,087
2	YIELD	-	-	-	-	-	10,500
3	UNIT COST	\$0	\$0	\$0	\$0	\$0	\$486
TOTAL UNIT COST		\$486					

Water Management Strategy Evaluation

Based on the analysis provided above, the SJRA Catahoula Aquifer Supplies project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	4	Moderately low cost compared to other new raw water projects.
Location	5	Project location places it within easy reach of prospective users.
Water Quality	2	Catahoula Aquifer supplies are of lower quality than existing surface water.
Environmental Land and Habitat	5	Minimal impacts identified from project development.
Environmental Flows	4	Project will provide a slight improvement in instream flows.
Local Preference	3	Some local support for Catahoula Aquifer projects.
Institutional Constraints	3	Obstacles to development fairly well-identified and understood.
Development Timeline	5	Short development timeline associated with wells.
Sponsorship	3	SJRA is considering this alternative for meeting future demands.
Vulnerability	3	Uncertainty of the long-term viability of the Catahoula Aquifer a risk factor involved in the project.
Regionalization	4	Supports current regionalization and potential expanded future regionalized expansion.
Impacts on Other WMS	5	Project may provide water for the Montgomery County Supply Expansion WMS.

Water User Group Application

The SJRA Catahoula Aquifer Supplies project 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is located near Lake Conroe where it may serve existing and future SJRA customers.
Size	Project is sized in accordance with estimated source availability. May be combined with other sources to meet regional needs.
Water Quality	This project provides raw water that may be treated through infrastructure planned under other WMS in order to provide water for municipal and other uses.
Unit Cost	The unit cost of the project is highly competitive with options for developing raw surface water.
Other Factors	This project reduces dependence on freshwater formations in the Gulf Coast Aquifer.

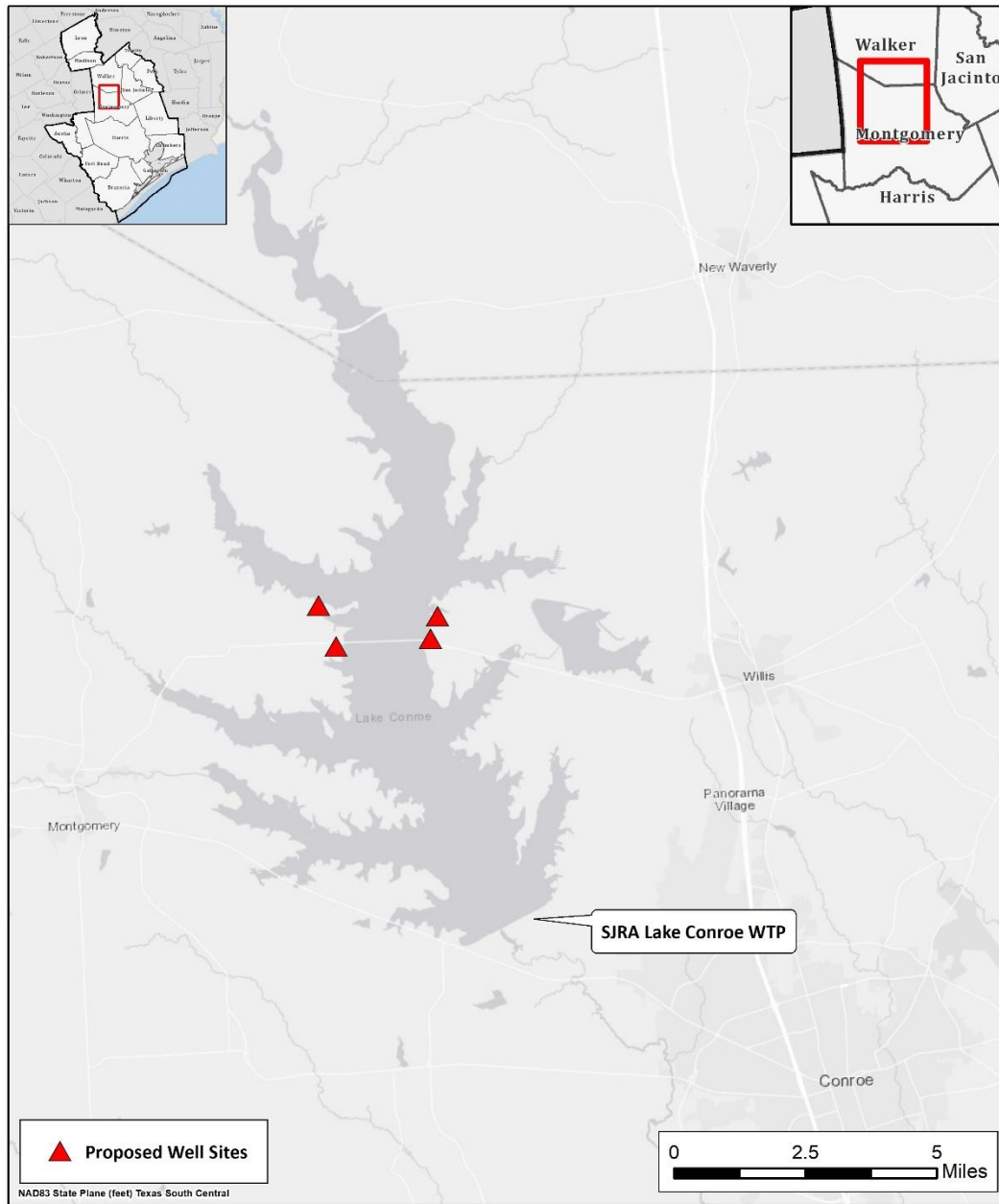
References

Freese and Nichols, Inc. 2012. *Catahoula Aquifer Evaluation*. Prepared for San Jacinto River Authority.

Freese and Nichols, Inc. 2015. *Catahoula Aquifer Phase II Feasibility Study*. Prepared for San Jacinto River Authority.

Freese and Nichols, Inc. 2025. *Raw Water Supply Master Plan*. Prepared for San Jacinto River Authority.

Location Map



SJRA Catahoula Aquifer Supplies Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Central Harris County Regional Water Authority Groundwater Reduction Plan
Project ID:	GWRP-001
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	5,466 ac-ft/yr (4.88 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	5 years
Project Capital Cost:	Included under associated infrastructure projects
Unit Water Cost (Rounded):	Included under associated infrastructure projects

Strategy Description

The Harris-Galveston Subsidence District (HGSD) has established requirements for entities within its boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the Central Harris County Regional Water Authority (CHCRWA) has contracted with the City of Houston (COH) to receive treated surface water. The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH. In order to utilize sufficient supplies to meet future surface water conversion obligations, CHCRWA is participating in multiple infrastructure projects related to the treatment and distribution of surface water.

Strategy Analyses

The project analyses for the CHCRWA Groundwater Reduction Plan (GRP) include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The CHCRWA will continue to deliver surface water to certain districts within the Authority to meet the requirements of its GRP. The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH, which is reflected in the Regional Plan as an existing supply. In order to meet future water demands and regulatory conversion obligations, the Authority has continued development and implementation of its GRP program. CHCRWA has partnered with other Regional Water Authorities

and COH in development of the Luce Bayou Interbasin Transfer Project to convey supplies from the Trinity River to Lake Houston and is also a participant in the expansion of the treatment capacity of the COH Northeast Water Purification Plant (NEWPP). The Authority has also increased its supply reservation from these facilities from an original reservation of 2.12 mgd (2,374 ac-ft/yr) currently applied in the Regional Plan as existing supply to 7.0 mgd (7,840 ac-ft/yr). CHCRWA is also developing an expansion of the infrastructure network through which it supplies its member districts.

Environmental Considerations

Any environmental impacts related to the GRP project are a factor of the associated source and infrastructure projects. Infrastructure development may result in some construction disturbance which could require mitigation. The most significant impact associated with the GRP is the source supply, which requires the interbasin transfer of surface water supplies.

Permitting and Development

The permitting and development requirements necessary for implementation of the CHCRWA GRP are associated with the source supply and infrastructure projects. CHCRWA is subject to contractual requirements established by COH as well as any relevant permitting required by the State of Texas and HGSD. Much of the permitting associated with implementation of large-scale shared infrastructure is primarily being addressed by COH.

Cost Analysis

The costs associated with developing this project are included under other infrastructure projects.

Water Management Strategy Evaluation

Based on the analysis provided above, the CHCRWA GRP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	Costs for project are related to the infrastructure projects which allow physical implementation of the GRP.
Location	3	Source supply requires an interbasin transfer of surface water and extensive conveyance infrastructure.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	3	Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.

CRITERIA	RATING	EXPLANATION
Local Preference	4	Local support. Limited opposition.
Institutional Constraints	3	Permits expected with minimal problems. Property available and some infrastructure already under development.
Development Timeline	5	Project to be developed within five years.
Sponsorship	5	Sponsors identified and project is in development.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No known significant impacts to other projects.

The CHCRWA GRP is not anticipated to affect vulnerable species and will not directly impact environmental flows. The project is not anticipated to impact agricultural land or production.

Water User Group Application

The CHCRWA GRP project 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.

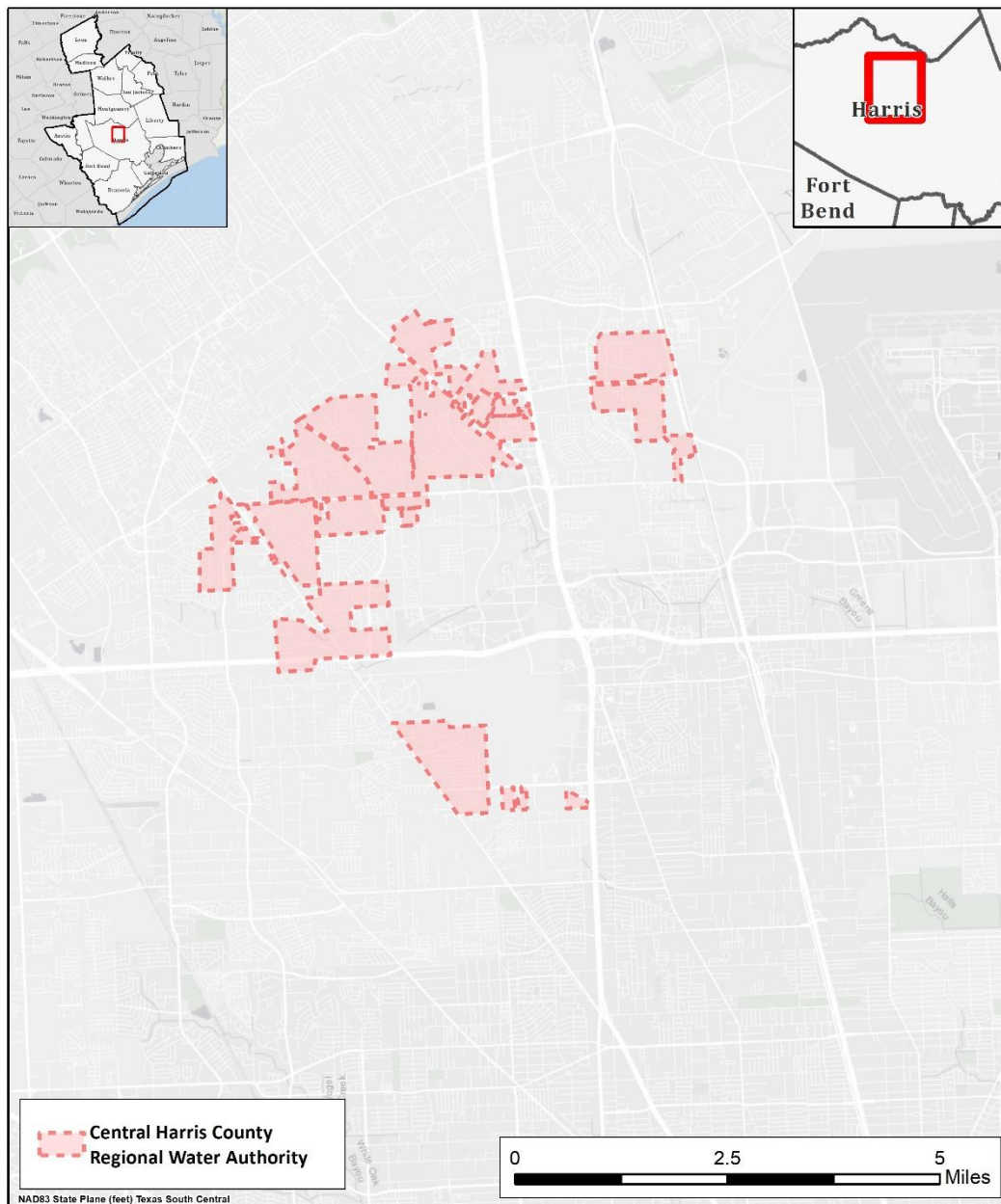
CRITERIA	WUG SUITABILITY
Proximity	Strategy is suited to serving WUGs located in the CHCRWA service area.
Size	Sized to convey the requisite amount of source water.
Water Quality	Treated water of quality appropriate for municipal use.
Unit Cost	Included under other infrastructure projects.
Other Factors	Reduces dependence on Gulf Coast Aquifer groundwater.

References

Central Harris County Regional Water Authority. *Central Harris County Water Users Consortium Ground Water Reduction Plan*, prepared by Pate Engineers, December 2003.

Harris-Galveston Subsidence District. *Harris-Galveston Subsidence District 2013 District Regulatory Plan*, May 2013.

Location Map



CHCRWA GRP Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	City of Houston Groundwater Reduction Plan
Project ID:	GWRP-002
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	60,766 ac-ft/yr (54.2 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	In progress
Project Capital Cost:	Included under associated infrastructure projects
Unit Water Cost (Rounded):	Included under associated infrastructure projects

Strategy Description

The Harris-Galveston Subsidence District (HGSD) has established requirements for entities within its boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged heavy pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the City of Houston (COH) has used its surface water rights and treatment capacity to provide an alternative to groundwater pumpage. The COH has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand. In order to utilize sufficient supplies to meet future surface water conversion obligations, COH is developing multiple infrastructure projects related to the treatment and distribution of surface water. The project also supports the City's One Water Houston approach to integrated, sustainable management of water resources.

Strategy Analyses

The project analyses for the COH Groundwater Reduction Plan (GRP) include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The COH has developed significant infrastructure for the development, treatment, and delivery of surface water supplies. These projects have formed the fundamental basis for much of the region's conversion from groundwater to alternative water sources. In several cases, such as the regional water authorities, COH supplies are already used as an alternative source of water and will continue to be a critical resource in the future.

In addition to providing water to regional authorities for their GRPs, COH maintains compliance with

HGSD rules through its own use of surface water supplies within the City’s retail water service area. COH has also made an opportunity available for other water users to join the COH GRP to promote synergy in addressing the region’s water supply issues. A total of six participants reside within HGSD Areas I and II. Another 89 participants are located in HGSD Area III. Of these total participants, 45 can be identified as named Water User Groups (WUGs) in the Region H Regional Water Plan (RWP).

In most cases, COH does not provide direct surface water supplies to these participants. Instead, COH provides its own over-conversion as a service to these participants to account for their pumpage of groundwater, causing a net reduction in overall groundwater use. In effect, the requirement for groundwater conversion is met jointly across the GRP as is done by other GRP sponsors in the region.

Environmental Considerations

Any environmental impacts related to the GRP strategy are a factor of the associated source and infrastructure projects. Infrastructure development may result in some construction disturbance which could require mitigation. The most significant impact associated with the GRP is the source supply, which requires the interbasin transfer of surface water supplies.

Permitting and Development

The permitting and development requirements necessary for implementation of the COH GRP are associated with the source supply and infrastructure projects. The permitting associated with implementation of infrastructure, such as the Northeast Water Purification Plant Expansion, is primarily addressed under specific projects in the RWP.

Cost Analysis

The costs associated with developing this project are included under other infrastructure projects.

Water Management Strategy Evaluation

Based on the analysis provided above, the COH GRP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	Costs for project are related to the infrastructure projects which allow physical implementation of the GRP.
Location	3	Source supply requires an interbasin transfer of surface water and extensive conveyance infrastructure.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.

CRITERIA	RATING	EXPLANATION
Environmental Flows	3	Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.
Local Preference	5	Widespread support for project.
Institutional Constraints	3	Permits expected with minimal problems. Property available.
Development Timeline	5	Project ongoing along with development of additional surface water infrastructure projects.
Sponsorship	5	Sponsor identified and project is in development.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No known significant impacts to other projects.

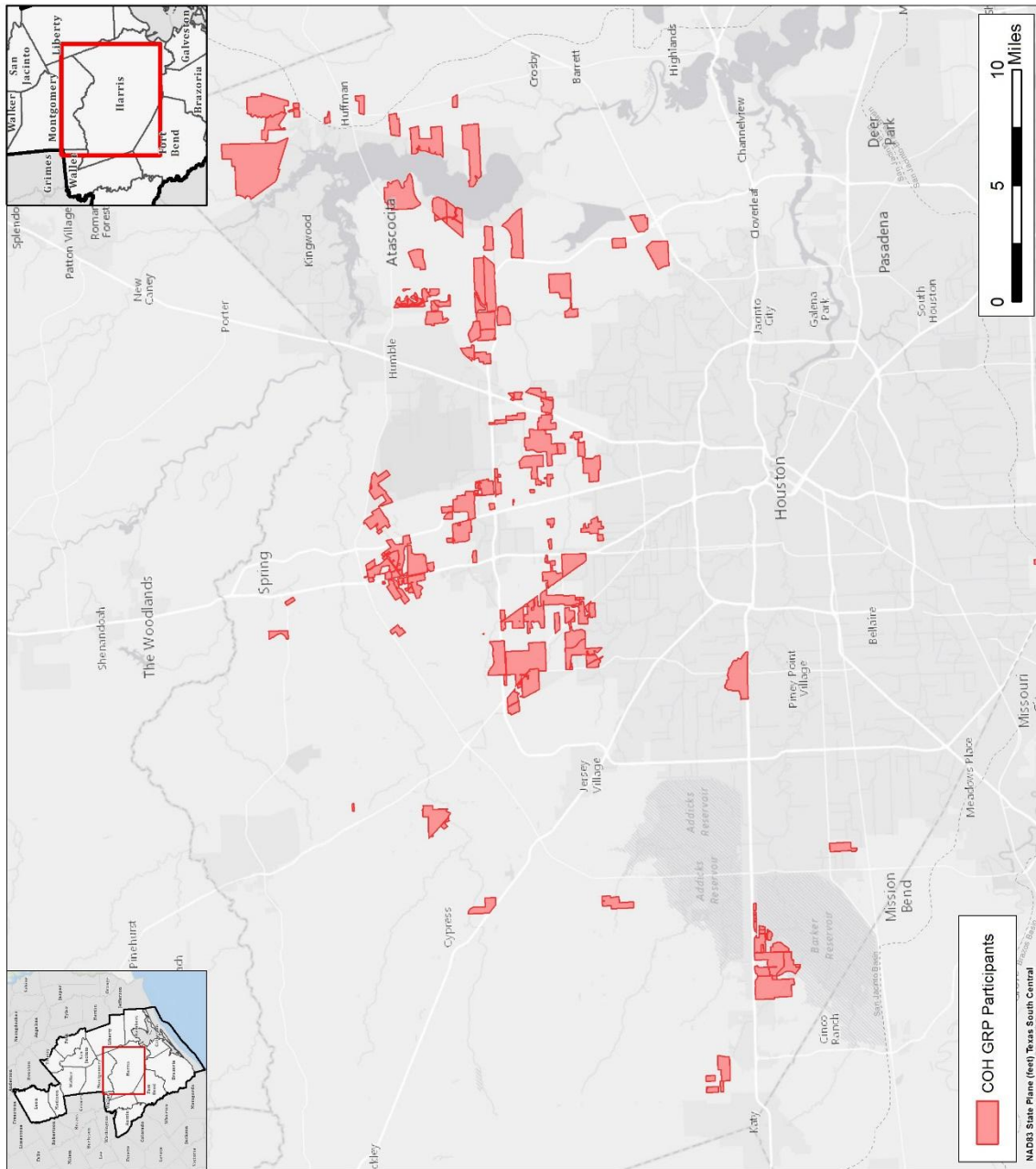
The COH GRP is not anticipated to affect acreage or vulnerable species and will not directly impact environmental flows. The project is not anticipated to impact agricultural land or production.

Water User Group Application

The COH GRP project 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.

CRITERIA	WUG SUITABILITY
Proximity	Requires conveyance infrastructure from source basin pipelines to demand centers.
Size	Sized to provide the requisite amount of source water.
Water Quality	Treated water of quality appropriate for municipal use.
Unit Cost	Included under other infrastructure projects.
Other Factors	Facilitates HGSD groundwater reduction compliance for multiple entities.

Location Map



City of Houston GRP Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	City of Missouri City Groundwater Reduction Plan
Project ID:	GWRP-003
Project Type:	Various
Potential Supply Quantity (Rounded):	11,200 ac-ft/yr (10 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	5 years
Project Capital Cost:	\$80,962,225 (Sept. 2023)
Unit Water Cost (Rounded):	\$761 per ac-ft (during loan period) \$253 per ac-ft (after loan period)

Strategy Description

The Fort Bend Subsidence District (FBSD) and Harris-Galveston Subsidence District (HGSD), in order to address the issue of land surface subsidence due to groundwater use within the counties under their jurisdiction, have enacted regulations limiting the percentage of overall supply that water users in certain portions of the county may produce from the Gulf Coast Aquifer. In order to meet this requirement, the City of Missouri City has developed a Groundwater Reduction Plan (GRP) to reduce groundwater use by implementing phased surface water conversion and direct reuse.

Strategy Analyses

The project analyses for the City of Missouri City GRP include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The City of Missouri City has partnered with 29 surrounding entities for purposes of meeting the required groundwater reduction. The primary approach for meeting the required reduction is phased conversion to surface water, with additional direct reuse supplies contributing as well. Due to the physical and logistic challenges associated with converting all participants to partial surface water supply, the GRP specifies overconversion of a portion of the Missouri City service area, allowing other co-participants to continue growth on groundwater while allowing the aggregate water use of partnering entities to meet FBSD and HGSD requirements.

The City of Missouri City has contracted with the Gulf Coast Water Authority (GCWA) for 20 mgd (22,400 ac-ft) of raw surface water supply conveyed through GCWA's canal system as well as additional option water. The 20 mgd surface water treatment facility and associated transmission infrastructure identified by the GRP for meeting the initial phase of conversion has been constructed

and is operational; this portion of Missouri City's surface water supply is reflected as an existing supply in the Regional Plan. Expanded transmission capacity to the Mustang Bayou area to support surface water conversion is anticipated to be active prior to 2030. Additional treatment capacity (potentially up to a total facility capacity of 30 mgd) is anticipated by approximately 2030. The City of Missouri City and its GRP co-participants have also developed direct reuse infrastructure, with additional utilization of this source anticipated to increase total reuse to between 3 and 4 mgd in the near future.

Environmental Considerations

One impact associated with the implementation of this project is the increase in GCWA diversions from the Brazos River. Increased diversion of water from the Brazos River will result in some decreases in instream flow downstream of the GCWA pump stations. However, these diversions will be made from existing water rights currently owned by the GCWA, contracted by the City of Missouri City, and no new water rights permits are required for this project. Otherwise, implementation of this project should produce minimal environmental impacts.

The direct reuse of the effluent source supply would be expected to have some degree of impact in terms of reduction of instream flows downstream of the wastewater treatment plant discharge point for any portion of the source supply originating from current levels of return flow. Any reuse from the portion of return flow generated from future demand growth would not be expected to create additional instream flow reductions, as this portion of potential supply is not yet generated or discharged.

Permitting and Development

Because the surface water supply source for this project is from existing water rights and would be delivered through GCWA's canal system, permitting of new surface water rights or modification of existing rights to add a diversion point will not be required. Construction of surface water treatment facility expansions will be required to utilize portions of the source supply, which may entail minor permitting for development of treatment facilities or conveyance.

Development of reuse supplies would require infrastructure development and, if in amounts exceeding current authorizations, permitting through TCEQ. Use of reclaimed wastewater effluent requires approval and permitting by the TCEQ under the requirements of 30 TAC §210. TCEQ classifies reclaimed water as Type 1 (higher quality for use where public contact is likely) or Type 2 (for uses with limited risk of human contact). Due to the potential for human contact, supplies for this project would have to be treated to Type 1 quality standards. If approved for use, the reclaimed water would have to be sampled and analyzed a minimum of twice per week.

Cost Analysis

Capital costs for future infrastructure phases of surface water treatment were estimated using standard regional planning costing assumptions for an estimated ultimate treatment capacity of up to 30 mgd (a 10 mgd expansion) as indicated in the GRP. It was assumed for the Regional Plan that increased reuse development would be within the capability of existing infrastructure or facilities currently under development. It was also assumed that development of direct reuse infrastructure would not require land or easement purchase or development of new transmission capacity. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow

increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs are presented in *Table 1*.

Table 1 – City of Missouri City GRP Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$53,553,649	\$53,553,649
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$17,976,927	\$17,976,927
3	LAND AND EASEMENTS	1	LS	\$1,669,450	\$1,669,450
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$3,419,585	\$3,419,585
5	INTEREST DURING CONSTRUCTION	1	LS	\$4,342,614	\$4,342,614
PROJECT CAPITAL COST					\$80,962,225

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$1,556,871	\$5,696,589	\$4,139,719	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$153,370	\$2,828,535	\$2,828,535	\$2,828,535	\$2,828,535	\$2,828,535
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$1,710,241	\$8,525,125	\$6,968,254	\$2,828,535	\$2,828,535	\$2,828,535

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$1,710,241	\$8,525,125	\$6,968,254	\$2,828,535	\$2,828,535	\$2,828,535
2	YIELD	6,720	11,200	11,200	11,200	11,200	11,200
3	UNIT COST	\$255	\$761	\$622	\$253	\$253	\$253
TOTAL UNIT COST		\$410					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES (BEFORE 2030)	1	LS	\$15,337,000	\$15,337,000
2	WATER TREATMENT PLANTS (EARLY 2030s)	1	LS	\$38,216,649	\$38,216,649
PROJECT COST					\$53,553,649

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES (BEFORE 2030)	1.0	%	\$15,337,000	\$153,370
2	WATER TREATMENT PLANTS (EARLY 2030s)	1.0	LS	\$2,675,165	\$2,675,165
ANNUAL OPERATION AND MAINTENANCE COST					\$2,828,535

Water Management Strategy Evaluation

Based on the analysis provided above, the City of Missouri City GRP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	3	Cost is moderate and decreases significantly after debt service.
Location	4	Some additional transmission infrastructure may be required.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	4	Minimal impacts anticipated.
Environmental Flows	2	Some decrease in environmental flows below diversion point. Diversion is from an existing water right.
Local Preference	4	No known opposition.
Institutional Constraints	3	Minimal permitting challenges or opposition expected.
Development Timeline	5	Project development, including permitting, could be accomplished in approximately five years or less.
Sponsorship	4	Sponsor has identified project and is committed to meeting conversion requirements.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

The City of Missouri City GRP includes construction of additional surface water treatment capacity as well as conveyance. The majority of this impact will be in urbanized areas with limited impacts to habitat. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The City of Missouri City GRP project 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use.
Size	Project is of appropriate size to utilize the City of Missouri City's surface water contracts.
Water Quality	This project is expected to provide water of acceptable quality.
Unit Cost	The cost of this project is relatively low.
Other Factors	This project reduces groundwater dependence.

References

Water Resources Management, LP. *City of Missouri City Joint Groundwater Reduction Plan*, prepared for City of Missouri City, October 2008.

Fort Bend Subsidence District. *Fort Bend Subsidence District 2013 Regulatory Plan*, August 2013.

Harris-Galveston Subsidence District. *Harris-Galveston Subsidence District 2013 District Regulatory Plan*, May 2013.

The map displays the Missouri City Water Treatment Plant (WTP) area, highlighted by a red triangle. The WTP is located near the intersection of the San Jacinto River and the Missouri City Canal. The map shows the Sugar Land area to the north and the Missouri City area to the south. The San Jacinto River is shown flowing through the area, with several canals branching off. The map includes a legend in the bottom left corner indicating the Missouri City WTP and GCWA Canals. A scale bar in the bottom right corner shows distances from 0 to 5 miles. An inset map in the top right corner shows the location of the study area within the state of Texas, with a red box highlighting the region around Houston.



Missouri City Groundwater Reduction Plan Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	City of Richmond Groundwater Reduction Plan
Project ID:	GWRP-004
Project Type:	Various
Potential Supply Quantity (Rounded):	6,720 ac-ft/yr (6 mgd)
Implementation Decade:	2030 (2028)
Development Timeline:	2 – 5 years
Project Capital Cost:	\$85,626,919 (Sept. 2023)
Unit Water Cost (Rounded):	\$1,252 per ac-ft (during loan period) \$355 per ac-ft (after loan period)

Strategy Description

The Fort Bend Subsidence District (FBSD) has established requirements for entities within its boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the City of Richmond has developed a Groundwater Reduction Plan (GRP) to reduce ground water use by implementing phased surface water conversion and direct reuse.

Strategy Analyses

The project analyses for the City of Richmond GRP include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The City of Richmond has partnered with 15 surrounding entities for purposes of meeting the required groundwater reduction. The primary approach for meeting the required reduction is phased conversion to surface water, with additional direct reuse supplies contributing as well. Due to the physical and logistic challenges associated with converting all participants to partial surface water supply, the GRP specifies over-conversion of a portion of the Richmond service area, allowing other co-participants to continue growth on groundwater while allowing the aggregate water use of partnering entities to meet FBSD requirements.

The City of Richmond has contracted with the Brazos River Authority (BRA) for 5,705 ac-ft/yr of raw surface water supply conveyed through the Brazos River. The initial 2 mgd surface water treatment facility and associated transmission infrastructure identified by the GRP has been constructed and is

operational; this portion of Richmond’s surface water supply is reflected as an existing supply in the Regional Plan. The GRP indicates that an additional 4 mgd in surface water treatment capacity and additional transmission infrastructure will be required by 2028, as well as a new 2 mgd groundwater disinfection plant to serve potential future GRP participants that will continue to grow on groundwater.

Environmental Considerations

One impact associated with the implementation of this project is the increase in diversions from the Brazos River. Increased diversion of water from the Brazos River will result in some minimal decreases in instream flow downstream of the City of Richmond diversion point. However, these diversions will be made from existing water rights currently owned by the BRA, contracted by Richmond, and no new water rights permits are required for this project. Some surface disturbance may be associated with development of expanded water plant facilities and transmission infrastructure. However, this construction would occur primarily on existing plant sites or in previously urbanized area and would cause little disturbance to undeveloped habitat. Some land disturbance may be associated with the construction of a new groundwater treatment plant in the eastern portion of Richmond’s extraterritorial jurisdiction.

Permitting and Development

Because the surface water supply source for this project is from existing water rights and would be delivered through the bed and banks of the Brazos River to an authorized take point, permitting of new surface water rights or modification of existing rights to add a diversion point will not be required. Construction of surface water treatment facility and distribution system expansions will be required to utilize portions of the source supply, which may entail minor permitting.

Cost Analysis

Capital and engineering costs for the projects associated with the City of Richmond GRP were summarized in the GRP and explained in detail in Appendix B of the Integrated Utility Master Plan and Financial Plan (2019). Costs associated with land acquisition, easements, environmental studies and mitigation, and interest during construction were not identified as part of this analysis; for purposes of the regional plan these components of capital cost were estimated using standard regional planning assumptions. Sponsor-provided costs were originally provided in 2023 dollars. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Total estimated costs for all project phases are presented in *Table 1*.

Table 1 – Richmond Groundwater Reduction Plan Project Costs

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$38,858,463	\$38,858,463
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$29,875,383	\$29,875,383
3	LAND AND EASEMENTS	1	LS	\$2,302,784	\$2,302,784
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$5,099,129	\$5,099,129
5	INTEREST DURING CONSTRUCTION	1	LS	\$9,491,161	\$9,491,161
PROJECT CAPITAL COST					\$85,626,919

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$6,024,802	\$6,024,802	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$2,129,095	\$2,129,095	\$2,129,095	\$2,129,095	\$2,129,095	\$2,129,095
3	PUMPING ENERGY COSTS	\$259,603	\$259,603	\$259,603	\$259,603	\$259,603	\$259,603
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$8,413,501	\$8,413,501	\$2,388,698	\$2,388,698	\$2,388,698	\$2,388,698

ITEM DESCRIPTION		ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$8,413,500	\$8,413,500	\$2,388,699	\$2,388,699	\$2,388,699	\$2,388,699
2	YIELD	6,720	6,720	6,720	6,720	6,720	6,720
3	UNIT COST	\$1,252	\$1,252	\$355	\$355	\$355	\$355
TOTAL UNIT COST		\$654					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$9,597,586	\$9,597,586
1	WATER TREATMENT PLANTS	1	LS	\$20,716,947	\$20,716,947
1	WATER STORAGE TANKS	1	LS	\$2,583,582	\$2,583,582
1	GROUNDWATER PLANT	1	LS	\$5,960,348	\$5,960,348
PROJECT COST					\$38,858,463

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS (INCLUDED IN SWTP)	2.5	%	\$3,580,796	\$89,520
1	PIPELINES	1.0	%	\$9,673,266	\$96,733
1	WATER TREATMENT PLANTS	1.0	LS	\$1,886,004	\$1,886,004
1	WATER STORAGE TANKS	1.0	%	\$2,583,582	\$25,836
1	OFF-CHANNEL RESERVOIRS	1.5	%	\$905,461	\$13,582
1	WELL FIELDS	1.0	%	\$1,742,107	\$17,421
ANNUAL OPERATION AND MAINTENANCE COST					\$2,129,095

Water Management Strategy Evaluation

Based on the analysis provided above, the City of Richmond GRP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Cost is high but decreases after completion of debt service.
Location	4	Some transmission infrastructure required.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	4	Minimal impacts anticipated.
Environmental Flows	2	Some decrease in environmental flows below diversion point. Diversion is from an existing water right.
Local Preference	4	No known opposition.
Institutional Constraints	3	Minimal permitting challenges or opposition expected.
Development Timeline	5	Project development, including permitting, could be accomplished in approximately five years or less.
Sponsorship	5	Sponsor has identified project and is in development.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

The City of Richmond GRP is not anticipated to affect vulnerable species or agricultural land or production. Implementation of the project may result in some minimal decreases in instream flow, but these diversions will be made from existing water rights.

Water User Group Application

The City of Richmond GRP project 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use.
Size	Project is of appropriate size to utilize the City of Richmond’s surface water contracts.
Water Quality	This project is expected to provide water of acceptable quality.
Unit Cost	The cost of this project is high but decreases after completion of debt service.
Other Factors	This project reduces groundwater dependence.

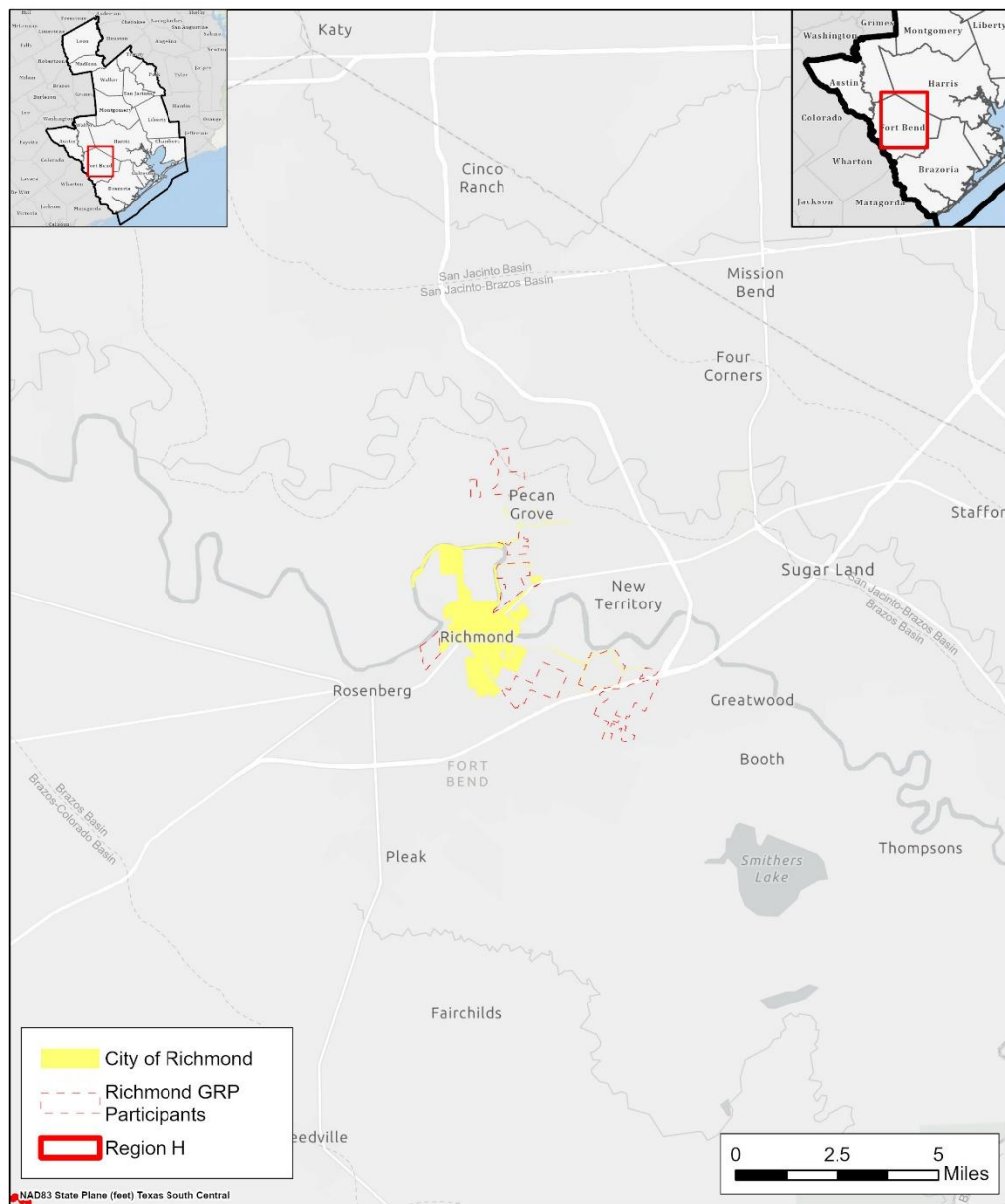
References

City of Richmond, TX. City of Richmond Groundwater Reduction Plan 2019 Update, August 2019.

City of Richmond, TX. City of Richmond Integrated Utility Master Plan & Financial Plan, March 2019.

Fort Bend Subsidence District. Fort Bend Subsidence District 2013 Regulatory Plan, August 2013.

Location Map



City of Richmond Groundwater Reduction Plan Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	City of Rosenberg Groundwater Reduction Plan
Project ID:	GWRP-005
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	3,920 ac-ft/yr (3.5 mgd)
Implementation Decade:	2030 (2027)
Development Timeline:	5 years
Project Capital Cost:	\$17,081,984 (Sept. 2023)
Unit Water Cost (Rounded):	\$344 per ac-ft (during loan period) \$37 per ac-ft (after loan period)

Strategy Description

The Fort Bend Subsidence District (FBSD), in order to address the issue of land surface subsidence due to groundwater use within Fort Bend County, has enacted regulations limiting the percentage of overall supply that water users in certain portions of the county may produce from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet this requirement, the City of Rosenberg has developed a Groundwater Reduction Plan (GRP) to reduce groundwater use by implementing surface water conversion.

Strategy Analyses

The project analyses for the City of Rosenberg GRP include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The City of Rosenberg has partnered with five surrounding entities for purposes of meeting the required groundwater reduction for the participating entities and their water supply customers. The primary approach for meeting the required reduction is phased conversion to surface water. Due to the physical and logistic challenges associated with converting all participants to partial surface water supply, the GRP specifies overconversion of some co-participants, allowing other co-participants to continue growth on groundwater while ensuring that the aggregate water use of partnering entities meets FBSD requirements. Rosenberg receives treated surface water from a 5.7-mgd contract with the Brazosport Water Authority (BWA), which is treated at the BWA facility in Lake Jackson and is conveyed via pipeline to the GRP participants' service area. The City of Rosenberg has also contracted with the Brazos River Authority (BRA) for 4,500 ac-ft/yr of raw surface water supply which could be

treated through current and future BWA facilities and conveyed to Rosenberg. The City of Rosenberg has developed expanded transmission infrastructure sufficient to meet its initial conversion goal of 3 mgd (3,360 ac-ft/yr) of surface water. Additional transmission and distribution infrastructure will be required for the 2027 conversion phase to increase surface water supplies by 3.5 mgd (3,920 ac-ft/yr); these expansions are reflected in the Regional Plan as conversion of additional demands within the City of Rosenberg and partnering entities supplied by the City's water system.

Environmental Considerations

One impact associated with the implementation of this project is the increase in diversions from the Brazos River. Increased diversion of water from the Brazos River will result in some decreases in instream flow downstream of the diversion point. However, these diversions will be made from existing water rights currently owned by BWA or BRA, contracted by Rosenberg, and no new water rights permits are required for this project. Some surface disturbance may be associated with development of expanded water plant facilities and transmission infrastructure. However, this construction would occur primarily on existing plant sites or in previously urbanized areas and would cause little disturbance to undeveloped habitat.

Permitting and Development

The surface water supply source for this project is from existing water rights. Expansion of the BWA treatment water treatment facility and distribution system expansions will be required to utilize portions of the source supply, which may entail minor permitting.

Cost Analysis

Capital and engineering costs for future expansion of transmission capacity are summarized in the City of Rosenberg GRP. Capital costs associated with land acquisition, environmental studies, and mitigation are not identified as separate items in the GRP and are assumed to be included in the capital cost specified. Interest during construction and annualized costs (debt service, operations and maintenance, and energy) are not identified in the GRP and were estimated using standard Regional Planning costing reference data. Capital costs were scaled to a September 2023 equivalent cost using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. The costs presented in this memorandum do not include the purchase cost of water. Water treatment costs are covered separately under the RWP analysis for expansion of BWA treatment facilities. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs for the City of Rosenberg GRP are presented in *Table 1*.

Table 1 – City of Rosenberg GRP Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$12,150,000	\$12,150,000
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$3,872,500	\$3,872,500
3	LAND AND EASEMENTS	1	LS	\$0	\$0
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$1,059,484	\$1,059,484
PROJECT CAPITAL COST					\$17,081,984

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$1,201,907	\$1,201,907	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$144,900	\$144,900	\$144,900	\$144,900	\$144,900	\$144,900
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$1,346,807	\$1,346,807	\$144,900	\$144,900	\$144,900	\$144,900

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$1,346,807	\$1,346,807	\$144,900	\$144,900	\$144,900	\$144,900
2	YIELD	3,920	3,920	3,920	3,920	3,920	3,920
3	UNIT COST	\$344	\$344	\$37	\$37	\$37	\$37
TOTAL UNIT COST		\$139					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$1,560,000	\$1,560,000
2	PIPELINES	1	LS	\$7,600,000	\$7,600,000
3	WATER STORAGE TANKS	1	LS	\$2,990,000	\$2,990,000
PROJECT COST					\$12,150,000

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$1,560,000	\$39,000
2	PIPELINES	1.0	%	\$7,600,000	\$76,000
3	WATER STORAGE TANKS	1.0	%	\$2,990,000	\$29,900
ANNUAL OPERATION AND MAINTENANCE COST					\$144,900

Water Management Strategy Evaluation

Based on the analysis provided above, the City of Rosenberg GRP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	4	Project expands delivery capacity at a relatively low cost.
Location	3	Substantial existing transmission infrastructure required from treatment location to point of use.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Limited impacts anticipated.
Environmental Flows	2	Some decrease in environmental flows below diversion point. Diversion is from an existing water right.
Local Preference	4	No known opposition.
Institutional Constraints	3	Minimal permitting challenges or opposition expected.
Development Timeline	5	Project development, including permitting, could be accomplished in approximately five years or less.
Sponsorship	5	Sponsor has identified project and is in development.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

The City of Rosenberg GRP includes minor additional pipeline construction for subsequent phases of conversion. The majority of this impact will be in developed areas with limited impacts to habitat. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The Rosenberg GRP project 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.

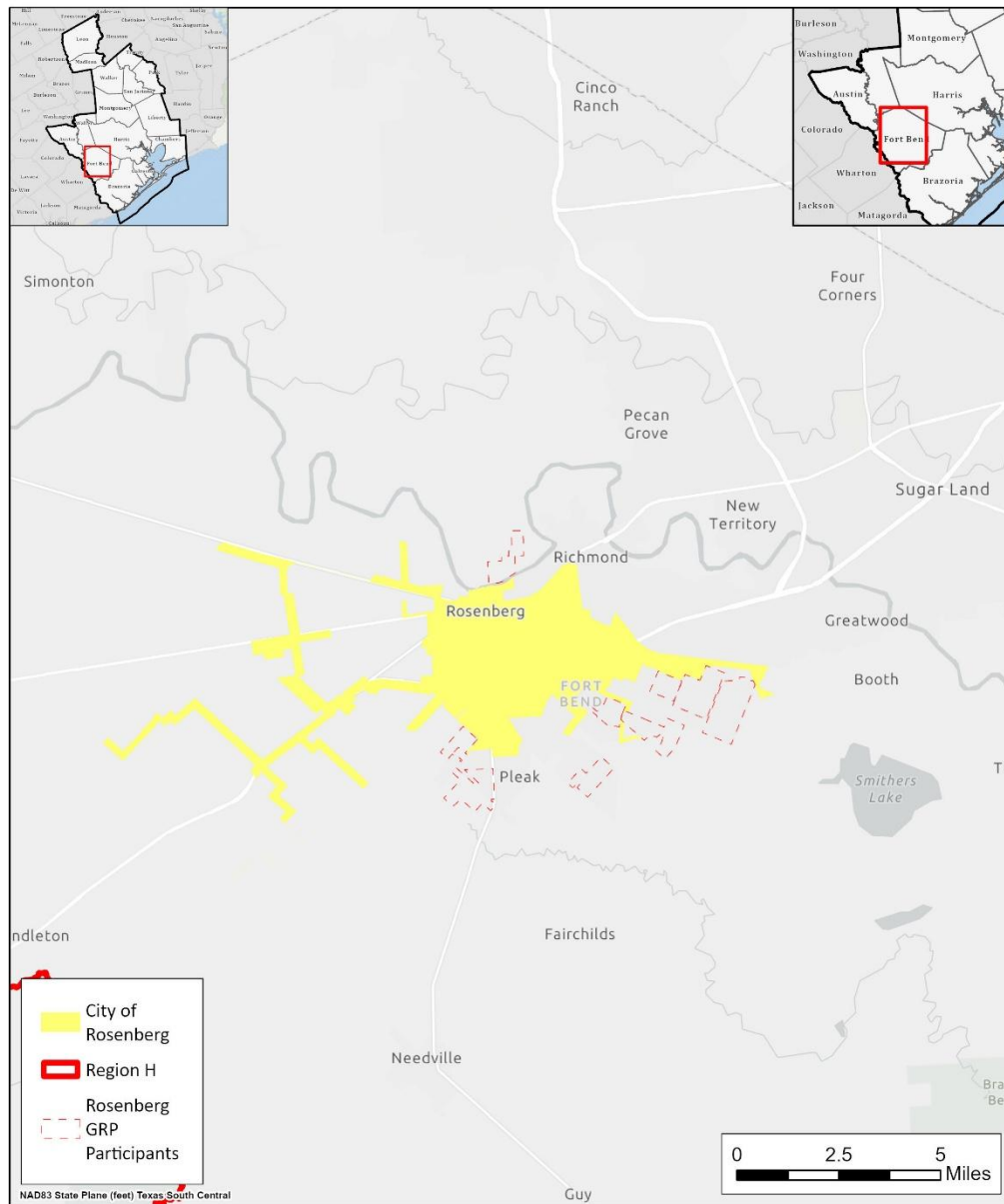
CRITERIA	WUG SUITABILITY
Proximity	Project requires limited expansion of conveyance infrastructure from treatment facilities to points of use.
Size	Project is of appropriate size to utilize the City of Rosenberg’s surface water contracts.
Water Quality	This project is expected to provide water of acceptable quality.
Unit Cost	The cost of this project is high but decreases after completion of debt service.
Other Factors	This project reduces groundwater dependence.

References

Jones and Carter, Inc. *City of Rosenberg Amended Groundwater Reduction Plan*, prepared for City of Rosenberg, TX, September 2014.

Fort Bend Subsidence District. *Fort Bend Subsidence District 2013 Regulatory Plan*, August 2013.

Location Map



City of Rosenberg Groundwater Reduction Plan Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	City of Sugar Land Integrated Water Resource Plan
Project ID:	GWRP-006
Project Type:	Various
Potential Supply Quantity (Rounded):	16,724 ac-ft/yr (14.9 mgd)
Implementation Decade:	2030
Development Timeline:	<5 years per project phase
Project Capital Cost:	\$205,801,342 (Sept. 2023)
Unit Water Cost (Rounded):	\$1,716 per ac-ft (during loan period) \$511 per ac-ft (after loan period)

Strategy Description

The Fort Bend Subsidence District (FBSD) has established requirements for entities within its boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the City of Sugar Land has developed a Groundwater Reduction Plan (GRP) to reduce groundwater use by implementing phased conversion to alternative water sources. In 2019, Sugar Land completed a new Integrated Water Resource Plan (IWRP) which details the City's plans for alternative water supply sources and infrastructure enhancements to meet growing demands and the required reduction in groundwater use. The strategies recommended in the IWRP include surface water conversion, direct reuse, and demand management.

Strategy Analyses

The project analyses for City of Sugar Land IWRP include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The City of Sugar Land has partnered with 18 surrounding entities for purposes of meeting the required groundwater reduction. The primary approach for meeting the required reduction is phased conversion to surface water, with additional direct reuse supplies and advanced demand management approaches contributing as well. Due to the physical and logistic challenges associated with converting all participants to partial surface water supply, the City's plans specify over-conversion of Fort Bend County MUD 128 and a portion of the Sugar Land service area, allowing other

co-participants to continue growth on groundwater while ensuring that the aggregate water use of partnering entities meets FBSD requirements.

Sugar Land owns a water right on Oyster Creek, part of the Brazos River Basin, for 5,638 ac-ft/yr (approximately 5 mgd), some of which is used to meet demands for non-potable water in the City's service area. Sugar Land has contracted with the Gulf Coast Water Authority (GCWA) for 20 mgd (22,400 ac-ft/yr) of raw surface water supply conveyed through GCWA's canal system. Sugar Land has also contracted with the Brazos River Authority (BRA) for an additional 14.9 mgd (16,667 ac-ft/yr) of raw surface water. The initial 10.85 mgd surface water treatment facility and associated transmission infrastructure identified by the GRP has been constructed and is operational; this portion of Sugar Land's surface water supply is reflected as an existing supply in the Regional Plan. The IWRP indicates that an additional 11.15 mgd in treatment capacity and additional transmission infrastructure will be required to meet long-term demand projections. The expansion in surface water infrastructure will be developed in multiple phases, providing an additional 5.65 mgd and subsequent 5.5 mgd expansion in treatment capacity. The first phase will also include expanded transmission infrastructure to convey treated surface water to four existing groundwater plants in the City's service area. One of these plants, located in the New Territory development, will also require a treatment plant conversion project to accommodate the chloramine-treated surface water.

Additionally, the IWRP identified opportunities to expand reclaimed water infrastructure at the South wastewater treatment plant (WWTP), North WWTP, and in the Greatwood and Tara Subdivision area to meet non-potable needs in Sugar Land's service area.

Finally, Sugar Land plans to implement advanced demand management measures beyond those recommended in the Region H Advanced Municipal Conservation and Water Loss Reduction Strategies. Ongoing installation and management of advanced metering infrastructure is estimated to provide up to 0.94 mgd of additional savings, and advanced loss reduction measures will provide an anticipated 0.24 mgd in additional savings beginning in 2030.

Environmental Considerations

One impact associated with the implementation of this project is the increase in GCWA and BRA diversions from the Brazos River. Increased diversion of water from the Brazos River will result in some minimal decreases in instream flow downstream of the GCWA pump stations. However, these diversions will be made from existing water rights currently owned by the GCWA and BRA, contracted by Sugar Land, and no new water rights permits are required for this project.

The direct reuse of the effluent source supply would be expected to have some degree of impact in terms of reduction of instream flows downstream of the WWTP discharge point for any portion of the source supply originating from current levels of return flow. Any reuse from the portion of return flow generated from future demand growth would not be expected to create additional instream flow reductions, as this portion of potential supply is not yet generated or discharged. Otherwise, implementation of this project should produce minimal environmental impacts.

Permitting and Development

Because the surface water supply source for this project is from existing water rights and would be delivered through GCWA's canal system, permitting of new surface water rights or modification of existing rights to add a diversion point will not be required. Construction of surface water treatment facility expansions will be required to utilize portions of the source supply, which may entail minor

permitting.

The development of expanded reuse supplies would require infrastructure development and permitting through the Texas Commission on Environmental Quality (TCEQ). Use of reclaimed wastewater effluent requires approval and permitting by the TCEQ under the requirements of 30 TAC §210. TCEQ classifies reclaimed water as Type 1 (higher quality for use where public contact is likely) or Type 2 (for uses with limited risk of human contact). Due to the potential for human contact, supplies for this project would have to be treated to Type 1 quality standards. If approved for use, the reclaimed water would have to be sampled and analyzed a minimum of twice per week.

Cost Analysis

The Sugar Land IWRP includes planning-level cost estimates for engineering and design, contingency, sitework, and construction for each of the recommended projects, as well as annual operation and maintenance costs. Additional information was provided by the Sugar Land Capital Improvement Program report. Standard regional planning assumptions were applied to estimate the cost of interest during construction, and all cost estimates were scaled to a September 2023 equivalent cost in accordance with TWDB requirements. Costs associated with environmental studies and mitigation are not identified as separate items, but for purposes of the regional plan it is assumed that these values are included in the estimates for other capital cost components. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Total estimated costs for all projects associated with the Sugar Land GRP are presented in *Table 1*.

Table 1 – Sugar Land Integrated Water Resource Plan Project Costs

OPINION OF PROBABLE CONSTRUCTION COST					September 2023		
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL		
PROJECT CAPITAL COST SUMMARY							
1	CONSTRUCTION COST	1	LS	\$142,111,121	\$142,111,121		
2	ENGINEERING, FINANCIAL, AND LEGAL SERVICES AND CONTINGENCIES	1	LS	\$37,662,704	\$37,662,704		
3	LAND AND EASEMENTS	1	LS	\$317,800	\$317,800		
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0		
5	INTEREST DURING CONSTRUCTION	1	LS	\$11,908,521	\$11,908,521		
6	ADVANCED LOSS REDUCTION AND AMI	1	LS	\$13,801,196	\$13,801,196		
PROJECT CAPITAL COST					\$205,801,342		
ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (2030 PHASE)	\$10,420,078	\$10,420,078	\$0	\$0	\$0	\$0
2	DEBT SERVICE (2040 PHASE)	\$0	\$2,395,473	\$2,395,473	\$0	\$0	\$0
3	DEBT SERVICE (2050 PHASE)	\$0	\$0	\$1,664,853	\$1,664,853	\$0	\$0
4	OPERATION AND MAINTENANCE (2030 PHASE)	\$4,722,389	\$4,722,389	\$4,722,389	\$4,722,389	\$4,722,389	\$4,722,389
5	OPERATION AND MAINTENANCE (2040 PHASE)	\$0	\$3,375,668	\$3,375,668	\$3,375,668	\$3,375,668	\$3,375,668
6	OPERATION AND MAINTENANCE (2050 PHASE)	\$0	\$0	\$444,990	\$444,990	\$444,990	\$444,990
7	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
8	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$15,142,466	\$20,913,607	\$12,603,373	\$10,207,900	\$8,543,047	\$8,543,047

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$15,142,466	\$20,913,607	\$12,603,373	\$10,207,900	\$8,543,047	\$8,543,047
2	YIELD	8,827	15,492	16,724	16,724	16,724	16,724
3	UNIT COST	\$1,716	\$1,350	\$754	\$610	\$511	\$511
TOTAL UNIT COST							\$833

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS (2030 PHASE - SURFACE WATER SYSTEM)	1	LS	\$5,980,500	\$5,980,500
2	PUMP STATIONS (2030 PHASE - RECLAIMED SYSTEM)	1	LS	\$1,888,198	\$1,888,198
3	PUMP STATIONS (2040 PHASE - SURFACE WATER SYSTEM)	1	LS	\$764,493	\$764,493
4	PUMP STATIONS (2040 PHASE - RECLAIMED SYSTEM)	1	LS	\$1,022,273	\$1,022,273
5	PUMP STATIONS (2050 PHASE - RECLAIMED SYSTEM)	1	LS	\$1,888,198	\$1,888,198
6	PIPELINES (2030 PHASE - SURFACE WATER SYSTEM)	1	LS	\$14,131,000	\$14,131,000
7	PIPELINES (2030 PHASE - GROUNDWATER SYSTEM)	1	LS	\$11,971,775	\$11,971,775
8	PIPELINES (2030 PHASE - RECLAIMED SYSTEM)	1	LS	\$7,741,458	\$7,741,458
9	PIPELINES (2040 PHASE - RECLAIMED SYSTEM)	1	LS	\$3,891,137	\$3,891,137
10	PIPELINES (2050 PHASE - RECLAIMED SYSTEM)	1	LS	\$7,741,458	\$7,741,458
11	WATER TREATMENT PLANTS (2030 PHASE - SURFACE WATER SYSTEM)	1	LS	\$53,824,500	\$53,824,500
12	WATER TREATMENT PLANTS (2030 PHASE - GROUNDWATER SYSTEM)	1	LS	\$9,873,000	\$9,873,000
13	WATER TREATMENT PLANTS (2040 PHASE - SURFACE WATER SYSTEM)	1	LS	\$10,943,094	\$10,943,094
14	WATER STORAGE TANKS (2030 PHASE - RECLAIMED SYSTEM)	1	LS	\$565,257	\$565,257
15	WATER STORAGE TANKS (2040 PHASE - RECLAIMED SYSTEM)	1	LS	\$300,669	\$300,669
16	WATER STORAGE TANKS (2050 PHASE - RECLAIMED SYSTEM)	1	LS	\$565,257	\$565,257
17	WASTEWATER RECLAMATION PLANTS (2030 PHASE - RECLAIMED SYSTEM)	1	LS	\$1,022,273	\$1,022,273
18	WASTEWATER RECLAMATION PLANTS (2040 PHASE - RECLAIMED SYSTEM)	1	LS	\$1,082,407	\$1,082,407
19	WASTEWATER RECLAMATION PLANTS (2050 PHASE - RECLAIMED SYSTEM)	1	LS	\$1,022,273	\$1,022,273
20	SITE CIVIL, MEP, AND INSTRUMENTATION (2030 PHASE - RECLAIMED SYSTEM)	1	LS	\$2,356,039	\$2,356,039
21	SITE CIVIL, MEP, AND INSTRUMENTATION (2040 PHASE - RECLAIMED SYSTEM)	1	LS	\$1,179,823	\$1,179,823
22	SITE CIVIL, MEP, AND INSTRUMENTATION (2050 PHASE - RECLAIMED SYSTEM)	1	LS	\$2,356,039	\$2,356,039
23	2030 PHASE - ADVANCED LOSS REDUCTION AND AMI	1	LS	\$13,801,196	\$13,801,196
PROJECT COST					\$155,912,317

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	2030 PHASE - SURFACE WATER SYSTEM	1.0	LS	\$3,127,907	\$3,127,907
2	2030 PHASE - GROUNDWATER SYSTEM	1.0	LS	\$119,718	\$119,718
3	2030 PHASE - RECLAIMED SYSTEM	1.0	LS	\$444,990	\$444,990
4	2030 PHASE - ADVANCED LOSS REDUCTION AND AMI	1.0	LS	\$1,029,774	\$1,029,774
5	2040 PHASE - SURFACE WATER SYSTEM	1.0	LS	\$3,131,525	\$3,131,525
6	2040 PHASE - RECLAIMED SYSTEM	1.0	LS	\$244,143	\$244,143
7	2050 PHASE - RECLAIMED SYSTEM	1.0	LS	\$444,990	\$444,990
ANNUAL OPERATION AND MAINTENANCE COST					\$8,543,047

Water Management Strategy Evaluation

Based on the analysis provided above, the City of Sugar Land GRP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Cost is relatively high but decreases substantially after completion of debt service.
Location	4	Some transmission infrastructure required.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	4	Minimal impacts anticipated.
Environmental Flows	2	Some decrease in environmental flows below diversion point. Diversion is from an existing water right.
Local Preference	4	No known opposition.
Institutional Constraints	3	Minimal permitting challenges or opposition expected.
Development Timeline	5	Project development, including permitting, could be accomplished in approximately five years or less per project phase.
Sponsorship	5	Sponsor has identified project and is in development.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

The City of Sugar Land GRP includes up to nine miles of pipelines. The majority of this impact will be in urbanized areas with limited impacts to habitat. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The City of Sugar Land GRP project 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use.
Size	Project is of appropriate size to utilize the City of Sugar Land’s surface water and reuse supplies.
Water Quality	This project is expected to provide water of acceptable quality for municipal use.
Unit Cost	The cost of this project is moderately high but decreases substantially after completion of debt service.
Other Factors	This project reduces groundwater dependence.

References

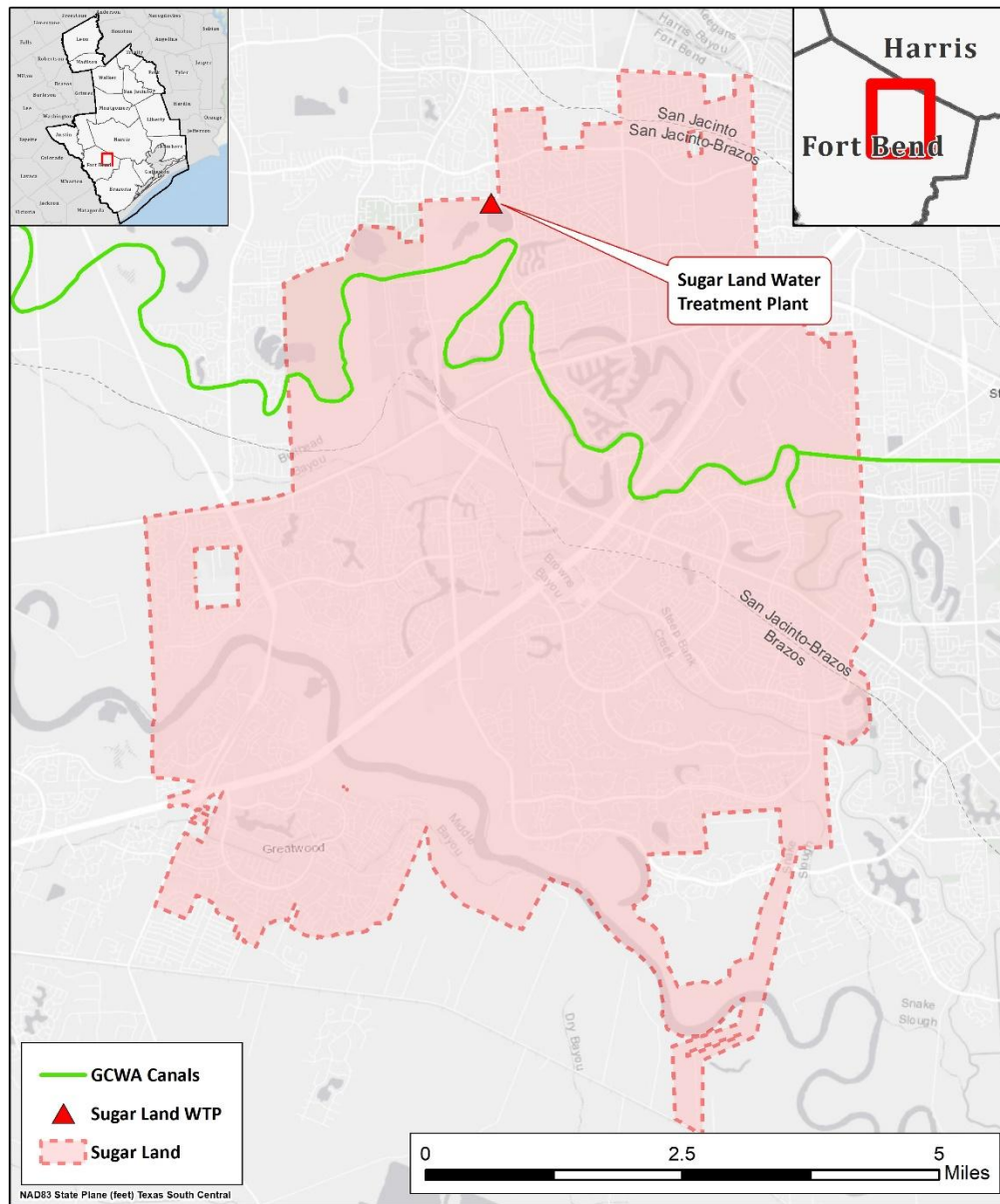
City of Sugar Land, TX. *City of Sugar Land Groundwater Reduction Plan*, March 2008.

City of Sugar Land, TX. *City of Sugar Land Integrated Water Resource Plan*, March 2019.

City of Sugar Land, TX. *2023-2027 Capital Improvement Program*, 2023.

Fort Bend Subsidence District. *Fort Bend Subsidence District 2013 Regulatory Plan*, August 2013.

Location Map



Sugar Land IWRP Location Map



Texas

THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Fort Bend County MUD 25 Groundwater Reduction Plan
Project ID:	GWRP-007
Project Type:	Various
Potential Supply Quantity (Rounded):	1,120 ac-ft/yr (1 mgd)
Implementation Decade:	2030
Development Timeline:	<5 years
Project Capital Cost:	\$11,567,244 (Sept. 2023)
Unit Water Cost (Rounded):	\$784 per ac-ft (during loan period) \$58 per ac-ft (after loan period)

Strategy Description

The Fort Bend Subsidence District (FBSD), in order to address the issue of land surface subsidence due to groundwater use within Fort Bend County, has enacted regulations limiting the percentage of overall supply that water users in certain portions of the county may produce from the Gulf Coast Aquifer. In order to meet this requirement, Fort Bend County Municipal Utility District No. 25 (MUD 25) developed a Groundwater Reduction Plan (GRP) in 2008 that outlined a plan to reduce groundwater use by implementing reuse, with considerations for supplemental surface water use as well. More recently, MUD 25 has proposed a plan to seek a contract for one mgd (1,120 ac-ft/yr) of surface water from local wholesale water providers.

Strategy Analyses

The project analyses for Fort Bend County MUD 25 GRP include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Fort Bend County MUD No. 25 has partnered with the Shadow Hawk Golf Course and the Orchard Lakes Development for purposes of meeting the required groundwater reduction. The primary approach for meeting the required reduction is direct reuse of effluent from MUD No. 25's wastewater treatment plant (WWTP) for irrigation and filling of amenity lakes in the Shadow Hawk Golf Course and the Orchard Lakes Development instead of existing groundwater wells.

The GRP analysis examined historical groundwater use along with per-capita usage rates and growth projections. Reuse potential was analyzed using best case (low demand, high reuse availability), worst case (high demand, low reuse availability), and realistic scenarios. Under worst case conditions, surface water conversion would be required beginning in 2015 and over-conversion credits would be

depleted by 2029, requiring an additional 100 million gallons of surface water conversion credits per year beginning in 2029. For the best case scenario, over-conversion and other credits would meet requirements through 2030, with no need for surface water conversion. For the realistic case, surface water conversion credits would have to begin in 2026 for FBSD requirements to be met through 2030. MUD No. 25 also has surface water conversion credit agreements with the City of Sugar Land.

The reuse infrastructure associated with the GRP has been developed and is actively producing direct reuse supply. Based on historical levels of production from 2010 to 2022, MUD 25 has used up to 521 ac-ft/yr of reclaimed water, which is reflected in the Region H Plan as an existing water supply. Direct reuse in MUD 25 is expected to increase to a maximum of 589 ac-ft/yr by 2030.

MUD 25 does not currently have access to any surface water sources but is seeking contracts, potentially with the City of Sugar Land, for up to 1 MGD (1,120 ac-ft/yr). This strategy assumes the successful negotiation for this supply with Sugar Land for MUD 25's next phase of conversion. It is also assumed that this agreement would be for treated water supply.

Environmental Considerations

The primary impact associated with the implementation of this water management project is the increase in diversions from the Brazos River. Increased diversion of water from the Brazos River will result in some minimal decreases in instream flow downstream of the intake point. However, these diversions would be made from existing water rights owned by a wholesale water provider, contracted by Fort Bend County MUD 25, and no new water rights permits would be required for this project.

Permitting and Development

Because the reuse system infrastructure for the GRP is already developed, no additional permitting is anticipated for that supply source. Procurement of surface water supplies from the City of Sugar Land or an alternative supplier would require a new supply contract. The addition of surface water supplies is expected to necessitate minor additional conveyance infrastructure which may involve additional permitting requirements.

Cost Analysis

The GRP does not include a detailed estimate of cost for the project. It was assumed that additional direct reuse beyond existing levels would not generate additional costs as the necessary infrastructure is active. A preliminary planning estimate of cost associated with a contractual surface water supply was developed using standard cost estimate procedures for Region H. As the contract and associated intake facilities have not yet been determined, this cost estimate includes such components as a pump station as well as one mile of pipeline for conveyance from the intake point to the MUD 25 system. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. *Table 1* summarizes the costs of key facilities, which are presented in September 2023 dollars.

Table 1 – Fort Bend County MUD 25 GRP Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$2,526,652	\$2,526,652
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$815,351	\$815,351
3	LAND AND EASEMENTS	1	LS	\$5,299,800	\$5,299,800
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$2,208,000	\$2,208,000
5	INTEREST DURING CONSTRUCTION	1	LS	\$717,441	\$717,441
PROJECT CAPITAL COST					\$11,567,244

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$813,884	\$813,884	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$42,473	\$42,473	\$42,473	\$42,473	\$42,473	\$42,473
3	PUMPING ENERGY COSTS	\$22,052	\$22,052	\$22,052	\$22,052	\$22,052	\$22,052
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$878,409	\$878,409	\$64,526	\$64,526	\$64,526	\$64,526

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$878,409	\$878,409	\$64,526	\$64,526	\$64,526	\$64,526
2	YIELD	1,120	1,120	1,120	1,120	1,120	1,120
3	UNIT COST	\$784	\$784	\$58	\$58	\$58	\$58
TOTAL UNIT COST		\$300					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$1,147,100	\$1,147,100
2	PIPELINES	1	LS	\$1,379,552	\$1,379,552
PROJECT COST					\$2,526,652

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$1,147,100	\$28,678
2	PIPELINES	1.0	%	\$1,379,552	\$13,796
ANNUAL OPERATION AND MAINTENANCE COST					\$42,473

Water Management Strategy Evaluation

Based on the analysis provided above, the Fort Bend County MUD 25 GRP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	3	The cost of this project is moderate and decreases significantly after completion of debt service.
Location	4	Some conveyance infrastructure may be necessary to access contractual supplies.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	5	Limited or no known impacts.
Environmental Flows	2	Minor reduction in environmental flows.
Local Preference	4	Project identified in participant's Joint GRP. No known opposition.
Institutional Constraints	3	Reuse system is complete. Surface water must be procured through a contract.
Development Timeline	5	Minimal development time (<5 years) required.
Sponsorship	4	Sponsor identified and project partially implemented.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	2	Project serves sponsor and limited number of co-participants.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

The Fort Bend County MUD 25 GRP project is not anticipated to affect vulnerable species. Additionally, the project will not directly impact environmental flows or agricultural land and production.

Water User Group Application

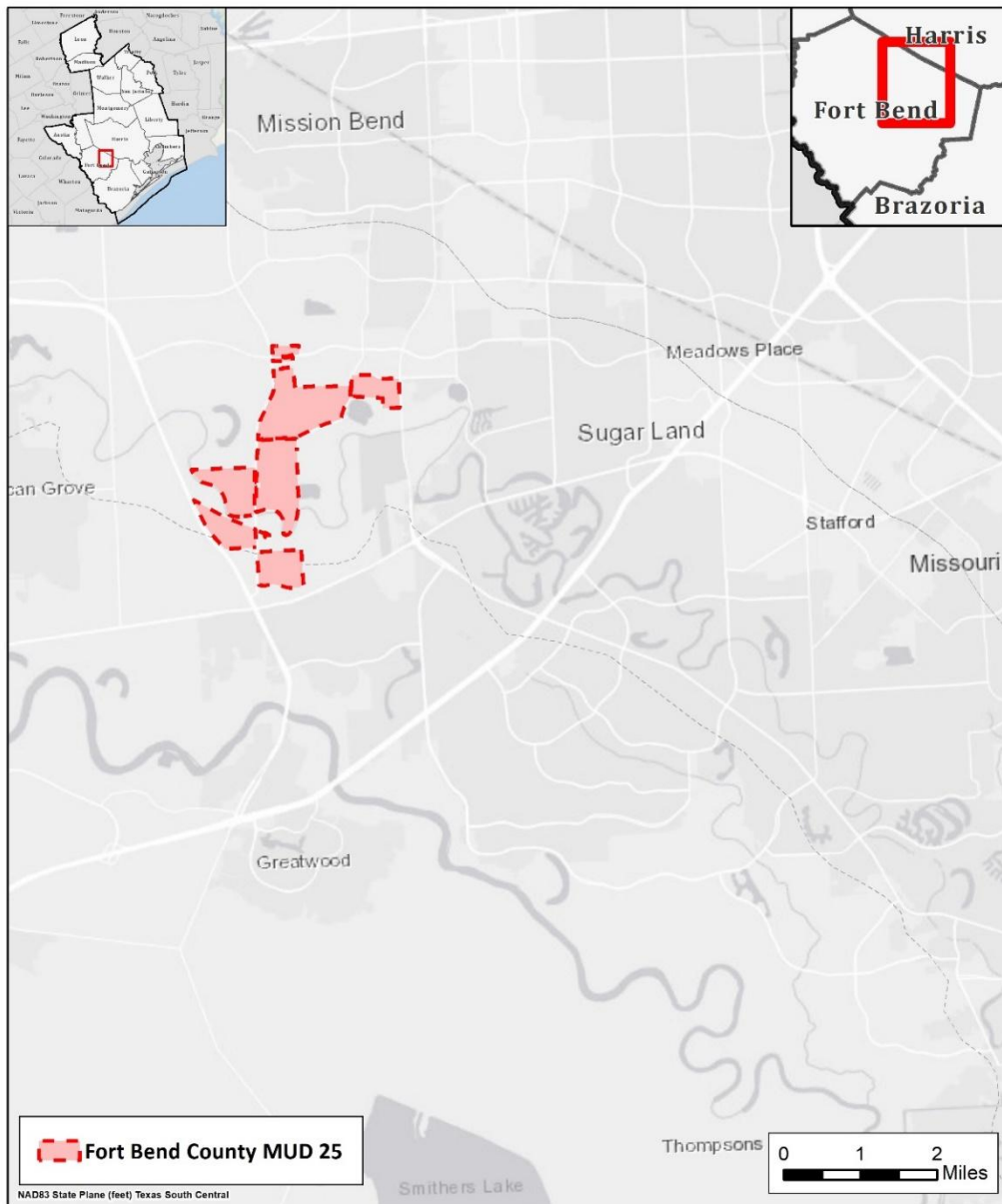
The Fort Bend County MUD 25 GRP project was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, 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.

CRITERIA	WUG SUITABILITY
Proximity	The project is located in close proximity to intended points of use.
Size	Overall project supply volume is appropriate to the target demands.
Water Quality	This project provides supplies of appropriate quality for intended uses.
Unit Cost	The cost of this project is moderate and decreases after completion of debt service.
Other Factors	This project is partially implemented but may require limited infrastructure for future contractual supplies.

References

CDM. *Fort Bend County MUD No. 25 Groundwater Reduction Plan*, prepared for Fort Bend County MUD No. 25, October 2008.

Fort Bend Subsidence District. *Fort Bend Subsidence District 2013 Regulatory Plan*, August 2013.

Location Map**Fort Bend County MUD 25 GRP
Location Map**

Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Fort Bend County WCID 2 Groundwater Reduction Plan
Project ID:	GWRP-008
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	3,360 – 6,720 ac-ft/yr (3 – 6 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	<5 years
Project Capital Cost:	\$71,687,468 (Sept. 2023)
Unit Water Cost (Rounded):	\$1,144 per ac-ft (during loan period) \$393 per ac-ft (after loan period)

Strategy Description

The Fort Bend Subsidence District (FBSD), in order to address the issue of land surface subsidence due to groundwater use within Fort Bend County, has enacted regulations limiting the percentage of overall supply that water users in certain portions of the county may produce from the Gulf Coast Aquifer. In order to meet this requirement, Fort Bend Water Control & Improvement District No. 2 (WCID 2) has developed a Groundwater Reduction Plan (GRP) to reduce groundwater use by implementing phased conversion to surface water.

Strategy Analyses

The project analyses for Fort Bend County WCID 2 GRP include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The WCID 2 GRP summarizes the planned projects for meeting the FBSD's timeline for partial conversion to non-groundwater sources. WCID 2, which provides retail water supply service to the City of Stafford and portions of the City of Missouri City, is partnering in this endeavor with Harris County MUD 122, Fifth Street Water Supply Corporation, and City of Meadows Place. WCID 2 has contracted with Gulf Coast Water Authority (GCWA) for 10.5 mgd (11,760 ac-ft/yr) of raw surface water supply delivered through GCWA's canal system. WCID 2 has also obtained 80 acres of land adjacent to the GCWA canal for treatment plant development.

The initial 3 mgd surface water treatment facility identified by the GRP has been constructed and is operational; this portion of WCID 2's surface water supply is reflected as an existing supply in the Regional Plan. The GRP indicates that an additional 3 mgd in treatment capacity will be required by 2025. A second 3 mgd expansion is anticipated by 2032.

Environmental Considerations

One impact associated with the implementation of this water management project is the increase in GCWA diversions from the Brazos River. Increased diversion of water from the Brazos River will result in some decreases in instream flow downstream of the GCWA pump stations. However, these diversions will be made from existing water rights currently owned by the GCWA, contracted by Fort Bend County WCID 2, and no new water rights permits are required for this project. Otherwise, implementation of this project should produce minimal environmental impacts.

Permitting and Development

Because the water supply source for this project is from existing water rights and will be delivered through GCWA's canal system, permitting of new surface water rights or modification of existing rights to add a diversion point will not be required. Construction of treatment facility expansions will be required to utilize portions of the source supply, which may entail minor permitting.

Cost Analysis

A preliminary planning estimate of project cost for the two planned expansions has been developed using standard regional planning assumptions. Estimated costs reflect a 3 mgd (3,360 ac-ft/yr) expansion in 2025 and an additional 3 mgd expansion reflected in 2032, which are included in the Regional Plan in the 2030 and 2040 planning decades. It was assumed for both phases that all construction could be accommodated in existing easements, with minor costs for additional surveying. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Total costs for both phases are presented in *Table 1*. All costs, including debt service and costs for operations and maintenance, were calculated using standard cost estimation procedures for Region H and are presented in September 2023 equivalent costs in accordance with TWDB guidance.

Table 1 – Fort Bend WCID 2 GRP Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$44,912,252	\$44,912,252
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$15,511,829	\$15,511,829
3	LAND AND EASEMENTS	1	LS	\$1,094,280	\$1,094,280
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$5,722,800	\$5,722,800
5	INTEREST DURING CONSTRUCTION	1	LS	\$4,446,307	\$4,446,307
PROJECT CAPITAL COST					\$71,687,468

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (2025 PHASE)	\$2,522,004	\$2,522,004	\$0	\$0	\$0	\$0
2	DEBT SERVICE (2032 PHASE)	\$0	\$2,522,004	\$2,522,004	\$0	\$0	\$0
3	OPERATION AND MAINTENANCE (2025 PHASE)	\$1,257,282	\$1,257,282	\$1,257,282	\$1,257,282	\$1,257,282	\$1,257,282
4	OPERATION AND MAINTENANCE (2032 PHASE)	\$0	\$1,257,282	\$1,257,282	\$1,257,282	\$1,257,282	\$1,257,282
5	PUMPING ENERGY COSTS	\$64,247	\$128,494	\$128,494	\$128,494	\$128,494	\$128,494
6	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$3,843,533	\$7,687,065	\$5,165,061	\$2,643,058	\$2,643,058	\$2,643,058

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$3,843,533	\$7,687,066	\$5,165,062	\$2,643,058	\$2,643,058	\$2,643,058
2	YIELD	3,360	6,720	6,720	6,720	6,720	6,720
3	UNIT COST	\$1,144	\$1,144	\$769	\$393	\$393	\$393
TOTAL UNIT COST		\$666					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS (2025 PHASE)	1	LS	\$8,127,000	\$8,127,000
2	PIPELINES (2025 PHASE)	1	LS	\$2,074,595	\$2,074,595
3	WATER TREATMENT PLANTS (2025 PHASE)	1	LS	\$12,254,530	\$12,254,530
4	PUMP STATIONS (2032 PHASE)	1	LS	\$8,127,000	\$8,127,000
5	PIPELINES (2032 PHASE)	1	LS	\$2,074,595	\$2,074,595
6	WATER TREATMENT PLANTS (2032 PHASE)	1	LS	\$12,254,530	\$12,254,530
PROJECT COST					\$44,912,252

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS (2025 PHASE)	2.5	%	\$8,127,000	\$203,175
2	PIPELINES (2025 PHASE)	1.0	%	\$2,074,595	\$20,746
3	WATER TREATMENT PLANTS (2025 PHASE)	1.0	LS	\$1,033,361	\$10,334
4	PUMP STATIONS (2032 PHASE)	2.5	%	\$8,127,000	\$203,175
5	PIPELINES (2032 PHASE)	1.0	%	\$2,074,595	\$20,746
6	WATER TREATMENT PLANTS (2032 PHASE)	1.0	LS	\$1,033,361	\$10,334
ANNUAL OPERATION AND MAINTENANCE COST					\$468,509

Water Management Strategy Evaluation

Based on the analysis provided above, the Fort Bend County WCID 2 GRP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	2	Cost is moderately high but reduces considerably after debt service completion.
Location	5	Relatively near demand centers.
Water Quality	3	No known issues regarding water quality.
Environmental Land and Habitat	4	Minimal impacts anticipated.
Environmental Flows	2	Some decrease in environmental flows below diversion point. Diversion is from an existing water right.
Local Preference	4	No known opposition.
Institutional Constraints	3	Minimal permitting challenges or opposition expected.
Development Timeline	5	Project development, including permitting, could be accomplished in approximately five years or less.
Sponsorship	5	Sponsor identified and project is in development.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	2	Project serves sponsor and limited number of co-participants.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

The Fort Bend WCID 2 GRP is not anticipated to affect vulnerable species and will not directly impact environmental flows. The project is not anticipated to impact agricultural land or production.

Water User Group Application

The Fort Bend County WCID 2 GRP project 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.

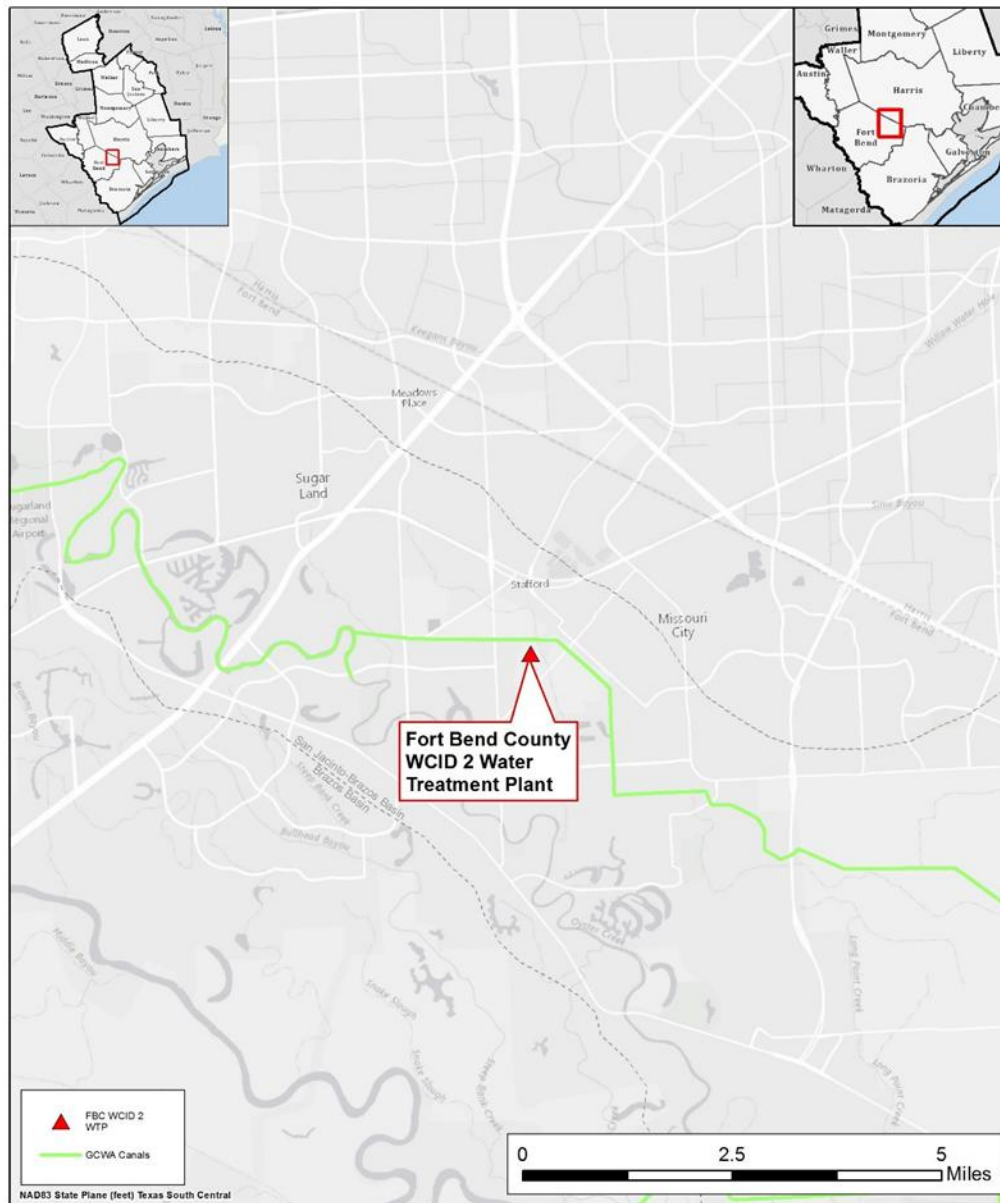
CRITERIA	WUG SUITABILITY
Proximity	The project is located in close proximity to intended points of use.
Size	The project is of appropriate size to utilize WCID 2's surface water contracts.
Water Quality	This project is expected to provide water of acceptable quality.
Unit Cost	The cost of this project is moderately high but decreases substantially after completion of debt service.
Other Factors	This project reduces groundwater dependence.

References

Jones and Carter, Inc. *Groundwater Reduction Plan: Fort Bend County W.C. and I.D. No. 2*, prepared for Fort Bend County WC&ID No. 2, February 2008.

Fort Bend Subsidence District. *Fort Bend Subsidence District 2013 Regulatory Plan*, August 2013.

Location Map



Fort Bend County WCID 2 Groundwater Reduction Plan Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Montgomery County MUDs 8 and 9 Supply Expansion
Project ID:	GWRP-009
Project Type:	Various
Potential Supply Quantity (Rounded):	2,240 ac-ft/yr (2.0 mgd)
Implementation Decade:	2030
Development Timeline:	5 years
Project Capital Cost:	\$53,547,608 (Sept. 2023)
Unit Water Cost (Rounded):	\$3,061 per ac-ft (during loan period) \$1,379 per ac-ft (after loan period)

Strategy Description

Montgomery County MUDs 8 and 9 have undertaken various measures in order to expand and diversify their available supplies, including production of groundwater from the Catahoula Aquifer and development of water treatment infrastructure to treat supplies from the Catahoula Aquifer and other supplies. The MUDs have also applied for and received from the Texas Commission on Environmental Quality (TCEQ) a bed-and-banks permit for conveyance of their own effluent as well as contracted effluent supplies purchased from the City of Huntsville. Additional measures previously examined by the MUDs in their Joint Groundwater Reduction Plan (GRP) could be used to address a portion of the projected demand growth for Montgomery County

Strategy Analyses

The project analyses for the Montgomery County MUDs 8 and 9 Supply Expansion project include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Montgomery County MUDs 8 and 9 have developed and are currently utilizing water supplies from the Catahoula Aquifer as a means of reducing dependence on overlying formations of the Gulf Coast Aquifer. The Joint GRP for the MUDs indicates development of additional conjunctive use of brackish groundwater supplies. Montgomery County MUDs 8 and 9 have also entered into a contract with the City of Huntsville for up to 2 mgd (2,240 ac-ft/yr) of effluent produced by Huntsville and conveyed to the MUDs through the West Fork of the San Jacinto River and Lake Conroe; additionally, the MUDs have obtained TCEQ authorization for reuse of a portion of their own wastewater discharges less amounts credited to other entities through agreements. The MUDs have obtained a bed-and-banks permit to convey these supplies to the point of diversion.

Environmental Considerations

The diversion of the effluent source supply would be expected to have some degree of impact in terms of reduction of instream flows downstream of the diversion point for any portion of the source supply originating from current levels of return flow. Any impacts would be anticipated to occur from reuse of effluent generated from current levels of discharge; diversion of the portion attributable to future growth would not be expected to cause additional impact. Treatment facility construction is associated with an existing residential development.

Permitting and Development

Increased use of Catahoula Aquifer supplies would require permitting through the Lone Star Groundwater Conservation District. Montgomery County MUDs 8 and 9 have received a bed-and-banks permit from TCEQ for conveyance of their own effluent as well as contracted effluent supplies purchased from the City of Huntsville. The MUDs and the City of Huntsville have additionally reached agreements with the San Jacinto River Authority and the City of Houston regarding commitment of a portion of these return flows to those entities. These additional supplies are identified in the analysis of the Regional Return Flows strategy included in this RWP.

Cost Analysis

The estimated costs for the project are presented in *Table 1*. The values presented in the table were developed from standard regional planning costing reference data and assume construction of a small pump station with intake, short pipeline, conventional treatment facility, and additional groundwater treatment capacity. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity.

Table 1 – Montgomery County MUDs 8 and 9 Supply Expansion Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$36,503,689	\$36,503,689
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$12,710,559	\$12,710,559
3	LAND AND EASEMENTS	1	LS	\$276,260	\$276,260
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$735,890	\$735,890
5	INTEREST DURING CONSTRUCTION	1	LS	\$3,321,210	\$3,321,210
PROJECT CAPITAL COST					\$53,547,608

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$3,767,667	\$3,767,667	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$3,057,940	\$3,057,940	\$3,057,940	\$3,057,940	\$3,057,940	\$3,057,940
3	PUMPING ENERGY COSTS	\$31,706	\$31,706	\$31,706	\$31,706	\$31,706	\$31,706
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$6,857,313	\$6,857,313	\$3,089,646	\$3,089,646	\$3,089,646	\$3,089,646

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$6,857,313	\$6,857,313	\$3,089,646	\$3,089,646	\$3,089,646	\$3,089,646
2	YIELD	2,240	2,240	2,240	2,240	2,240	2,240
3	UNIT COST	\$3,061	\$3,061	\$1,379	\$1,379	\$1,379	\$1,379
TOTAL UNIT COST		\$1,940					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$5,732,400	\$5,732,400
2	PIPELINES	1	LS	\$1,314,639	\$1,314,639
3	WATER TREATMENT PLANTS	1	LS	\$29,456,650	\$29,456,650
PROJECT COST					\$36,503,689

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$5,732,400	\$143,310
2	PIPELINES	1.0	%	\$1,314,639	\$13,146
3	WATER TREATMENT PLANTS	1.0	LS	\$2,901,483	\$2,901,483
ANNUAL OPERATION AND MAINTENANCE COST					\$3,057,940

Water Management Strategy Evaluation

Based on the analysis provided above, the Montgomery County MUDs 8 and 9 Supply Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	This project provides water at a high cost, particularly during debt service, but generates treated rather than raw supply.
Location	4	Bed and banks conveyance to treatment facility required
Water Quality	3	The project takes advantage of existing and future discharges in the San Jacinto basin.
Environmental Land and Habitat	4	Majority of projects would be constructed in already-developed areas or existing rights-of-way.
Environmental Flows	2	Diversion of discharges would create reduction in environmental flows.
Local Preference	3	Limited opposition to project.
Institutional Constraints	5	Bed-and-banks permit has been granted
Development Timeline	5	Permit could be developed in a relatively short period of time.
Sponsorship	4	Sponsors are identified and have initiated permitting efforts.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	2	Direct service limited to sponsor systems but potentially benefits broader area by offsetting groundwater demands.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

Montgomery County MUDs 8 and 9 Supply Expansion is not anticipated to affect vulnerable species or agricultural land and production. The project may potentially reduce future return flows to the San Jacinto River Basin. However, this reduction in return flows may also correlate to a reduction in diversions of other surface water from within the basin and reduces dependence on groundwater resources.

Water User Group Application

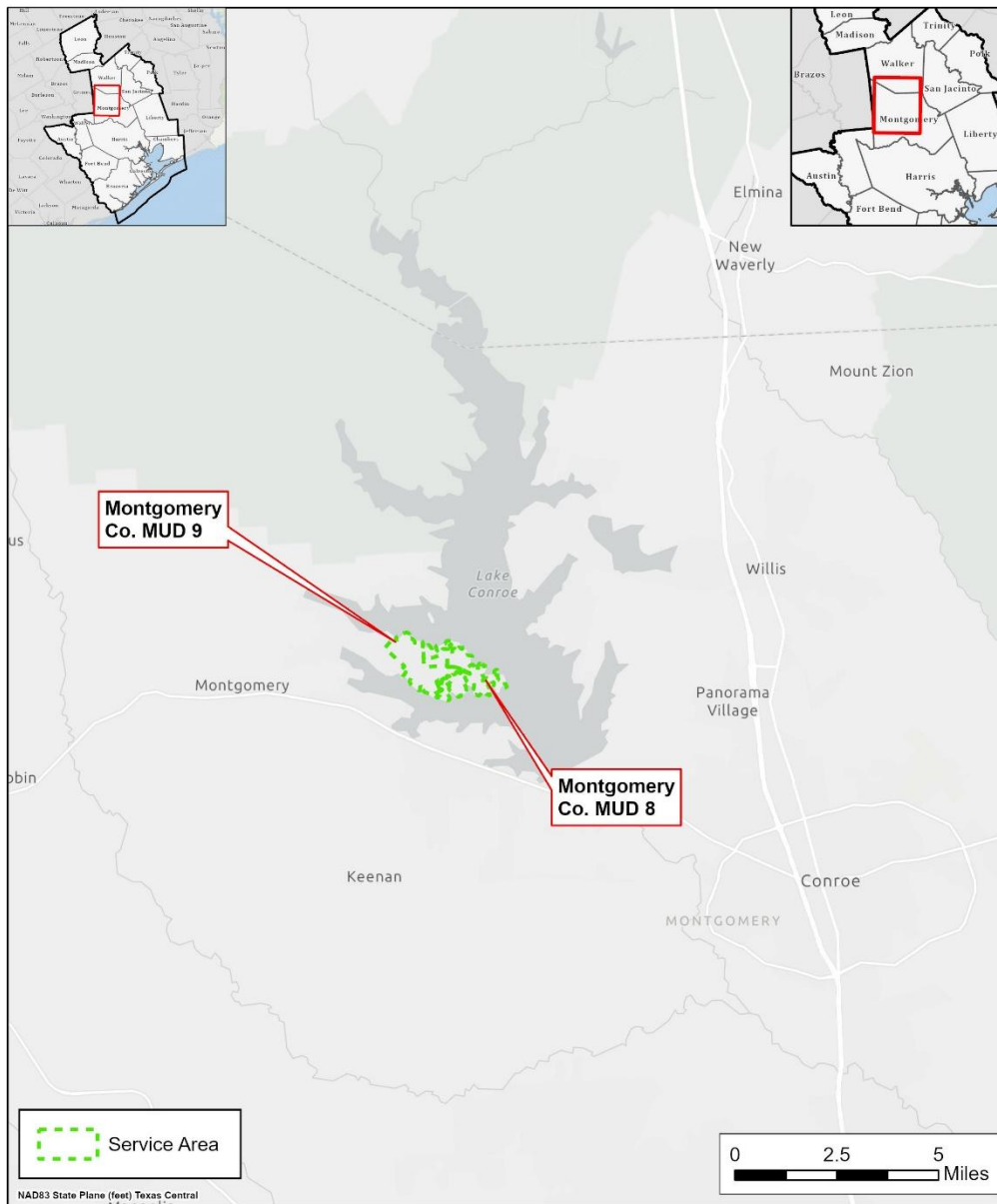
Determination of the Water User Groups (WUGs) to which the project may be applied was evaluated based on the factors below. Currently, the only identified users are Montgomery County MUDs 8 and 9.

CRITERIA	WUG SUITABILITY
Proximity	Reuse diversion point located in close proximity to intended points of use.
Size	Overall project supply volume is appropriate to the conversion target demands identified by contract recipients.
Water Quality	This project provides a treated water supply to meet municipal demands.
Unit Cost	This project provides water at a high cost, particularly during debt service, but generates treated rather than raw supply.
Other Factors	Implementation of reuse supply from this project requires a bed-and-banks permit for downstream use, which has been approved.

References

NRS Consulting Engineers, Inc., *Joint Groundwater Reduction Plan, Montgomery County Municipal Utility District No. 8 and Montgomery County Municipal Utility District No. 9*, prepared for Montgomery County MUD Nos. 8 and 9, April 2011.

Jones and Carter, Inc, *Amendment to the Joint Groundwater Reduction Plan for Montgomery County MUD Nos. 8 & 9*, Montgomery County MUD Nos. 8 and 9, April 2014.

Location Map

**Montgomery County
MUDs 8 and 9 Supply Expansion
Location Map**



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Montgomery County Supply Expansion
Project ID:	GWRP-010
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	75,000 ac-ft/yr (67 mgd)
Implementation Decade:	2030
Development Timeline:	5-10 years per phase
Project Capital Cost:	\$779,670,290 (Sept. 2023)
Unit Water Cost (Rounded):	\$550-\$1,262 per ac-ft (during loan period) \$387 per ac-ft (after loan period)

Strategy Description

Montgomery County has experienced rapid population growth in recent decades, with estimates from the Regional Water Planning (RWP) process indicating the continuation of growth and urbanization into the future. Water demands within the county are currently met primarily with groundwater from the Gulf Coast Aquifer. Other existing supply sources include brackish groundwater from the Catahoula aquifer, reuse of treated wastewater effluent, and surface water from Lake Conroe provided by the San Jacinto River Authority (SJRA) to its customers within the county. Demand projections for the 2026 RWP indicate that dry year water demands for Montgomery County would exceed the Modeled Available Groundwater (MAG) value for the county as early as the 2030 planning timestep. While the MAG is not applied by the Texas Water Code or local Groundwater Conservation District (GCD) regulations as a maximum value of allowable groundwater production in the county, it does represent an estimate of long-term average sustainable groundwater production, indicating that additional water supplies will be needed to meet future needs within Montgomery County. One option to address projected Montgomery County needs is increased use of surface water from Lake Conroe by existing surface water users and phased conversion of additional water systems to surface water.

Strategy Analyses

The project analyses for Montgomery County Supply Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Lake Conroe is located on the West Fork of the San Jacinto River in Montgomery County, approximately seven miles west of the City of Conroe. The reservoir, which was completed in 1973

by COH and the San Jacinto River Authority (SJRA), is impounded by an earthen dam and concrete spillway and has a drainage area of around 450 square miles. At the conservation pool elevation of 201 feet above MSL, the reservoir has a volume of approximately 417,605 acre-feet and a water surface area of approximately 19,894 acres (31.1 square miles). Lake Conroe is operated by SJRA. Certificate of Adjudication 10-4963 authorizes 100,000 ac-ft/yr in permitted water rights from the Lake, with one third (33,333 ac-ft/yr) owned by SJRA and the remaining two thirds owned by the COH. SJRA reserves COH's portion of the yield of Lake Conroe. The reservoir is permitted for municipal, industrial, irrigation, mining, and recreation uses. Modeling of the reservoir for the 2026 RWP indicates a reliable supply for year 2030 conditions of 80,000 acre-feet per year (ac-ft/yr), decreasing slightly to 76,850 ac-ft/yr by year 2080 due to reservoir sedimentation; it should be noted that surface water modeling for the RWP process incorporates conservative conditions which exclude return flows and assume all water rights attempting to divert their maximum permitted amounts.

In order to address demand growth and protect groundwater resources, SJRA has implemented surface water infrastructure through its Groundwater Reduction Plan (GRP) Division to meet a portion of customer needs. This infrastructure, which includes a raw water intake, 30 million gallon per day (mgd) surface water treatment plant, and over 50 miles of pipeline, serves six local water providers. The SJRA GRP study considered possible future expansion stages of this surface water infrastructure to meet additional water demands within the county through increased surface water usage by current customers and phased conversion of additional water systems to partial use of surface water. Due to the logistical and financial hurdles to connecting all water systems within the county to surface water, the SJRA GRP examined conversion of some entities with surface water in order to create flexibility for more remote systems to continue growth on groundwater supplies.

The Montgomery County Supply Expansion water management strategy (WMS) recommended in the 2026 RWP applies similar phased surface water conversion concepts as those from the SJRA GRP and other GRPs within the Harris-Galveston Subsidence District (HGSD) and Fort Bend Subsidence District (FBSD). Due to differences in projected demands, MAG values, and other parameters since the SJRA GRP study, the timing, magnitude, and potential converted entities vary from those in the GRP. The concept applied for the RWP estimates additional conversion of existing surface water recipients to 50 percent surface water source by approximately 2030 utilizing remaining capacity from existing infrastructure. By 2040, infrastructure expansion and an increase in surface water blend to 80 percent would be applied. Subsequent treatment and transmission expansions in 2050 and 2060 would allow for additional entities to convert partially to surface water, with the surface water source percentage for all converted entities increasing through 2080. Treatment capacity expansions are estimated as 25 mgd capacity modules (*Table 1*). It should be noted that infrastructure capacities, conversion levels, timing, and strategy allocations presented in the RWP are hypothetical, and the project could be developed with different parameters if deemed appropriate during more detailed planning and design stages.

Table 1 – Hypothetical Montgomery County Supply Expansion Treatment Phasing

Treated Water Parameter	2030	2040	2050	2060	2070	2080
Existing Capacity (ac-ft)	33,600	33,600	33,600	33,600	33,600	33,600
Expansions (ac-ft)	0	0	25,000	25,000	25,000	0
Cumulative Capacity (ac-ft)	33,600	33,600	58,600	83,600	108,600	108,600
Approx. Cumulative Capacity (MGD)	30	30	50	75	100	100

The value of 75,000 ac-ft/yr shown in this memorandum is intended to reflect the incremental volume of expanded surface water treatment capacity necessary for the proposed Montgomery County Supply Expansion WMS and is the primary infrastructure aspect of the WMS. In addition to the associated Lake Conroe supplies associated with this treatment infrastructure, the overarching strategy does incorporate other supplies, including groundwater increases for some entities (offset by pumpage reductions by others), brackish groundwater production, and local-scale reuse. Because these smaller projects are distributed among many WUGs, they are reflected in the RWP under corresponding WUG Infrastructure Expansion WMS Projects but are not included in this memorandum.

Environmental Considerations

One impact associated with the implementation of this project is the increase in diversions from the San Jacinto River and Lake Conroe. Increased diversion of water will result in some decreases in instream flow downstream of the Lake Conroe diversion point. However, these diversions will be made from existing water rights currently owned by the SJRA and the City of Houston, and no new water rights permits are required for this project. Some surface disturbance may be associated with development of expanded water plant facilities and transmission infrastructure. However, this construction would occur primarily on existing plant sites or in previously urbanized areas and would cause little disturbance to undeveloped habitat. Implementation of this project should produce limited additional environmental impacts.

Permitting and Development

Because the surface water supply source for this project is from existing water rights, permitting of new surface water rights or modification of existing rights to add a diversion point will not be required. Permitting efforts specific to additional water supply sources, which may be incorporated in later decades, are considered in the analysis of projects specific to those sources. Construction of expansions of the surface water treatment facility and distribution system will be required to utilize portions of the source supply, which may entail minor permitting.

Cost Analysis

Capital costs for phased expansion of surface water treatment plant and transmission capacity were based upon prior estimates of several phased 25 mgd expansions from the SJRA GRP, adjusted for differing timing and more recent cost indices. Capital costs for engineering and legal services, land acquisition, environmental studies, mitigation, and interest during construction were estimated using standard regional water planning costing assumptions. Annualized costs for debt service and operations and maintenance were estimated using standard Regional Planning costing reference data. Capital costs were scaled to a September 2023 equivalent cost in accordance with TWDB guidance. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs are presented in *Table 2*.

Table 2 – Montgomery County Supply Expansion Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$528,890,118	\$528,890,118
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$181,109,882	\$181,109,882
3	LAND AND EASEMENTS	1	LS	\$19,837,752	\$19,837,752
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$1,474,661	\$1,474,661
5	INTEREST DURING CONSTRUCTION	1	LS	\$48,357,877	\$48,357,877
PROJECT CAPITAL COST					\$779,670,290

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$12,268,260	\$42,590,181	\$42,590,181	\$12,268,260	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$8,465,824	\$18,946,046	\$27,411,870	\$27,411,870	\$27,411,870
3	PUMPING ENERGY COSTS	\$0	\$0	\$1,581,777	\$1,581,777	\$1,581,777	\$1,581,777
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$0	\$20,734,084	\$63,118,004	\$71,583,829	\$41,261,907	\$28,993,648

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$20,734,084	\$63,118,004	\$71,583,828	\$41,261,907	\$28,993,647
2	YIELD	-	25,000	50,000	75,000	75,000	75,000
3	UNIT COST	\$0	\$829	\$1,262	\$954	\$550	\$387
TOTAL UNIT COST							\$752

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$23,580,402	\$23,580,402
2	PIPELINES	1	LS	\$80,033,188	\$80,033,188
3	WATER TREATMENT PLANTS	1	LS	\$362,821,048	\$362,821,048
4	WATER STORAGE TANKS	1	LS	\$62,455,480	\$62,455,480
PROJECT COST					\$528,890,119

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$23,580,402	\$589,510
2	PIPELINES	1.0	%	\$80,033,188	\$800,332
3	WATER TREATMENT PLANTS	1.0	LS	\$25,397,473	\$25,397,473
4	WATER STORAGE TANKS	1.0	%	\$62,455,480	\$624,555
ANNUAL OPERATION AND MAINTENANCE COST					\$27,411,870

Water Management Strategy Evaluation

Based on the analysis provided above, the Montgomery County Supply Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Costs are moderate to high but decrease substantially in later decades after debt service completion.
Location	4	Transmission infrastructure required to convert additional entities to surface water.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	4	Minimal impacts anticipated.
Environmental Flows	2	Some decrease in environmental flows below diversion point. Diversion is from an existing water right.
Local Preference	3	Some local support.
Institutional Constraints	3	Minimal permitting challenges or opposition expected for future conversion infrastructure.
Development Timeline	5	Individual phases of project development, including permitting, could be accomplished in approximately five years or less.
Sponsorship	3	Potential sponsor has been identified.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

Water User Group Application

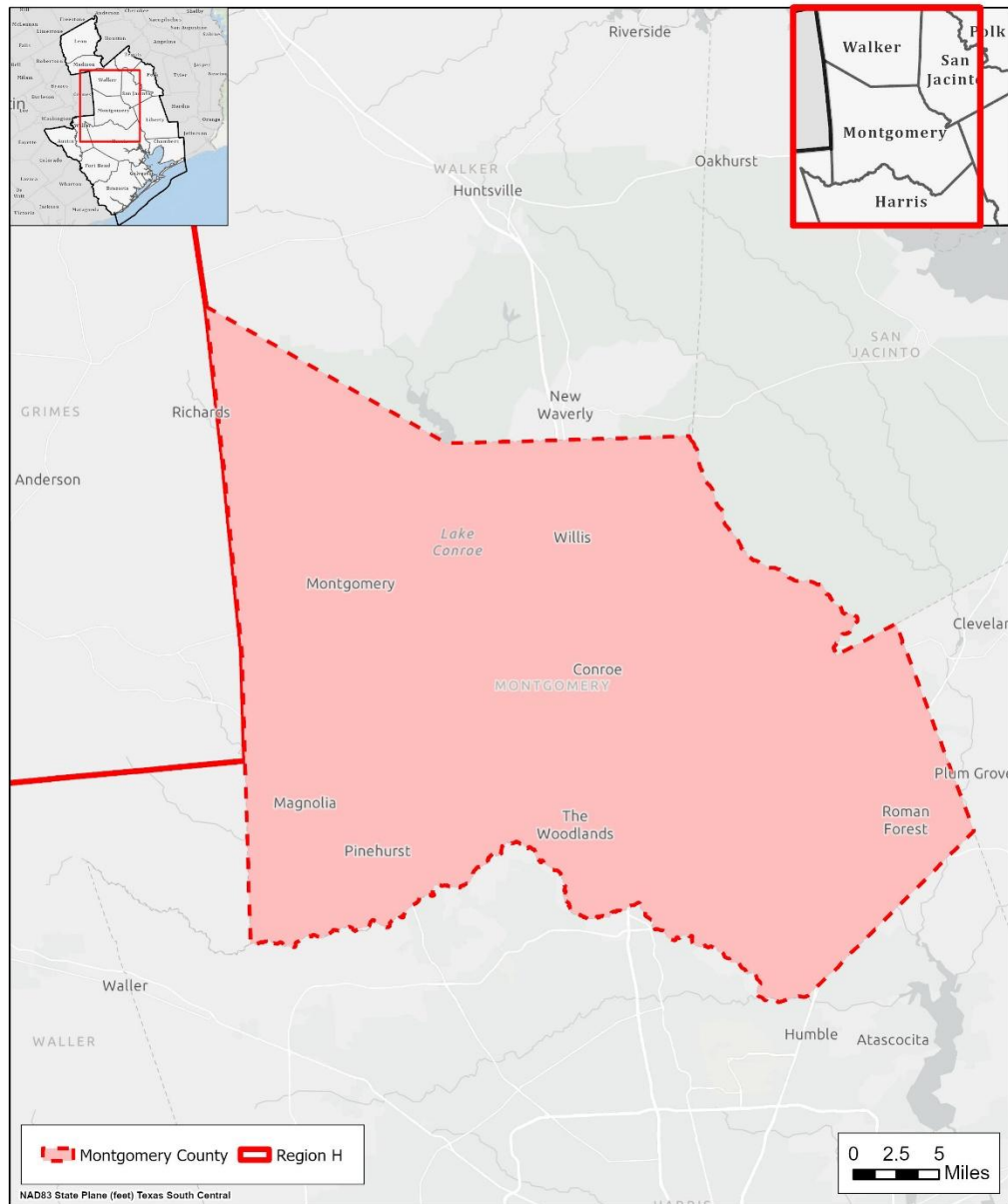
The Montgomery County Supply Expansion project was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use. Some major transmission infrastructure is required.
Size	Project is of appropriate size to meet customer demands.
Water Quality	This project is expected to provide water of acceptable quality.
Unit Cost	The cost of this project is initially moderate to high but decreases substantially after completion of debt service.
Other Factors	This project reduces groundwater dependence.

References

Brown and Gay Engineers, Inc. *San Jacinto River Authority Joint Groundwater Reduction Plan*, prepared for SJRA, March 2011.

Location Map



Montgomery County Supply Expansion Location Map



THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	North Fort Bend Water Authority Groundwater Reduction Plan
Project ID:	GWRP-011
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	76,720 ac-ft/yr (68.5 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	5 years
Project Capital Cost:	Included under associated infrastructure projects
Unit Water Cost (Rounded):	Included under associated infrastructure projects

Strategy Description

The Harris-Galveston Subsidence District (HGSD) and Fort Bend Subsidence District (FBSD) have established requirements for entities within their boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the North Fort Bend Water Authority (NFBWA) has contracted with the City of Houston (COH) to receive treated surface water. The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH. In order to utilize sufficient supplies to meet future surface water conversion obligations, NFBWA is participating in multiple infrastructure projects related to the treatment and distribution of surface water.

Strategy Analyses

The project analyses for the NFBWA Groundwater Reduction Plan (GRP) include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The NFBWA will deliver surface water to the majority of the MUDs and the City of Fulshear within the Authority to meet the requirements of its GRP approved by the FBSD. The Authority has already developed transmission and distribution infrastructure to its initial obligations for reducing groundwater demand and are receiving water from COH, which is reflected in the Regional Plan as an existing supply. In order to meet future water demands and regulatory conversion obligations, the Authority has continued development and implementation of its GRP program. NFBWA partnered

with other Regional Water Authorities and COH in development of the Luce Bayou Interbasin Transfer Project to convey supplies from the Trinity River to Lake Houston and is also a participant in the expansion of the treatment capacity of the COH Northeast Water Purification Plant (NEWPP). The Authority has also increased its supply reservation from these facilities from an original reservation of 19.5 mgd (21,840 ac-ft/yr) currently applied in the Regional Plan as existing supply to 88 mgd (98,560 ac-ft/yr). NFBWA is partnering with West Harris County Regional Water Authority (WHCRWA) to develop a new shared transmission pipeline system, referred to by the sponsors as the Surface Water Supply Project (formerly the Second Source Transmission Line), which will convey increased treated surface water supplies from the Northeast Water Purification Plant. NFBWA is also developing its Phase 2 Distribution Expansion to extend the infrastructure network through which it supplies its member districts, allowing for greater overall volume conveyed and conversion of additional districts to surface water.

Environmental Considerations

Any environmental impacts related to the GRP project are a factor of the associated source and infrastructure projects. Infrastructure development may result in some construction disturbance which could require mitigation. The most significant impact associated with the GRP is the source supply, which requires the interbasin transfer of surface water supplies.

Permitting and Development

NFBWA is subject to requirements imposed by the COH as well as the State of Texas. As indicated above, the Authority relies on the COH and WHCRWA to address the permitting and development requirements of projects for which those entities are primarily responsible. For the Authority's expansion of distribution infrastructure, at least some level of construction permitting would be anticipated.

For shared transmission with WHCRWA, environmental clearance has been received from TWDB and the Authority has received U.S. Army Corps of Engineers clearance under a nationwide permit. Some mitigation for construction in forested wetlands is required for the shared transmission.

Cost Analysis

The costs associated with developing this project are included under other infrastructure projects.

Water Management Strategy Evaluation

Based on the analysis provided above, the NFBWA GRP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	Costs for project are related to the infrastructure projects which allow physical implementation of the GRP.
Location	3	Source supply requires an interbasin transfer of surface water and extensive conveyance infrastructure.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	3	Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.
Local Preference	4	Local support. Limited opposition.
Institutional Constraints	3	Permits expected with minimal problems. Some permits already obtained. Property available.
Development Timeline	5	Project to be developed by 2025, with some portions active earlier.
Sponsorship	5	Sponsors identified and project is in development.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No known significant impacts to other projects.

The NFBWA GRP is not anticipated to affect vulnerable species. Additionally, the project will not directly impact environmental flows or agricultural land and production.

Water User Group Application

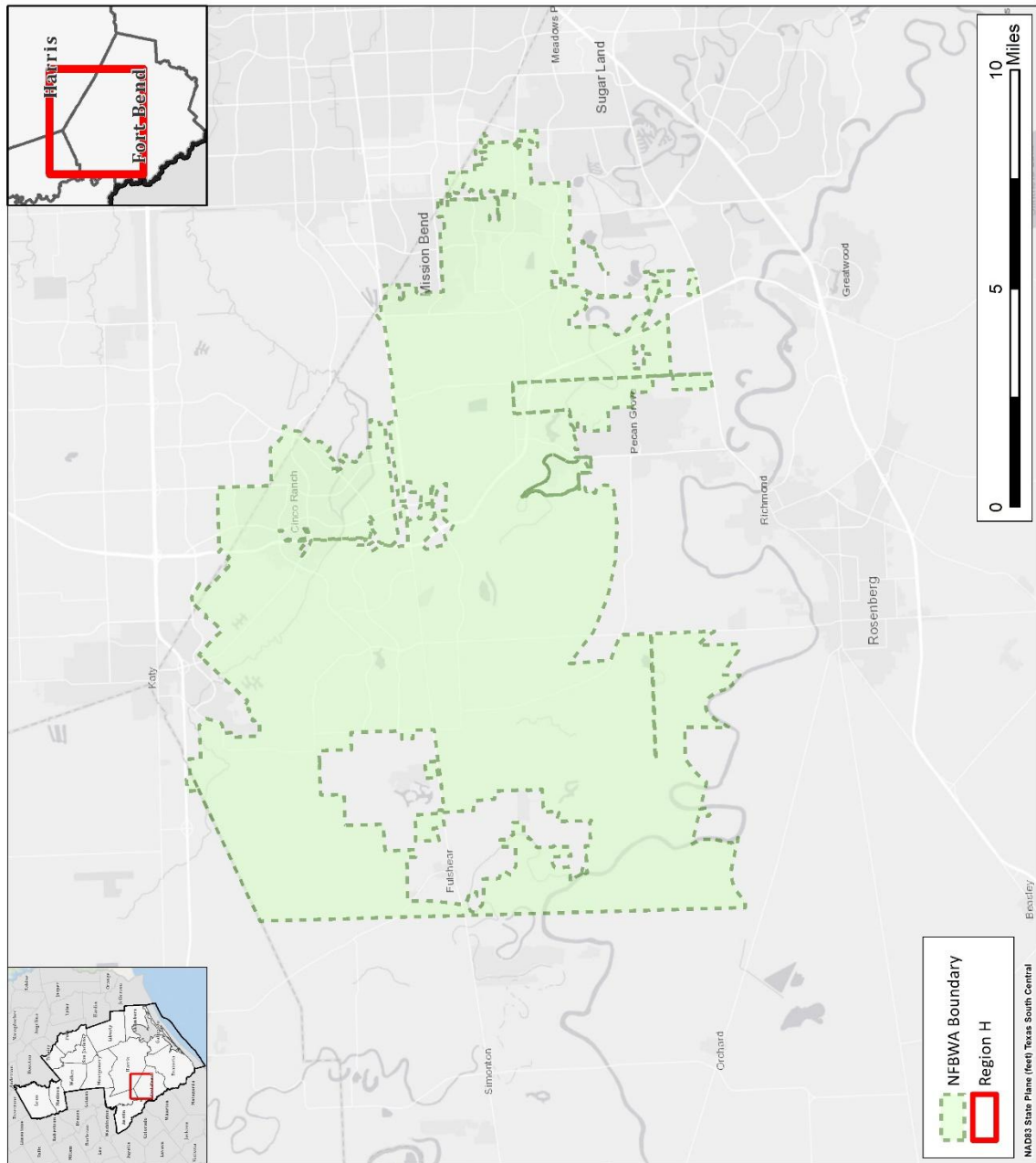
The NFBWA GRP project was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the suitability of the strategy to the WUGs served. It is anticipated that the project will only serve NFBWA, its wholesale customers, and GRP participants.

CRITERIA	WUG SUITABILITY
Proximity	Strategy is suited to serving WUGs located in northern Fort Bend County.
Size	Sized to convey the requisite amount of source water.
Water Quality	Treated water of quality appropriate for municipal use.
Unit Cost	Included under other infrastructure projects.
Other Factors	Reduces dependence on Gulf Coast Aquifer groundwater.

References

Fort Bend Subsidence District. *Fort Bend Subsidence District 2013 Regulatory Plan*, August 2013.

Location Map



NFBWA GRP Location Map



THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	North Harris County Regional Water Authority Groundwater Reduction Plan
Project ID:	GWRP-012
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	143,360 ac-ft/yr (128 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	5 years
Project Capital Cost:	Included under associated infrastructure projects
Unit Water Cost (Rounded):	Included under associated infrastructure projects

Strategy Description

The Harris-Galveston Subsidence District (HGSD) has established requirements for entities within its boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the North Harris County Regional Water Authority (NHCRWA) has contracted with the City of Houston (COH) to receive treated surface water. The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH. In order to utilize sufficient supplies to meet future surface water conversion obligations, NHCRWA is participating in multiple infrastructure projects related to the treatment and distribution of surface water.

Strategy Analyses

The project analyses for the NHCRWA Groundwater Reduction Plan (GRP) include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The NHCRWA will continue to deliver surface water to districts within the Authority to meet the requirements of its GRP. The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH, which is reflected in the Regional Plan as an existing supply. In order to meet future water demands and regulatory conversion obligations, the Authority has continued development and implementation of its GRP program. NHCRWA partnered with other Regional Water Authorities and COH in development of the Luce Bayou Interbasin Transfer Project to convey supplies from the Trinity

River to Lake Houston, and the Authority is also a participant in the expansion of the treatment capacity of the COH Northeast Water Purification Plant (NEWPP). The Authority has also increased its supply reservation from these facilities from an original reservation of 31 mgd (34,720 ac-ft/yr), currently applied in the Regional Plan as existing supply, to 159 mgd (178,080 ac-ft/yr), and has partnered with Central Harris County Regional Water Authority (CHCRWA) and COH to develop shared transmission of treated surface water supplies from the NEWPP; NHCRWA continues to develop expansion of the infrastructure network through which it supplies its member districts.

Environmental Considerations

Any environmental impacts related to the GRP project are a factor of the associated source and infrastructure projects. Infrastructure development may result in some construction disturbance which could require mitigation. The most significant impact associated with the GRP is the source supply, which requires the interbasin transfer of surface water supplies.

Permitting and Development

The permitting and development requirements necessary for implementation of the NHCRWA GRP are associated with the source supply and infrastructure projects. NHCRWA is subject to contractual requirements established by COH as well as any relevant permitting required by the State of Texas and HGSD. Much of the permitting associated with implementation of large-scale shared infrastructure is primarily being addressed by COH.

Cost Analysis

The costs associated with developing this project are included under other infrastructure projects.

Water Management Strategy Evaluation

Based on the analysis provided above, the NHCRWA GRP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	Costs for project are related to the infrastructure projects which allow physical implementation of the GRP.
Location	3	Source supply requires an interbasin transfer of surface water and extensive conveyance infrastructure.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	3	Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.

CRITERIA	RATING	EXPLANATION
Local Preference	4	Local support. Limited opposition.
Institutional Constraints	3	Permits expected with minimal problems. Property available.
Development Timeline	5	Project to be developed by 2025, with some portions active earlier.
Sponsorship	5	Sponsors identified and project is in development.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No known significant impacts to other projects.

The NHCWA GRP is not anticipated to affect vulnerable species. Additionally, the project will not directly impact environmental flows or agricultural land and production.

Water User Group Application

The NHCRWA GRP project 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.

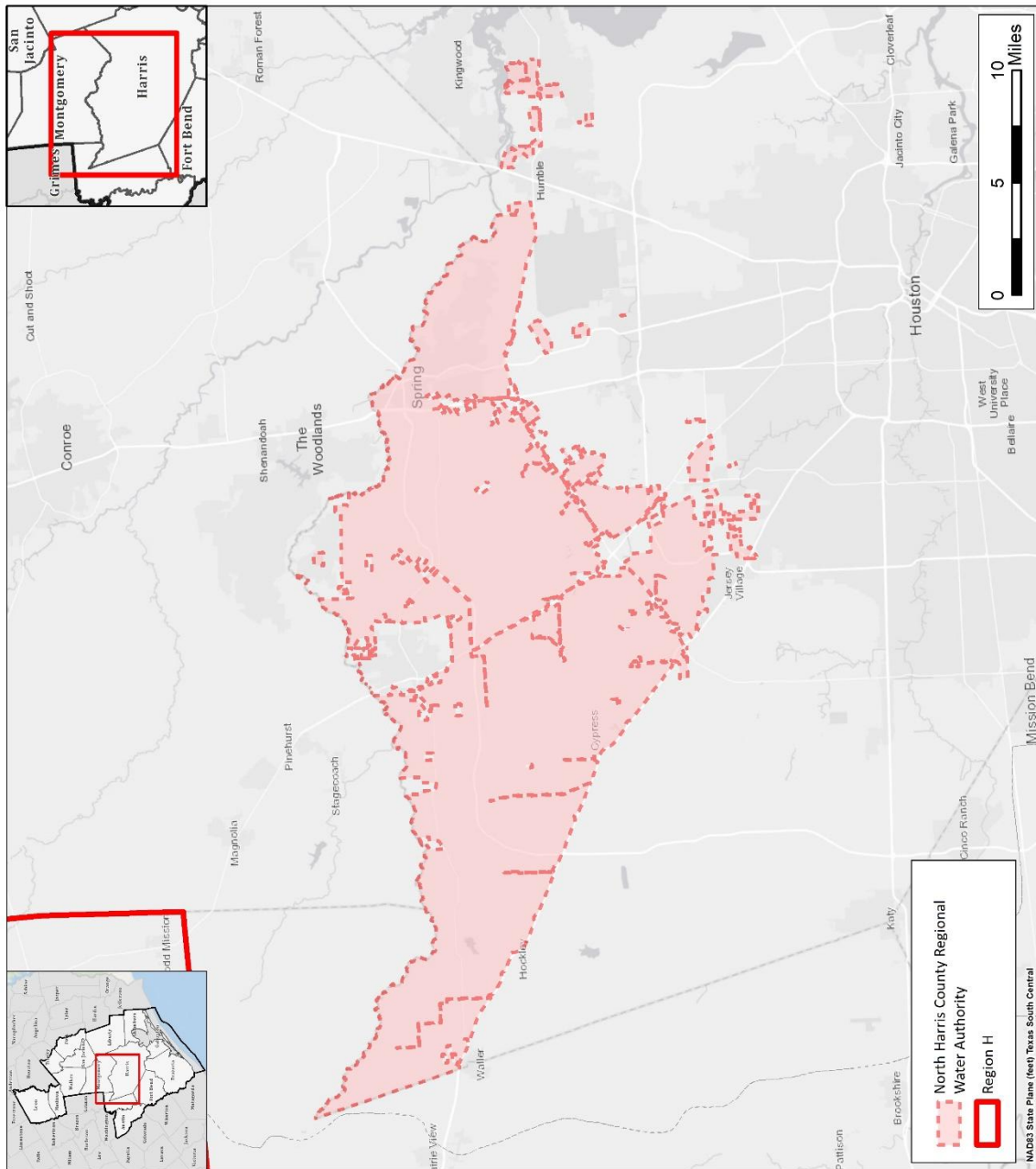
CRITERIA	WUG SUITABILITY
Proximity	Strategy is suited to serving WUGs located in northern Harris County.
Size	Sized to convey the requisite amount of source water.
Water Quality	Treated water of quality appropriate for municipal use.
Unit Cost	Included under other infrastructure projects.
Other Factors	Reduces dependence on Gulf Coast Aquifer groundwater.

References

AECOM. *2014 North Harris County Regional Water Authority Groundwater Reduction Plan*, prepared for NHCRWA, June 2014.

Harris-Galveston Subsidence District. *Harris-Galveston Subsidence District 2013 District Regulatory Plan*, May 2013.

Location Map



NHCRWA GRP Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	West Harris County Regional Water Authority Groundwater Reduction Plan
Project ID:	GWRP-013
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	92,288 ac-ft/yr (82.4 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	5 years
Project Capital Cost:	Included under associated infrastructure projects
Unit Water Cost (Rounded):	Included under associated infrastructure projects

Strategy Description

The Harris-Galveston Subsidence District (HGSD) and Fort Bend Subsidence District (FBSD) have established requirements for entities within their boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to meet these requirements, the West Harris County Regional Water Authority (WHCRWA) has contracted with the City of Houston (COH) to receive treated surface water. The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH. In order to utilize sufficient supplies to meet future surface water conversion obligations, WHCRWA is participating in multiple infrastructure projects related to the treatment and distribution of surface water.

Strategy Analyses

The project analyses for the WHCRWA Groundwater Reduction Plan (GRP) include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The Authority has already developed transmission and distribution infrastructure to meet its initial obligations for reducing groundwater demand and is receiving water from COH, which is reflected in the Regional Plan as an existing supply. In order to meet future water demands and regulatory conversion obligations, the Authority has continued development and implementation of its GRP program. WHCRWA partnered with other Regional Water Authorities and COH in development of the

Luce Bayou Interbasin Transfer Project to convey supplies from the Trinity River to Lake Houston and is also a participant in the expansion of the treatment capacity of the COH Northeast Water Purification Plant (NEWPP). The Authority has also increased its supply reservation from these facilities from an original reservation of 28.25 mgd (31,640 ac-ft/yr) currently applied in the Regional Plan as existing supply to 110.65 mgd (123,943 ac-ft/yr). WHCRWA is partnering with North Fort Bend Water Authority (NFBWA) to develop a new shared transmission pipeline system, referred to by the sponsors as the Surface Water Supply Project, which will convey increased treated surface water supplies from the NEWPP. WHCRWA is also developing an expansion of the infrastructure network through which it supplies its member districts, allowing for greater overall volume conveyed and conversion of additional districts to surface water.

Environmental Considerations

Any environmental impacts related to the GRP project are a factor of the associated source and infrastructure projects. Infrastructure development may result in some construction disturbance which could require mitigation. The most significant impact associated with the GRP is the source supply, which requires the interbasin transfer of surface water supplies.

Permitting and Development

The permitting and development requirements necessary for implementation of the WHCRWA GRP are associated with the source supply and infrastructure projects. WHCRWA is subject to contractual requirements established by COH as well as any relevant permitting required by the State of Texas and HGSD. Much of the permitting associated with implementation of large-scale shared infrastructure is primarily being addressed by COH.

For shared transmission with NFBWA, environmental clearance has been received from TWDB and the Authority has received U. S. Army Corps of Engineers clearance under a nationwide permit. Some mitigation for construction in forested wetlands is required for the shared transmission. WHCRWA has also received TWDB environmental clearance for expansion of its distribution system.

Cost Analysis

The costs associated with developing this project are included under other infrastructure projects.

Water Management Strategy Evaluation

Based on the analysis provided above, the WHCRWA GRP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	Costs for project are related to the infrastructure projects which allow physical implementation of the GRP.
Location	3	Source supply requires an interbasin transfer of surface water and extensive conveyance infrastructure.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	3	Project does not directly impact flows. Source projects will result in decreased instream flows downstream of diversion location in source basin.
Local Preference	4	Local support. Limited opposition.
Institutional Constraints	3	Permits expected with minimal problems. Some permits already obtained. Property available.
Development Timeline	5	Project to be developed by 2025, with some portions active earlier.
Sponsorship	5	Sponsors identified and project is in development.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	No known significant impacts to other projects.

The WHCRWA GRP is not anticipated to affect vulnerable species or agricultural land and production. The project will not directly impact environmental flows.

Water User Group Application

The WHCRWA GRP project 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 anticipated that the project will only serve WHCRWA, its wholesale customers, and GRP participants.

CRITERIA	WUG SUITABILITY
Proximity	Strategy is suited to serving WUGs located in western Harris County.
Size	Sized to convey the requisite amount of source water.
Water Quality	Treated water of quality appropriate for municipal use.
Unit Cost	Included under other infrastructure projects.
Other Factors	Reduces dependence on Gulf Coast Aquifer groundwater.

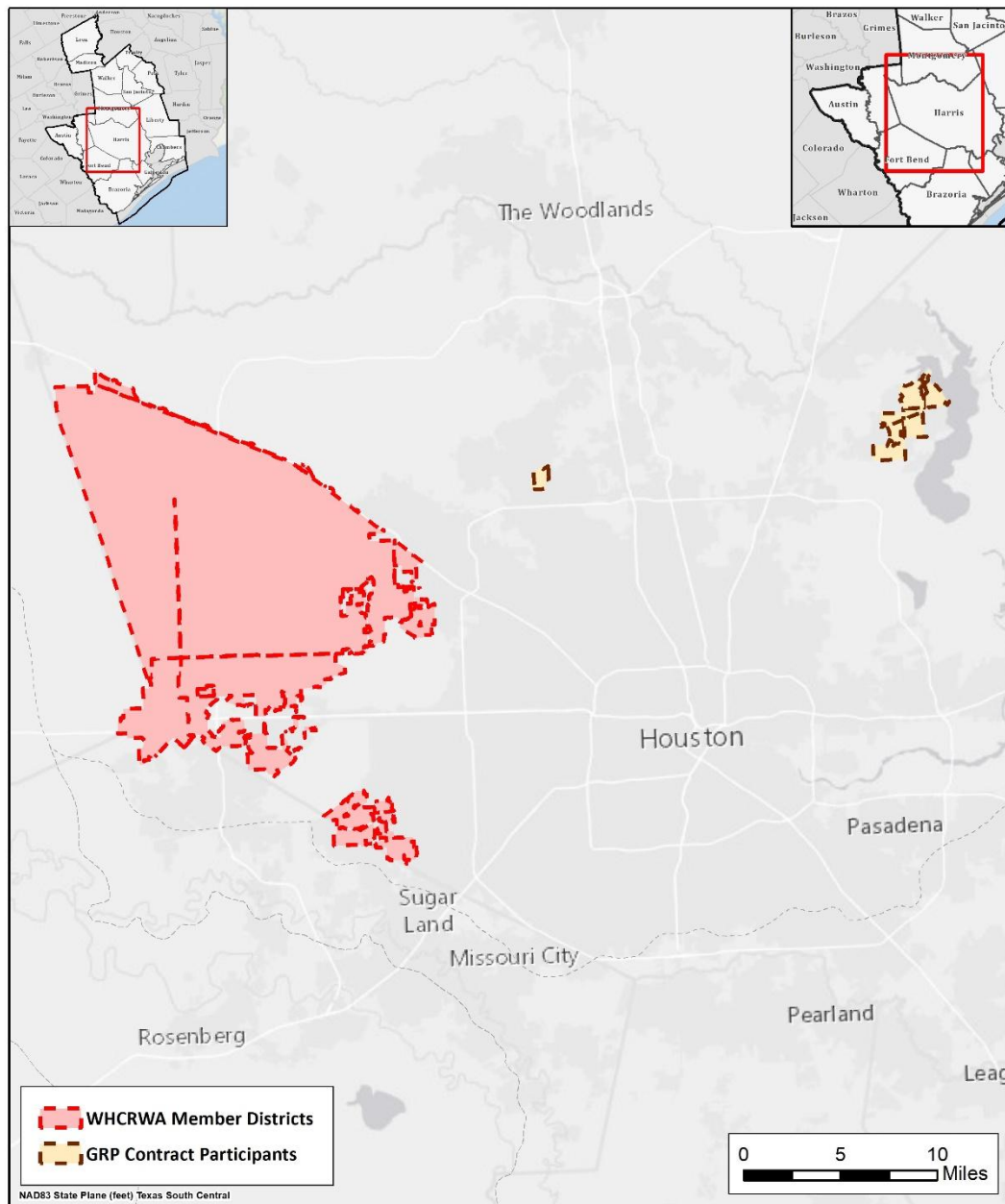
References

Dannenbaum Engineering Corporation. *West Harris County Regional Water Authority Groundwater Reduction Plan*, prepared for WHCRWA, June 2014.

Fort Bend Subsidence District. *Fort Bend Subsidence District 2013 Regulatory Plan*, August 2013.

Harris-Galveston Subsidence District. *Harris-Galveston Subsidence District 2013 District Regulatory Plan*, May 2013.

Location Map



WHCRWA GRP Location Map



Texas

THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	City of Houston Reuse
Project ID:	REUS-001
Project Type:	Reuse
Potential Supply Quantity (Rounded):	Up to 191,139 ac-ft/yr (Up to 170.6 mgd)
Implementation Decade:	2040
Development Timeline:	5-10 years
Project Capital Cost:	\$820,816,940 (Sept. 2023)
Unit Water Cost (Rounded):	\$130 to 3,595 per ac-ft (during loan period) \$20 to 1,748 per ac-ft (after loan period)

Strategy Description

The City of Houston (COH) holds Water Right (WR) 5827 that permits the diversion and reuse of up to 580,923 ac-ft/yr in the San Jacinto River Basin or in the Trinity, Trinity-San Jacinto, and San Jacinto-Brazos Basins through interbasin transfer. This permit relates to more than 30 individual wastewater treatment plant (WWTP) discharges located on the Houston Ship Channel, Greens Bayou, Buffalo Bayou, Cole Creek, Berry Bayou, Keegans Bayou, Brickhouse Gully, White Oak Bayou, Evans Gully, and Lake Houston. In an effort to protect and maintain freshwater inflows to Galveston Bay, the permit limits diversions to 50 percent of the volume discharged on a daily basis from each wastewater treatment plant.

Although this permit was granted in 2011, COH has not yet implemented this permit through infrastructure development, as alternative water supplies have been readily available. Currently, the permit is only used to account for diversions from Lake Houston related to upstream WWTPs in the Kingwood area. This project examines various alternatives for utilizing this water as a supply in the 2026 Region H Regional Water Plan (RWP). Several options for water supply development were considered in detail after a comprehensive review of the permit and potential demands:

1. Greens Bayou Diversion
2. East Water Purification Plant Reuse Supply Diversion
 - a. 69th Street WWTP Diversion
 - b. Sims Bayou North WWTP Diversion
3. Southwest WWTP Diversion

Option 1 provides for the diversion of water from Greens Bayou at the site of the Northeast WWTP from 10 different WWTPs as a source of water to the West Canal to supply downstream industrial customers as well as the EWPP. Permitted discharges from these 10 WWTPs are as much as 45.5 mgd.

Option 2 is a blended, potable reuse alternative to provide water to the EWPP. Water may be diverted

from Buffalo Bayou at the 69th Street WWTP site and/or from Sims Bayou at the Sims Bayou North WWTP, each of which receive flow from seven WWTPs upstream. Diverted return flows may be conveyed through pipeline to the EWPP where it would be blended with water from Lake Houston or the Trinity River Basin before being treated for use as a potable supply. The permitted discharges amount to 267.9 and 143.8 mgd of potential diversions at the 69th Street and Sims Bayou North WWTPs, respectively.

Option 3 involves diverting flow from Brays Bayou at a diversion point at the current location of the Southwest WWTP. Permitted discharges from this location and the four upstream WWTPs are as much as 121.6 mgd. However, Option 3 considers decommissioning the Southwest WWTP, which is currently permitted to discharge up to 60 mgd of treated effluent. Wastewater flows currently treated at this site would be redirected to the Almeda Sims WWTP, increasing the permitted discharges at and upstream from the Sims Bayou North WWTP to as much as 203.8 mgd and decreasing potential diversions at the location of the Southwest WWTP. An advanced water treatment facility (AWTF) would be constructed on the site of the decommissioned WWTP to treat diversions permitted under WR 5827. This option includes a transmission line to convey treated, potable reuse from the AWTF to a connection point in the COH water supply system. To account for the removal of the WWTP co-located with the diversion point, diversions for this option are limited to flows available from the four upstream WWTPs.

Another alternative for the development of reclaimed water supplies utilizing flows captured in this permit is the development of a reclaimed water supply to industrial customers along the Houston Ship Channel originating from the 69th Street and Sims Bayou North WWTPs. This alternative has been studied in past RWP and has not been recommended as a strategy in the 2026 RWP.

The project also supports the City's One Water Houston approach to integrated, sustainable management of water resources.

Strategy Analyses

The project analyses for City of Houston Reuse include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The potential supply available from each of the take points is limited by a number of different factors including:

- Discharge rate of upstream WWTPs as varying over the course of the planning horizon,
- Consideration for bay and estuary inflows as stipulated by WR 5827,
- The instantaneous diversion rate as specified by WR 5827 and infrastructure in place to capture flows,
- Instream flow requirements as specified by WR 5827, and
- Basin hydrology.

In order to evaluate these factors and their impacts on the options presented above, the analysis utilized a model based on existing data sources in order to predict availability over time. This model was used for the evaluation of water availability from all project options.

Naturalized flows from the Texas Commission on Environmental Quality (TCEQ) San Jacinto Basin Water Availability Model (WAM) were extracted to provide a basis for natural stream flows on a monthly basis for a historic period from January 1940 through December 1996. These flows represent naturalized conditions without diversions and discharges made following development of the basin. This data was developed for all four of the proposed diversion points considered by Options 1 through 3. Daily streamflow data was investigated for each diversion point as a basis with which to disaggregate these monthly flow values into daily flow records. Only two points, the 69th Street and Southwest WWTP diversion points, were found to have nearby sources of daily streamflow records that provided an adequate data set for assessment. Daily records for the 69th Street Plant were used in the analysis of the Northeast and Sims Bayou North WWTP points to provide a pattern of daily flow variation although the monthly magnitude for both of these sites was taken from the unique WAM output for each site.

Flows from WWTPs associated with WR 5827 were identified for the year 2010 using information from Environmental Protection Agency (EPA) Discharge Monitoring Report (DMR) data. These discharges were compared against the discharges permitted in WR 5827 to determine the remaining capacity in each plant. The COH population projections for the decades from 2030 through 2080 were used to scale the total wastewater flow from these WWTPs over time, and the total increase in flow was apportioned to the individual WWTPs based on their remaining capacity in 2010. In that way, plants with larger shares of the remaining WWTP capacity were assumed to bear more of the burden as wastewater flows increased over time. These discharges for plants upstream of a diversion point could be added to the naturalized flows identified above to represent actual flow in the channels.

Finally, diversions were assumed to be limited by a number of factors including the maximum diversion rate at the identified diversion point, a limit of 50 percent of the upstream discharges to protect bay and estuary inflows, and the instream flow limits associated with each diversion point. Diversions of effluent from upstream were limited in such a way that diversions could not cause the downstream instream flow targets to not be met on any given day.

Output from the model provided the potential yield that could be developed from the various alternatives in each decade from 2030 through 2080 and also provided a distribution of daily diversion rates at each site over time for use in sizing pump station and pipeline infrastructure. *Table 1* and *Table 2*, below, summarize the potential firm yield of each option and the required plant capacity to develop the supply, respectively.

Table 1 – Potential Firm Yield by Option (ac-ft/yr)

OPTION		2030	2040	2050	2060	2070	2080
1	Greens Bayou	3,678	4,017	4,370	4,543	4,481	4,531
2a	69th Street WWTP	111,702	113,715	115,416	116,192	115,915	116,137
2b	Sims Bayou North WWTP	43,290	46,139	48,547	49,646	49,253	49,568
3	Southwest WWTP	18,827	19,772	20,568	20,929	20,800	20,903
TOTAL		177,498	183,644	188,901	191,311	190,449	191,139

Table 2 – Required Pump Station Capacity by Option (mgd)¹

OPTION		2030	2040	2050	2060	2070	2080
1	Greens Bayou Diversion	5	5	5	5	5	5
2a	69th Street WWTP	100	105	105	105	105	105
2b	Sims Bayou North WWTP	40	45	45	45	45	45
3	Southwest WWTP	20	20	20	20	20	20

¹ In 5 mgd increments.

Environmental Considerations

The majority of the infrastructure required for development of the COH Reuse options would be constructed in developed areas. For instance, Options 2a and 2b both involve construction in industrial areas along the Ship Channel and are not likely to significantly impact habitat. Option 1 has the greatest potential to impact undeveloped areas although the majority of this conveyance is to be constructed within existing right-of-way.

Permitting and Development

The existing WR 5827 provides for the discharge, conveyance, and diversion of effluent throughout the COH service area. However, the use of this water may require additional permitting depending upon use. Of particular concern are options that will make use of reclaimed water for potable uses through blending with alternative supplies. This approach to water management is an emerging source of supply and projects will require some consideration of how to safely and effectively incorporate these projects into existing water portfolios.

Based on a preliminary desktop review, the following environmental permits and permitting activities are likely to apply:

- U.S. Army Corps of Engineers (USACE) Section 404 Permit – All proposed pipeline rights-of-way (ROW), temporary workspace, and access road locations should be delineated for waters of the U.S., including wetlands. The proposed pipeline construction would likely be permitted under Nationwide Permit (NWP) 12-Utility Line Activities either with or without a Pre-construction Notification (PCN) to the USACE depending on the amount of impacts to waters of the U.S. The proposed pipeline that would cross the Houston Ship Channel would require a PCN and a Section 10 permit since the Houston Ship Channel is considered a navigable water of the U.S. by the USACE.
- Texas Historical Commission (THC) Coordination - Projects sponsored by public entities that affect a cumulative area greater than five acres or that disturb more than 5,000 cubic yards require advance consultation with the Texas Antiquities Committee according to Section 191.0525 (d) of the Antiquities Code of Texas. Because the proposed project may exceed these thresholds, coordination with the THC would be required. The THC may determine that archeological and/or historical surveys are needed.
- Threatened and Endangered Species – All proposed pipeline ROW, temporary workspace, and access road locations should be surveyed for potential threatened and endangered species habitat. If preferred habitat for threatened or endangered species is present, presence/absence surveys for the species would be required.

- Discharge and Diversion Points of Redirected WWTP Flows – WR 5827 may require minor amendment to reflect the redirection of wastewater inflows from the Southwest WWTP to the Almeda Sims WWTP and the associated reuse diversion point at Sims Bayou North WWTP.

The construction of pipelines would likely require a Stormwater Pollution Prevention Plan (SWPPP) and a TCEQ Construction General Permit (TXR 150000).

Cost Analysis

Costs were developed for Options 1, 2a, 2b, and 3 using default costing methods for regional plan development, as outlined by TWDB guidance. Cost estimates for each option are summarized below in *Table 3*, and detailed estimates are shown in *Table 4* through *Table 7*. At this time, it has been assumed that flows diverted from the channel will not require additional treatment before being blended with other raw water sources and treated to potable standards. Options 1, 2a, and 2b primarily consist of transmission infrastructure from diversion points to existing water purification plants. Costs for Option 3 are substantially higher than those for Options 1, 2a, and 2b due to the construction of an advanced water treatment facility on the site of the existing Southwest WWTP. The City of Houston Reuse project for the 2026 RWP includes all four of these options, with a projected total capital cost in September 2023 dollars of \$820,816,940.

Table 3 – Project Cost Summary

Option		Project Cost	Potential Firm Yield (ac ft/yr)	Initial Unit Cost (\$/ac ft)
1	Greens Bayou	\$12,736,972	4,531	\$263
2a	69th Street WWTP	\$178,631,795	116,137	\$130
2b	Sims Bayou North WWTP	\$138,484,427	49,568	\$250
3	Southwest WWTP	\$490,963,746	20,903	\$3,595
Total		\$820,816,940	191,139	

Table 4 – Option 1 Project Cost Summary

OPINION OF PROBABLE CONSTRUCTION COST							September 2023
ITEM	DESCRIPTION			QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY							
1	CONSTRUCTION COST			1	LS	\$5,335,734	\$5,335,734
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES			1	LS	\$1,844,805	\$1,844,805
3	LAND AND EASEMENTS			1	LS	\$2,973,300	\$2,973,300
4	ENVIRONMENTAL - STUDIES AND MITIGATION			1	LS	\$2,183,966	\$2,183,966
5	INTEREST DURING CONSTRUCTION			1	LS	\$399,167	\$399,167
PROJECT CAPITAL COST							\$12,736,972

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$896,187	\$896,187	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$126,583	\$126,583	\$126,583	\$126,583	\$126,583
3	PUMPING ENERGY COSTS	\$0	\$32,829	\$32,829	\$32,829	\$32,829	\$32,829
TOTAL ANNUAL COST		\$0	\$1,055,599	\$1,055,599	\$159,412	\$159,412	\$159,412

ITEM DESCRIPTION		ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$1,055,599	\$1,055,599	\$159,412	\$159,412	\$159,412
2	YIELD	3,678	4,017	4,370	4,543	4,481	4,531
3	UNIT COST	\$0	\$263	\$242	\$35	\$36	\$35
TOTAL UNIT COST							\$101

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$4,881,700	\$4,881,700
2	PIPELINES	1	LS	\$414,956	\$414,956
3	PIPELINE CROSSINGS	1	LS	\$39,078	\$39,078
PROJECT COST					\$5,335,734

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$4,881,700	\$122,043
2	PIPELINES	1.0	%	\$414,956	\$4,150
3	PIPELINE CROSSINGS	1.0	%	\$39,078	\$391
ANNUAL OPERATION AND MAINTENANCE COST					\$126,583

Table 5 – Option 2a Project Cost Summary

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$116,021,892	\$116,021,892
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$35,489,618	\$35,489,618
3	LAND AND EASEMENTS	1	LS	\$19,170,800	\$19,170,800
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$2,351,295	\$2,351,295
5	INTEREST DURING CONSTRUCTION	1	LS	\$5,598,189	\$5,598,189
PROJECT CAPITAL COST					\$178,631,795

ITEM DESCRIPTION		ANNUAL TOTAL					
ANNUAL COST SUMMARY							
		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$12,568,725	\$12,568,725	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$1,365,134	\$1,365,134	\$1,365,134	\$1,365,134	\$1,365,134
3	PUMPING ENERGY COSTS	\$0	\$900,719	\$900,719	\$900,719	\$900,719	\$900,719
TOTAL ANNUAL COST		\$0	\$14,834,579	\$14,834,579	\$2,265,853	\$2,265,853	\$2,265,853

ITEM DESCRIPTION		ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$14,834,579	\$14,834,579	\$2,265,853	\$2,265,853	\$2,265,853
2	YIELD	111,702	113,715	115,416	116,192	115,915	116,137
3	UNIT COST	\$0	\$130	\$129	\$20	\$20	\$20
TOTAL UNIT COST							\$53

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$13,661,014	\$13,661,014
2	PIPELINES	1	LS	\$98,227,268	\$98,227,268
3	PIPELINE CROSSINGS	1	LS	\$4,133,610	\$4,133,610
PROJECT COST					\$116,021,892

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$13,661,014	\$341,525
2	PIPELINES	1.0	%	\$98,227,268	\$982,273
3	PIPELINE CROSSINGS	1.0	%	\$4,133,610	\$41,336
ANNUAL OPERATION AND MAINTENANCE COST					\$1,365,134

Table 6 – Option 2b Project Cost Summary

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$86,598,026	\$86,598,026
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$27,302,374	\$27,302,374
3	LAND AND EASEMENTS	1	LS	\$17,905,800	\$17,905,800
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$2,338,227	\$2,338,227
5	INTEREST DURING CONSTRUCTION	1	LS	\$4,340,000	\$4,340,000
PROJECT CAPITAL COST					\$138,484,427

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$9,743,913	\$9,743,913	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$1,262,870	\$1,262,870	\$1,262,870	\$1,262,870	\$1,262,870
3	PUMPING ENERGY COSTS	\$0	\$525,944	\$525,944	\$525,944	\$525,944	\$525,944
TOTAL ANNUAL COST		\$0	\$11,532,728	\$11,532,728	\$1,788,814	\$1,788,814	\$1,788,814

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$11,532,728	\$11,532,728	\$1,788,814	\$1,788,814	\$1,788,814
2	YIELD	43,290	46,139	48,547	49,646	49,253	49,568
3	UNIT COST	\$0	\$250	\$238	\$36	\$36	\$36
TOTAL UNIT COST							\$99

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$26,459,320	\$26,459,320
2	PIPELINES	1	LS	\$56,382,852	\$56,382,852
3	PIPELINE CROSSINGS	1	LS	\$3,755,854	\$3,755,854
PROJECT COST					\$86,598,026

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$26,459,320	\$661,483
2	PIPELINES	1.0	%	\$56,382,852	\$563,829
3	PIPELINE CROSSINGS	1.0	%	\$3,755,854	\$37,559
ANNUAL OPERATION AND MAINTENANCE COST					\$1,262,870

Table 7 – Option 3 Project Cost Summary

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$328,767,692	\$328,767,692
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$113,825,536	\$113,825,536
3	LAND AND EASEMENTS	1	LS	\$21,990,650	\$21,990,650
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$10,993,426	\$10,993,426
5	INTEREST DURING CONSTRUCTION	1	LS	\$15,386,442	\$15,386,442
PROJECT CAPITAL COST					\$490,963,746

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$34,544,738	\$34,544,738	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$36,167,346	\$36,167,346	\$36,167,346	\$36,167,346	\$36,167,346
3	PUMPING ENERGY COSTS	\$0	\$366,274	\$366,274	\$366,274	\$366,274	\$366,274
TOTAL ANNUAL COST		\$0	\$71,078,358	\$71,078,358	\$36,533,620	\$36,533,620	\$36,533,620

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$71,078,358	\$71,078,358	\$36,533,620	\$36,533,620	\$36,533,620
2	YIELD	18,827	19,772	20,568	20,929	20,800	20,903
3	UNIT COST	\$0	\$3,595	\$3,456	\$1,746	\$1,756	\$1,748
TOTAL UNIT COST							\$2,067

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$9,468,282	\$9,468,282
2	PIPELINES	1	LS	\$23,115,469	\$23,115,469
3	PIPELINE CROSSINGS	1	LS	\$1,747,666	\$1,747,666
4	ADVANCED WATER TREATMENT FACILITY	1	LS	\$294,436,275	\$294,436,275
PROJECT COST					\$328,767,692

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$9,468,282	\$236,707
2	PIPELINES	1.0	%	\$23,115,469	\$231,155
3	PIPELINE CROSSINGS	1.0	%	\$1,747,666	\$17,477
4	ADVANCED WATER TREATMENT FACILITY	1.0	LS	\$35,682,008	\$35,682,008
ANNUAL OPERATION AND MAINTENANCE COST					\$36,167,346

Water Management Strategy Evaluation

Based on the analysis provided above, the City of Houston Reuse project was evaluated across twelve different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1-5	Options 1, 2a, and 2b provide raw water and are very economical compared to alternative raw water supply projects. Option 3 provides treated water at a high cost.
Location	4	Water supplies are already permitted for use in the identified basins of need. Projects include transmission infrastructure to convey water to existing treatment plants and/or connect to existing water supply system.
Water Quality	3	The project takes advantage of existing and planned discharges in the Houston area.
Environmental Land and Habitat	4	Majority of projects are to be constructed in already-developed areas or existing rights-of-way.
Environmental Flows	2	Projects will reduce the level of flows returned to streams to a level planned for during permitting process.
Local Preference	4	Support for reuse and water-efficient projects in the area.
Institutional Constraints	3	Property acquisition required for project development.
Development Timeline	4	Larger alternatives may take approximately 10 years to implement although others may be developed much sooner.
Sponsorship	4	City of Houston is committed to reuse as a long-term project.
Vulnerability	4	Potential impacts from water quality events upstream and the opportunity for damage to critical infrastructure.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	3	This project is not expected to impact other strategies.

The COH Reuse concepts presented include up to 15 miles of pipelines depending on final configuration of the project which will impact an associated 90 acres of land. The majority of this impact will be in urbanized areas with limited impacts to habitat. The project may potentially reduce return flows to various basins by as much as 191,139 ac-ft/yr. However, this reduction in return flows may also correlate to a reduction in diversions of surface water from other basins. These diversions are already permitted for consumptive use under the City of Houston's Water Right 5827 which accounts for environmental flows. COH Reuse is not anticipated to impact agricultural land or production.

Water User Group Application

The City of Houston Reuse project 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.

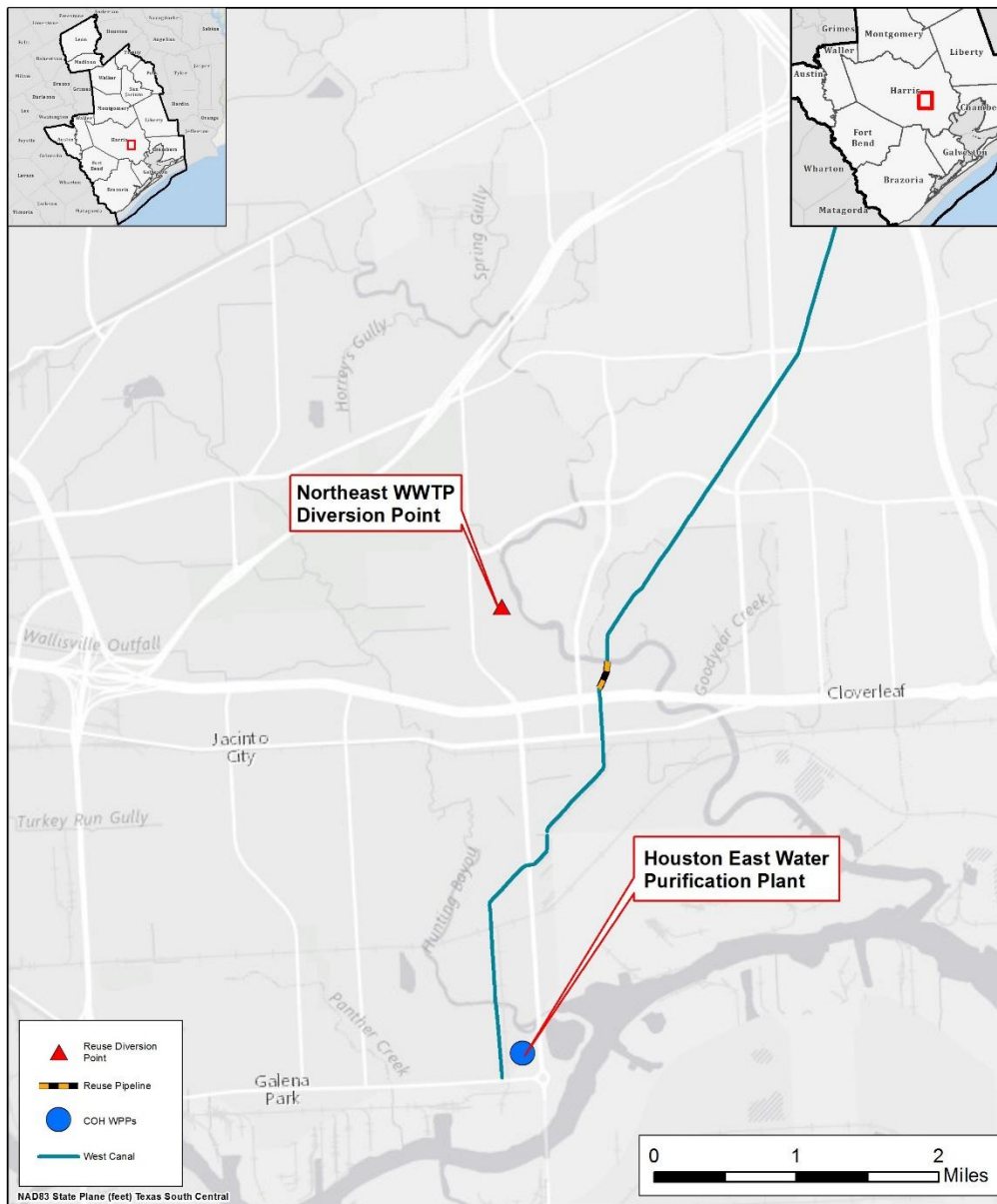
CRITERIA	WUG SUITABILITY
Proximity	Withdrawal of the identified reclaimed source is generally limited to the permitted diversion points. However, use of existing and proposed infrastructure may make the supply available for use by COH and its customers.
Size	The concentration of reclaimed supplies through bed and banks transfer makes it possible to develop this project to fairly significant volumes of water commensurate with the demands projected for COH and its service area.
Water Quality	The reclaimed water projects will deliver raw water to two treatment plants which may be treated and used for meeting any potential need. Option 3 will provide treated water of quality that is acceptable for municipal use.
Unit Cost	The unit cost for the project varies based on capacity and the specifics of each option. However, the identified unit costs of the raw water options are economical compared to other long-term raw water options.
Other Factors	This project requires the use of reclaimed water blended with other sources as a potable drinking water supply in Options 1 and 2 and the direct treatment and reuse of reclaimed water as a potable supply in Option 3. These are emerging practices and may take some time to be fully adopted.

References

Texas Commission on Environmental Quality. *Water Right Permit Number 5827*, May 2011.

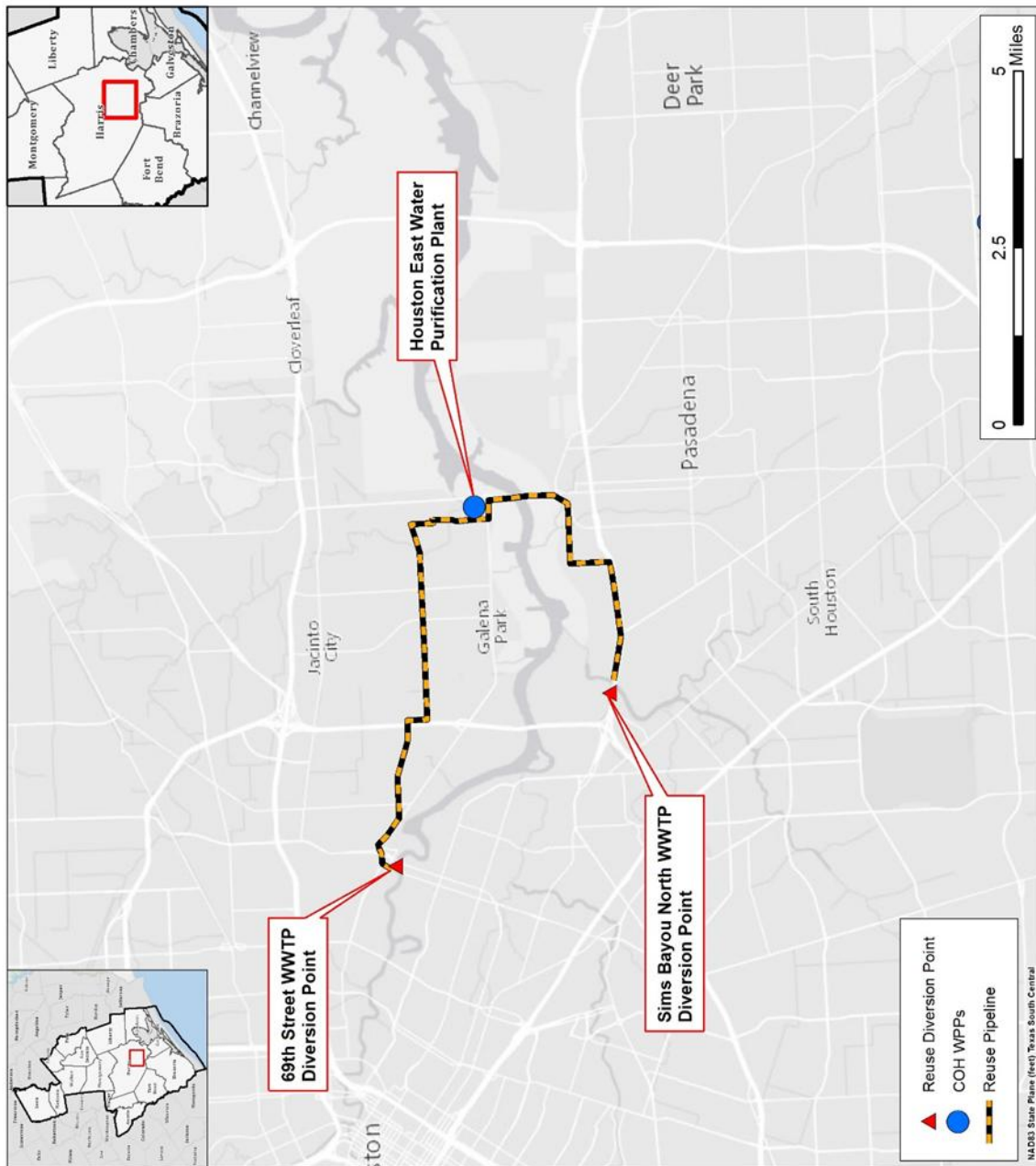
Texas Parks and Wildlife, https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/listed-species/, Accessed May 16, 2019.

Texas Parks and Wildlife, <https://tpwd.texas.gov/gis/rtest/>, Accessed April 8, 2019.

Location Map – Option 1**Houston Reuse Option 1
Location Map**

Texas

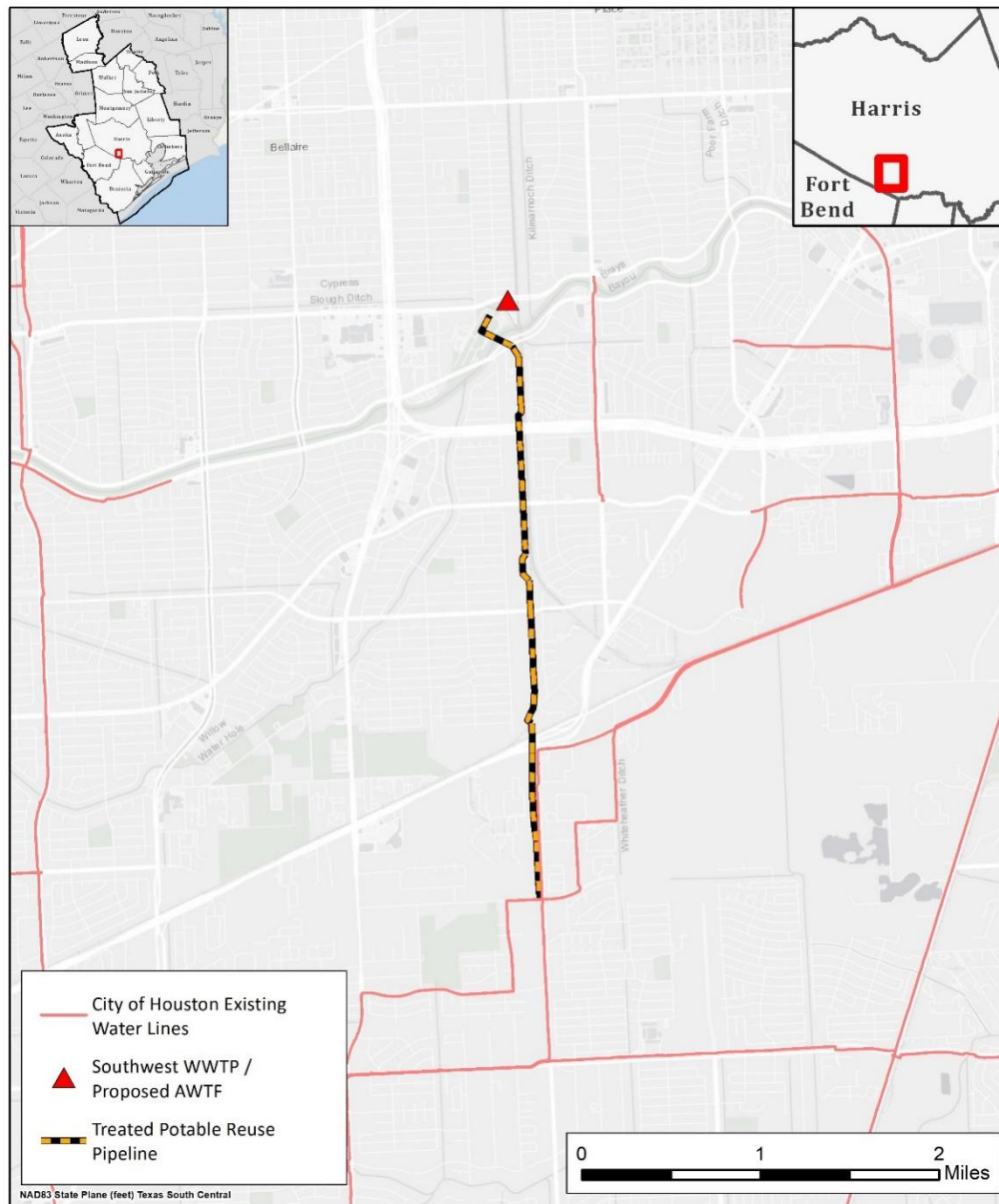
Location Map – Options 2a and 2b



Houston Reuse Option 2 Location Map



Location Map – Option 3



Houston Reuse Option 3 Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	City of Pearland Reuse
Project ID:	REUS-002
Project Type:	Reuse
Potential Supply Quantity (Rounded):	314 - 1,154 ac-ft/yr (0.25 - 1 mgd)
Implementation Decade:	2040
Development Timeline:	<5 years per phase
Project Capital Cost:	\$24,161,522 (Sept. 2023)
Unit Water Cost (Rounded):	\$1,683 per ac-ft (during loan period) \$210 per ac-ft (after loan period)

Strategy Description

To plan for future growth and reduce dependence on groundwater, the City of Pearland has identified opportunities to meet irrigation and other demands through effluent reuse from its existing wastewater treatment facilities.

Strategy Analyses

The project analyses for the City of Pearland Reuse project include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The City of Pearland has five wastewater treatment plants (WWTPs) which are capable of producing Type 1 effluent for reuse. Type 1 indicates a high-quality effluent treated to acceptable standards for application where contact with the public is likely. Pearland is considering utilizing a portion of this effluent for municipal irrigation at two locations; one site will use approximately 0.25 mgd (280 ac-ft/yr) while the other smaller location will receive 0.03 mgd (34 ac-ft/yr). This amount is anticipated to increase in subsequent decades. While Pearland has not yet established a target volume for this expanded reuse, for purposes of the Regional Plan it was assumed that, at a minimum, it would be possible for Pearland to supply three additional irrigation locations with 280 ac-ft/yr of reuse supply each. Considered in context of the City of Pearland's projected year 2040 water demand of 23,675 ac-ft, this is intended to serve as a conservative estimate, and it is possible that Pearland could elect to utilize reuse in excess of this amount.

Environmental Considerations

The direct reuse of the effluent source supply would be expected to have some degree of impact in terms of reduction of instream flows downstream of the WWTP discharge point for any portion of the source supply originating from current levels of return flow. Any reuse from the portion of return flow generated from future demand growth would not be expected to create additional instream flow reductions, as this portion of potential supply is not yet generated or discharged.

Permitting and Development

The source WWTP facilities for the project already generate effluent treated to the required standards for the intended use and therefore limited permitting effort is anticipated. Some minor permitting effort may be required as part of transmission infrastructure development.

Cost Analysis

A detailed estimate of project cost is not available for the project at this time. A preliminary planning estimate of project cost was developed using standard cost estimate procedures for Region H. It was assumed for this estimate that 314 ac-ft of supply would be developed for year 2040, with infrastructure limited to three miles of 6-inch pipeline, a booster pump station, and a ground storage tank. Future reuse expansion was estimated with three additional reuse areas, each requiring similar infrastructure. It was assumed for both phases that all construction could be accommodated within existing easements and plant sites. Costs presented in *Table 1*, including debt service and costs for operations and maintenance, were calculated using standard cost estimation procedures for Region H.

Table 1 – City of Pearland Reuse Project Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$16,518,843	\$16,518,843
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$5,333,354	\$5,333,354
3	LAND AND EASEMENTS	1	LS	\$119,251	\$119,251
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$691,492	\$691,492
5	INTEREST DURING CONSTRUCTION	1	LS	\$1,498,582	\$1,498,582
PROJECT CAPITAL COST					\$24,161,522

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (PHASE 1)	\$0	\$428,917	\$428,917	\$0	\$0	\$0
	DEBT SERVICE (PHASE 2)	\$0	\$0	\$1,271,113	\$1,271,113	\$0	\$0
2	OPERATION AND MAINTENANCE (PHASE 1)	\$0	\$54,436	\$54,436	\$54,436	\$54,436	\$54,436
	OPERATION AND MAINTENANCE (PHASE 2)	\$0	\$0	\$159,708	\$159,708	\$159,708	\$159,708
3	PUMPING ENERGY COSTS	\$0	\$8,101	\$28,384	\$28,384	\$28,384	\$28,384
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$0	\$491,455	\$1,942,559	\$1,513,642	\$242,528	\$242,528

ITEM DESCRIPTION		ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$491,455	\$1,942,559	\$1,513,642	\$242,529	\$242,529
2	YIELD	-	314	1,154	1,154	1,154	1,154
3	UNIT COST	\$0	\$1,565	\$1,683	\$1,312	\$210	\$210
TOTAL UNIT COST							\$899

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$3,263,700	\$3,263,700
2	PIPELINES	1	LS	\$8,964,832	\$8,964,832
3	WATER STORAGE TANKS	1	LS	\$4,290,311	\$4,290,311
PROJECT COST					\$16,518,843

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$3,263,700	\$81,593
2	PIPELINES	1.0	%	\$8,964,832	\$89,648
3	WATER STORAGE TANKS	1.0	%	\$4,290,311	\$42,903
ANNUAL OPERATION AND MAINTENANCE COST					\$214,144

Water Management Strategy Evaluation

Based on the analysis provided above, the City of Pearland Reuse project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Costs are high during debt service and are reduced considerably after completion of debt service.
Location	4	Source located near points of demand with some conveyance infrastructure required.
Water Quality	3	No known issues regarding water quality. The project is expected to produce Type 1 effluent suitable for the intended use.
Environmental Land and Habitat	4	Minimal impacts anticipated.
Environmental Flows	2	Some decrease in environmental flows below WWTPs.
Local Preference	4	No known opposition.
Institutional Constraints	5	Minimal or no permitting challenges or opposition expected.
Development Timeline	5	Project development, including permitting, could be accomplished in approximately five years or less.
Sponsorship	4	Sponsor is identified and committed to project.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	1	Project would primarily serve the sponsor entity.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

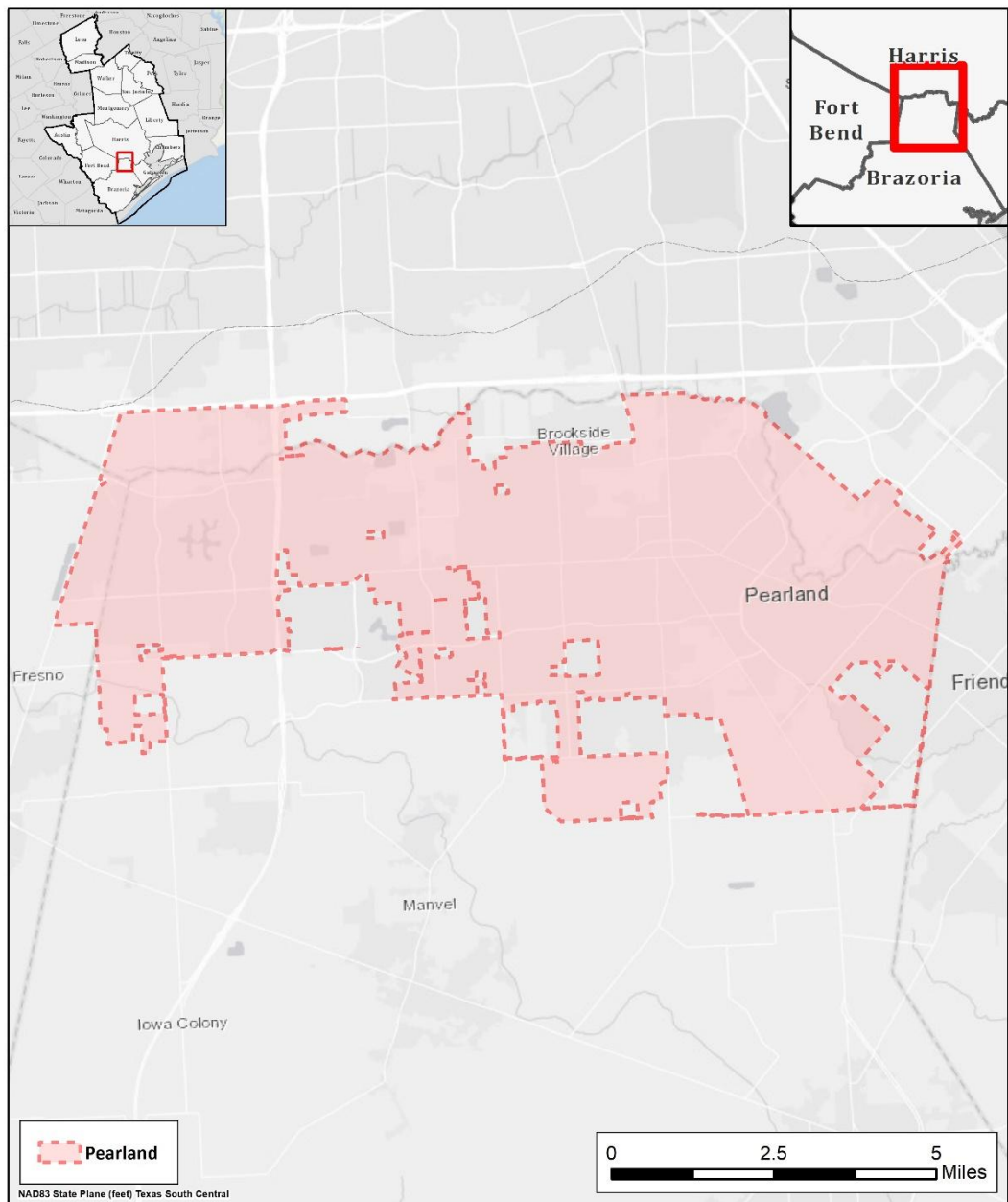
City of Pearland Reuse is not anticipated to affect acreage or vulnerable species. The project may potentially reduce return flows by as much as 1,154 ac-ft/yr. However, this reduction in return flows may also correlate to a reduction in diversions of surface water from other basins. City of Pearland Reuse is not anticipated to impact agricultural land or production.

Water User Group Application

The City of Pearland Reuse project 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 anticipated that the project will only serve the City of Pearland and any entities that it provides with water supply.

CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use, with some limited conveyance infrastructure required.
Size	Project begins with a relatively small volume but is anticipated to expand with time.
Water Quality	The WWTPs which would provide the effluent supply for this project are able to produce high quality Type 1 effluent.
Unit Cost	The cost of this project is high and decreases substantially after completion of debt service.
Other Factors	This project reduces groundwater dependence.

Location Map



City of Pearland Reuse Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	GCWA Municipal Reuse
Project ID:	REUS-003
Project Type:	Reuse
Potential Supply Quantity (Rounded):	16,800 ac-ft/yr (15.0 mgd)
Implementation Decade:	2030
Development Timeline:	5 years
Project Capital Cost:	\$11,014,500 (Sept. 2023)
Unit Water Cost (Rounded):	\$79 per ac-ft (during loan period) \$33 per ac-ft (after loan period)

Strategy Description

League City is located primarily in northern Galveston County with some water service area in southeastern Harris County. The City is supplied primarily with surface water from the Gulf Coast Water Authority (GCWA) and City of Houston (COH). Surface water supply from GCWA is obtained from the Brazos River Basin in Galveston County and supply from the COH is obtained from the Trinity River in Harris County. The City also produces some self-supplied groundwater from the Gulf Coast Aquifer. Historically, League City has directly reused treated wastewater effluent to irrigate golf courses throughout the City, other irrigation, chemical feed, and wash down of equipment at the City's wastewater treatment plant (WWTP). As League City's population and water demands continue to grow, there will be greater volumes of wastewater effluent that can be treated and reused for the aforementioned historical uses, as well as for irrigation of commercial and residential development common areas and landscaping. In turn, this could potentially reduce the City's needs for other water supply sources.

Strategy Analyses

The project analyses for the GCWA Municipal Reuse include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The size of a potential reuse project was estimated based on the projected water demands for League City. It was assumed that up to 15 mgd (16,800 ac-ft per year) of effluent could be reused by 2030. Project infrastructure consists primarily of pump station and transmission elements to facilitate use of effluent treated at existing WWTPs.

Environmental Considerations

Environmental impacts of the project would be examined in detail during the Texas Commission on Environmental Quality (TCEQ) permitting or permit amendment process. The study includes areas within the Brazos and Trinity River Basins, which are subject to environmental flow requirements, including those established in accordance with 30 TAC §298 which establish seasonal requirements for flows. Any increase in reuse at current levels of wastewater flows would cause some reduction in return flows. Any portion of the supply based on return flow from future growth rather than existing development would not be expected to further reduce streamflow.

Infrastructure required for implementation of this project would consist primarily of limited conveyance infrastructure to connect to points of use. Use of existing easements or replacement of existing supply conveyances would minimize habitat impacts.

Permitting and Development

Use of reclaimed wastewater effluent requires approval and permitting by the TCEQ under the requirements of 30 TAC §210. TCEQ classifies reclaimed water as Type 1 (higher quality for use where public contact is likely) or Type 2 (for uses with limited risk of human contact). Due to the potential for human contact, supplies for this project would have to be treated to Type 1 quality standards. If approved for use, the reclaimed water would have to be sampled and analyzed a minimum of twice per week. League City is currently planning a new WWTP that will have treatment processes capable of achieving Type 1 requirements.

Cost Analysis

Costs associated with future expanded reuse for irrigation would largely be associated with development of pumping and transmission infrastructure to connect to points of use. Costs were developed for the project based on the estimated cost and infrastructure capacity data provided by the project sponsor, in conjunction with standard Regional Water Planning costing procedures and assumptions. Costs for mitigation are anticipated to be minimal and were assumed to be included in the costs provided by the sponsor. Annualized debt service, pumping energy costs, and costs of operation and maintenance were estimated using standard assumptions for Region H. Estimated costs are presented in *Table 1*.

Table 1 – GCWA Municipal Reuse Project Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$8,916,500	\$8,916,500
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$1,678,400	\$1,678,400
3	LAND AND EASEMENTS	1	LS	\$0	\$0
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$419,600	\$419,600
PROJECT CAPITAL COST					\$11,014,500

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$774,992	\$774,992	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$185,338	\$185,338	\$185,338	\$185,338	\$185,338	\$185,338
3	PUMPING ENERGY COSTS	\$371,218	\$371,218	\$371,218	\$371,218	\$371,218	\$371,218
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$1,331,548	\$1,331,548	\$556,556	\$556,556	\$556,556	\$556,556

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$1,331,548	\$1,331,548	\$556,556	\$556,556	\$556,556	\$556,556
2	YIELD	16,800	16,800	16,800	16,800	16,800	16,800
3	UNIT COST	\$79	\$79	\$33	\$33	\$33	\$33
TOTAL UNIT COST		\$49					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$6,411,500	\$6,411,500
2	PIPELINES	1	LS	\$2,505,000	\$2,505,000
PROJECT COST					\$8,916,500

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$6,411,500	\$160,288
2	PIPELINES	1.0	%	\$2,505,000	\$25,050
ANNUAL OPERATION AND MAINTENANCE COST					\$185,338

Water Management Strategy Evaluation

Based on the analysis provided above, the GCWA Municipal Reuse project was evaluated across 12 different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	Proposed project is expected to deliver at a very low cost due limited need for additional infrastructure.
Location	5	Source located near points of demand with minimal conveyance infrastructure required.

CRITERIA	RATING	EXPLANATION
Water Quality	3	No known issues regarding water quality.
Environmental Land and Habitat	5	No impacts / minimal impacts.
Environmental Flows	2	Minor reduction in environmental flows.
Local Preference	4	Direct reuse for non-potable uses is already being done by the City. No known opposition.
Institutional Constraints	3	Minimal permitting challenges or opposition expected.
Development Timeline	5	Project development, including permitting, could be accomplished in approximately five years or less.
Sponsorship	4	Project sponsor identified.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	2	Serves sponsor entity and supports a limited number of associated systems.
Impacts on Other WMS	3	No significant impacts recognized to other projects. Could reduce irrigation demands on other supply sources.

The GCWA Municipal Reuse project includes no additional pipeline construction for subsequent phases of conversion. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The GCWA Municipal Reuse project was assumed to serve the needs of the League City Water User Group (WUG). This information was considered in context of 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 project as well as other factors that may relate to the applicability of the project to the WUG(s) served.

CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use.
Size	Overall project supply volume is relatively small but is appropriate to the target irrigation demands, including golf courses and greenspaces.
Water Quality	This project provides a treated water source that may primarily used to serve irrigation demands.
Unit Cost	The cost of this project is minimal and appropriate to the target use.

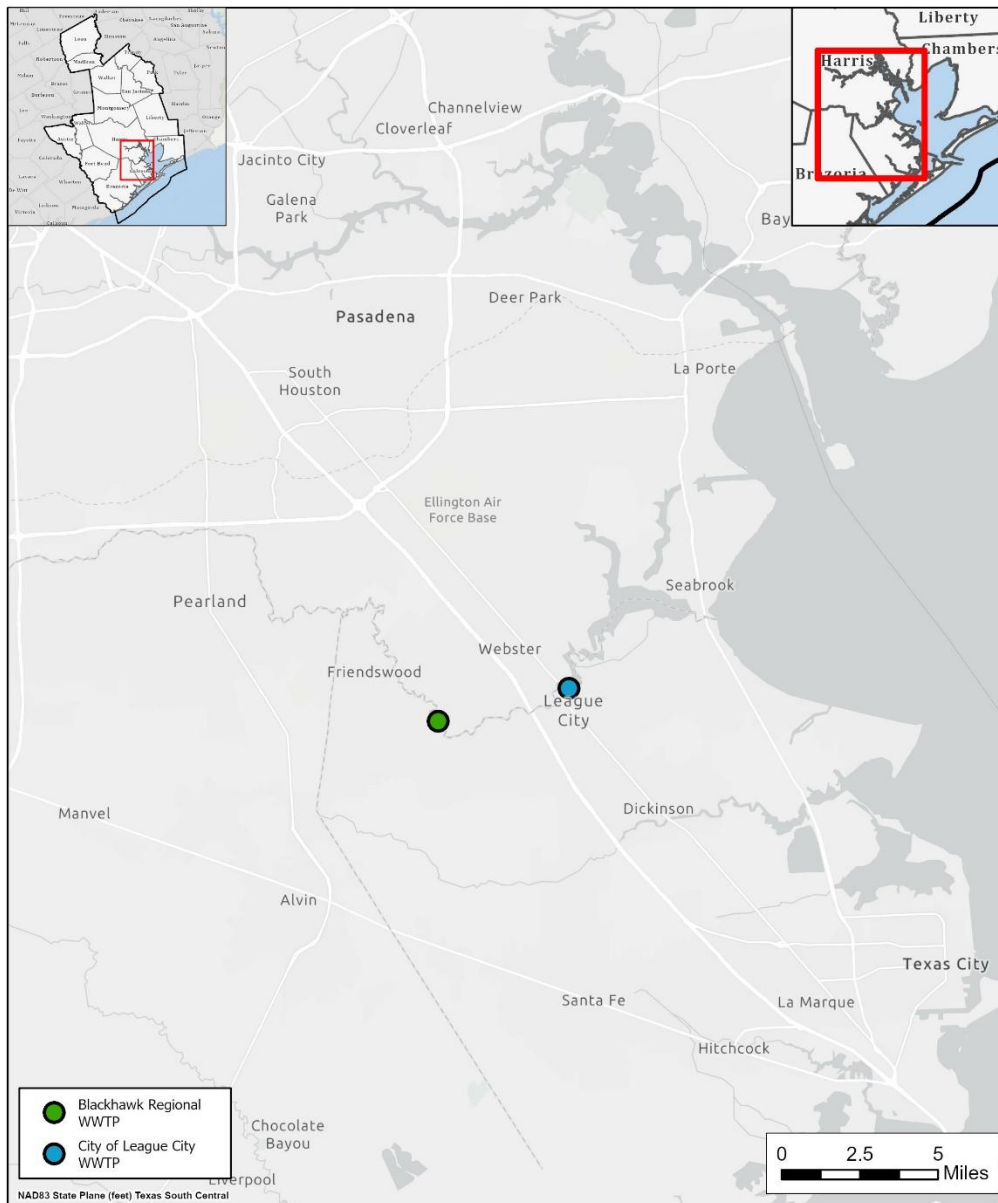
CRITERIA	WUG SUITABILITY
Other Factors	Some reuse permitting or permit amendment effort may be necessary for the sponsor WUGs to implement this project.

References

League City Water Reuse, City of League City. 2024. <https://www.leaguecitytx.gov/3315/Water-Reuse>

Texas Water Development Board, Water Use Surveys. 2024.

Location Map



GCWA Municipal Reuse Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	North Fort Bend Water Authority Member District Reuse
Project ID:	REUS-004
Project Type:	Reuse
Potential Supply Quantity (Rounded):	5,600 ac-ft/yr (5.0 mgd)
Implementation Decade:	2030
Development Timeline:	1 – 3 years
Project Capital Cost:	\$66,013,267 (Sept. 2023)
Unit Water Cost (Rounded):	\$1,573 per ac-ft (during loan period) \$744 per ac-ft (after loan period)

Strategy Description

Population growth in Region H over recent decades has spurred the development of direct wastewater reuse facilities to assist water systems in meeting water demands from golf courses, greenspace, and maintenance of amenity lakes. The North Fort Bend Water Authority (NFBWA) has identified a number of existing Municipal Utility Districts (MUDs) within its boundaries which are developing new wastewater reclamation projects for the purpose of supplying outdoor water demands.

Strategy Analyses

The project analyses for NFBWA Member District Reuse include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The water systems within NFBWA are supplied primarily by treated surface water delivered by NFBWA or by groundwater from the Gulf Coast Aquifer pumped by the member districts. Reuse of wastewater flows would create a new supply of water for meeting outdoor water demands. Reuse systems of this type would produce high quality effluent, which would have to be treated to TCEQ Type 1 reclaimed water standards due to the potential for public contact.

NFBWA has identified a number of member districts, listed in *Table 1*, with reuse projects in various stages of design and construction. For purposes of the Regional Water Plan, effluent supply availability was estimated from projected population for the applicable member districts and projected per-capita demands for NFBWA after application of recommended conservation and water loss reduction WMS. A return flow factor of 40 percent based on analyses from prior RWPs was then applied, with availability also constrained by the anticipated infrastructure capacity for each system.

Due to potential variations among systems regarding future growth in outdoor water needs, supplies for the project were conservatively assumed to remain level through year 2080.

Table 1 – NFBWA Member Districts Pursuing Reuse Projects

Municipal Utility Districts
Cinco Southwest MUD No. 1
Fort Bend County MUD No. 34
Fort Bend County MUD No. 35
Fort Bend County MUD No. 57
Fort Bend County MUD No. 118
Fort Bend County MUD No. 122
Fort Bend County MUD No. 123
Fort Bend County MUD No. 133
Fort Bend County MUD No. 146
Fort Bend County MUD No. 151
Fort Bend County MUD No. 182
Fort Bend County MUD No. 185
Fort Bend County MUD No. 194
Grand Lakes MUD

Environmental Considerations

The diversion of the effluent source supply would be expected to have some degree of impact in terms of reduction of instream flows downstream of plant facilities for any portion of the source supply originating from current levels of return flow. Any reuse from the portion of return flow generated from future demand growth would not be expected to create additional instream flow reductions, as this portion of potential supply is not yet generated or discharged.

Permitting and Development

Use of reclaimed wastewater effluent requires approval and permitting by the TCEQ under the requirements of 30 Texas Administrative Code (TAC) §210. TCEQ classifies reclaimed water as Type 1 (higher quality for use where public contact is likely) or Type 2 (for uses with limited risk of human contact). Due to the potential for human contact, supplies for this project would have to be treated to Type 1 quality standards. If approved for use, the reclaimed water would have to be sampled and analyzed a minimum of twice per week.

Cost Analysis

A preliminary planning level cost estimate was prepared for NFBWA Member District Reuse using default costing methods for regional plan development. Costs were developed based on basic costing guidelines as outlined by TWDB guidance. Cost calculations assumed infrastructure components would include a tertiary treatment facility, ground storage tanks, a pump station, and one mile of pipeline for each participating member district. Costs for interest during construction and annualized costs (debt service, operations and maintenance, and energy) were estimated using standard Regional Planning costing reference data. Estimated costs are presented in *Table 2*.

Table 2 – NFBWA Member District Reuse Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$45,287,622	\$45,287,622
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$15,420,431	\$15,420,431
3	LAND AND EASEMENTS	1	LS	\$161,669	\$161,669
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$1,049,172	\$1,049,172
5	INTEREST DURING CONSTRUCTION	1	LS	\$4,094,374	\$4,094,374
PROJECT CAPITAL COST					\$66,013,267

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$4,644,765	\$4,644,765	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$4,013,137	\$4,013,137	\$4,013,137	\$4,013,137	\$4,013,137	\$4,013,137
3	PUMPING ENERGY COSTS	\$150,617	\$150,617	\$150,617	\$150,617	\$150,617	\$150,617
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$8,808,518	\$8,808,518	\$4,163,754	\$4,163,754	\$4,163,754	\$4,163,754

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$8,808,518	\$8,808,518	\$4,163,754	\$4,163,754	\$4,163,754	\$4,163,754
2	YIELD	5,600	5,600	5,600	5,600	5,600	5,600
3	UNIT COST	\$1,573	\$1,573	\$744	\$744	\$744	\$744
TOTAL UNIT COST		\$1,020					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$9,178,500	\$9,178,500
2	PIPELINES	1	LS	\$8,604,734	\$8,604,734
3	WATER STORAGE TANKS	1	LS	\$11,722,717	\$11,722,717
4	WASTEWATER RECLAMATION PLANTS	1	LS	\$15,781,671	\$15,781,671
PROJECT COST					\$45,287,622

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$9,178,500	\$229,463
2	PIPELINES	1.0	%	\$8,604,734	\$86,047
3	WATER STORAGE TANKS	1.0	%	\$11,722,717	\$117,227
4	WASTEWATER RECLAMATION PLANTS	1.0	LS	\$3,580,400	\$3,580,400
ANNUAL OPERATION AND MAINTENANCE COST					\$4,013,137

Water Management Strategy Evaluation

Based on the analysis provided above, the NFBWA Member District Reuse project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Cost is high but decreases after completion of debt service.
Location	5	Direct reuse infrastructure would be located in close proximity to points of water use.
Water Quality	3	The project is expected to produce Type 1 effluent suitable for the intended use.
Environmental Land and Habitat	4	Minimal impacts anticipated.
Environmental Flows	2	Diversion of discharges would create reduction in environmental flows.
Local Preference	3	No known opposition to the proposed project.
Institutional Constraints	3	Permits expected with minimal problems.
Development Timeline	5	Project could be developed in a relatively short period of time.
Sponsorship	5	Individual member districts have notified NFBWA of intent to pursue reuse and are in various stages of planning and construction.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	2	Implemented primarily at the individual member district level. Overall strategy serves a limited number of systems but supports overall regionalization in conjunction with other projects.
Impacts on Other WMS	3	No significant impacts recognized to other project.

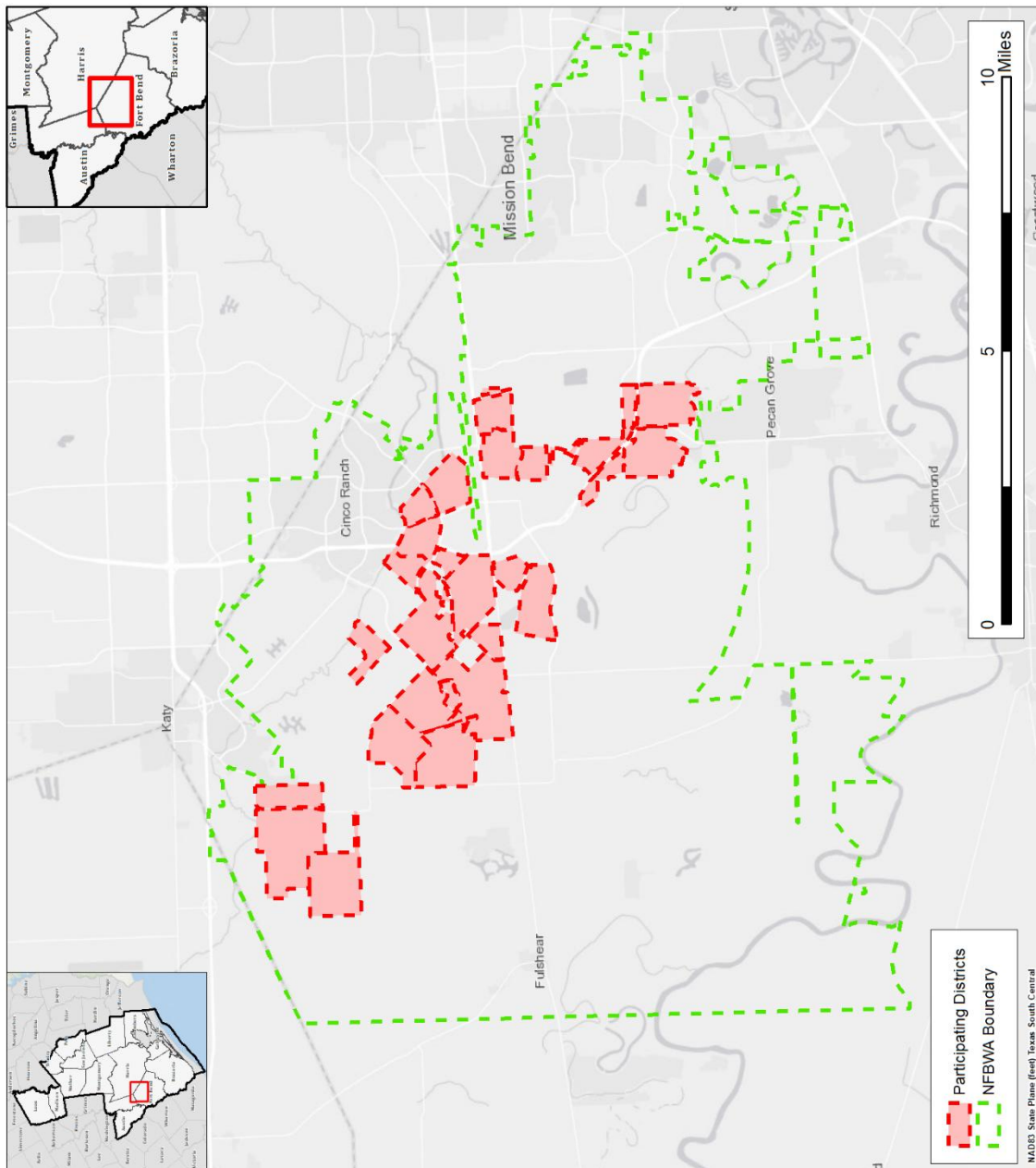
The NFBWA Member District Reuse project is not anticipated to affect acreage or vulnerable species and is not anticipated to impact agricultural land or production. The project may potentially reduce return flows by as much as 4,280 ac-ft/yr.

Water User Group Application

The NFBWA Member District Reuse project 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 anticipated that the project will only serve the member districts in NFBWA developing reuse infrastructure.

CRITERIA	WUG SUITABILITY
Proximity	Project diversion point located in close proximity to intended points of use.
Size	Overall project supply volume is appropriate to the intended use.
Water Quality	The project is expected to produce Type 1 effluent suitable for the intended use.
Unit Cost	Cost is high but decreases after completion of debt service.
Other Factors	Implementation of supply from this project requires permitting through TCEQ.

Location Map



NFBWA Member District Reuse Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	North Harris County Regional Water Authority Member District Reuse
Project ID:	REUS-005
Project Type:	Reuse
Potential Supply Quantity (Rounded):	300 ac-ft/yr (0.3 mgd)
Implementation Decade:	2030
Development Timeline:	1 – 3 years
Project Capital Cost:	\$5,441,580 (Sept. 2023)
Unit Water Cost (Rounded):	\$2,206 per ac-ft (during loan period) \$929 per ac-ft (after loan period)

Strategy Description

Population growth in Region H over recent decades has spurred the development of direct wastewater reuse facilities to assist water systems in meeting water demands from golf courses and greenspace. The North Harris County Regional Water Authority (NHCRWA) has identified the potential for one or more of its member districts to develop new wastewater reclamation projects for the purpose of supplying existing golf course or green space water demands.

Strategy Analyses

The project analyses for NHCRWA Member District Reuse include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The water systems within NHCRWA are supplied primarily by treated surface water delivered by NHCRWA or by groundwater from the Gulf Coast Aquifer pumped by member districts. Reuse of wastewater flows would create a new supply of water for meeting golf course or greenspace irrigation demands. A reuse system of this type would produce high quality effluent, which would have to be treated to TCEQ Type 1 reclaimed water standards due to the potential for public contact. Supply volume was conservatively estimated as 300 ac-ft/yr to approximate the supply for a single golf course; implementation of reclaimed water infrastructure by multiple member districts could generate a larger supply.

Environmental Considerations

The diversion of the effluent source supply would be expected to have some degree of impact in terms

of reduction of instream flows downstream of plant facilities for any portion of the source supply originating from current levels of return flow. Any reuse from the portion of return flow generated from future demand growth would not be expected to create additional instream flow reductions, as this portion of potential supply is not yet generated or discharged.

Permitting and Development

Use of reclaimed wastewater effluent requires approval and permitting by the TCEQ under the requirements of 30 Texas Administrative Code (TAC) §210. TCEQ classifies reclaimed water as Type 1 (higher quality for use where public contact is likely) or Type 2 (for uses with limited risk of human contact). Due to the potential for human contact, supplies for this project would have to be treated to Type 1 quality standards. If approved for use, the reclaimed water would have to be sampled and analyzed a minimum of twice per week.

Cost Analysis

A preliminary planning level cost estimate was prepared for NHCRWA Member District Reuse using default costing methods for regional plan development. Costs were developed based on basic costing guidelines as outlined by TWDB guidance. Cost calculations assumed infrastructure components would include a tertiary treatment facility, ground storage tanks, a pump station, and one mile of pipeline. Costs for interest during construction and annualized costs (debt service, operations and maintenance, and energy) were estimated using standard Regional Planning costing reference data. Estimated costs are presented in *Table 1*.

Table 1 – NHCRWA Member District Reuse Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$3,710,990	\$3,710,990
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$1,261,493	\$1,261,493
3	LAND AND EASEMENTS	1	LS	\$15,758	\$15,758
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$115,833	\$115,833
5	INTEREST DURING CONSTRUCTION	1	LS	\$337,506	\$337,506
PROJECT CAPITAL COST					\$5,441,580

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$382,875	\$382,875	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$272,905	\$272,905	\$272,905	\$272,905	\$272,905	\$272,905
3	PUMPING ENERGY COSTS	\$5,944	\$5,944	\$5,944	\$5,944	\$5,944	\$5,944
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$661,724	\$661,724	\$278,849	\$278,849	\$278,849	\$278,849

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$661,724	\$661,724	\$278,849	\$278,849	\$278,849	\$278,849
2	YIELD	300	300	300	300	300	300
3	UNIT COST	\$2,206	\$2,206	\$929	\$929	\$929	\$929
TOTAL UNIT COST		\$1,355					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$760,300	\$760,300
2	PIPELINES	1	LS	\$747,069	\$747,069
3	WATER STORAGE TANKS	1	LS	\$1,074,524	\$1,074,524
4	WASTEWATER RECLAMATION PLANTS	1	LS	\$1,129,097	\$1,129,097
PROJECT COST					\$3,710,990

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$760,300	\$19,008
2	PIPELINES	1.0	%	\$747,069	\$7,471
3	WATER STORAGE TANKS	1.0	%	\$1,074,524	\$10,745
4	WASTEWATER RECLAMATION PLANTS	1.0	LS	\$235,682	\$235,682
ANNUAL OPERATION AND MAINTENANCE COST					\$272,905

Water Management Strategy Evaluation

Based on the analysis provided above, the NHCRWA Member District Reuse project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Cost is high but decreases after completion of debt service.
Location	5	Direct reuse infrastructure would be located in close proximity to points of water use.
Water Quality	3	The project is expected to produce Type 1 effluent suitable for the intended use.
Environmental Land and Habitat	4	Minimal impacts anticipated.
Environmental Flows	2	Diversion of discharges would create reduction in environmental flows.
Local Preference	3	No known opposition to the proposed project.
Institutional Constraints	3	Permits expected with minimal problems.
Development Timeline	5	Project could be developed in a relatively short period of time.
Sponsorship	3	Commitment level by individual member districts is uncertain.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	2	Implemented primarily at the individual member district level. Overall strategy serves a limited number of systems but supports overall regionalization in conjunction with other projects.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

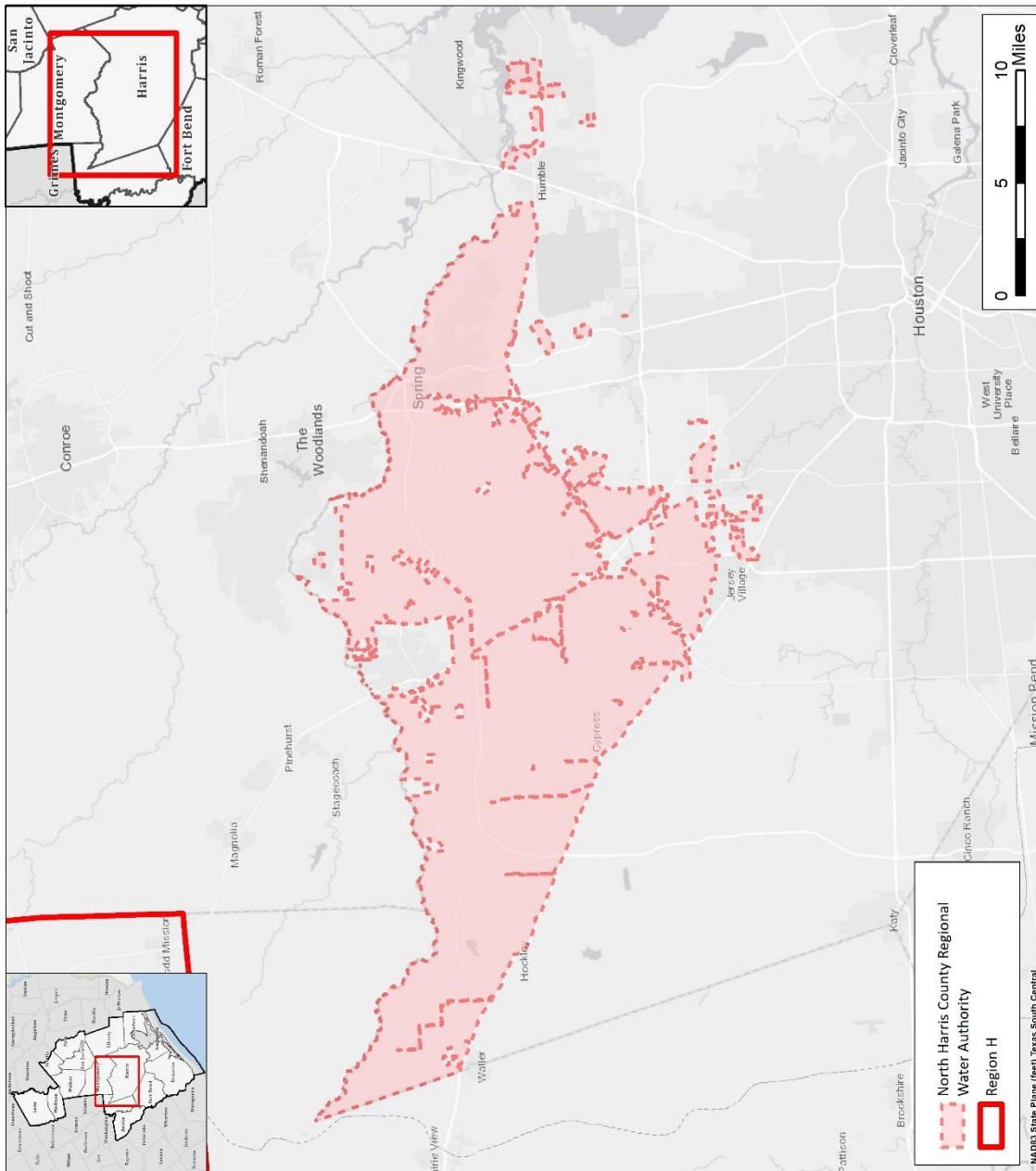
The NHCRWA Member District Reuse project is not anticipated to affect acreage or vulnerable species and is not anticipated to impact agricultural land or production. The project may potentially reduce return flows by as much as 300 ac-ft/yr.

Water User Group Application

The NHCRWA Member District Reuse project 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 anticipated that the project will only serve the member districts on NHCRWA developing reuse infrastructure.

CRITERIA	WUG SUITABILITY
Proximity	Project diversion point located in close proximity to intended points of use.
Size	Overall project supply volume is appropriate to the intended use.
Water Quality	The project is expected to produce Type 1 effluent suitable for the intended use.
Unit Cost	Cost is high but decreases after completion of debt service.
Other Factors	Implementation of supply from this project requires permitting through TCEQ.

Location Map



NHCRWA Member District Reuse Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	River Plantation Reuse
Project ID:	REUS-006
Project Type:	Reuse
Potential Supply Quantity (Rounded):	51 ac-ft/yr (0.05 mgd)
Implementation Decade:	2030
Development Timeline:	5 years
Project Capital Cost:	\$0 (Sept. 2023)
Unit Water Cost (Rounded):	\$0 per ac-ft (during loan period) \$0 per ac-ft (after loan period)

Strategy Description

In order to address demand growth and protect groundwater resources, River Plantation Municipal Utility District (MUD) in conjunction with East Plantation Utility District (UD) and the River Plantation Country Club have implemented use of reclaimed water to offset groundwater use for golf course and green space irrigation. In order to address growing demands within Montgomery County, additional reuse capacity from existing reuse infrastructure could be utilized to meet an increased amount of anticipated municipal water demand. Based on prior analyses for the River Plantation and East Plantation Joint Groundwater Reduction Plan (GRP), the amount of reuse applied to irrigation demands could be increased from current levels of approximately 83 million gallons per year (mgy) to 100 mgy by year 2030.

Strategy Analyses

The project analyses for River Plantation Reuse include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Assessment of supply availability for the River Plantation Reuse was evaluated and summarized within the GRP document and supporting analysis. River Plantation MUD has operated reuse infrastructure since 1988 and currently produces approximately 83 mgy (256 ac-ft/yr) of reclaimed water for golf course irrigation, with the capacity to convey up to 100 mgy (307 ac-ft/yr) to its reuse irrigation system. Prior studies indicate that the source wastewater treatment plant currently regularly produces over 100 million gallons of effluent per year.

Environmental Considerations

Environmental impacts of the project would be examined in detail during the Texas Commission on Environmental Quality (TCEQ) permitting or permit amendment process. The study includes areas within the San Jacinto River Basin, which is subject to environmental flow requirements, including those established in accordance with 30 TAC §298 which establish seasonal requirements for flows. Any increase in reuse at current levels of wastewater flows would cause some reduction in return flows. Any portion of the supply based on return flow from future growth rather than existing development would not be expected to further reduce streamflow.

Infrastructure required for implementation of this project would consist primarily of limited conveyance infrastructure to connect to points of use. Use of existing easements or replacement of existing groundwater supply conveyances would minimize habitat impacts.

Permitting and Development

Use of reclaimed wastewater effluent requires approval and permitting by the TCEQ under the requirements of 30 TAC §210. TCEQ classifies reclaimed water as Type 1 (higher quality for use where public contact is likely) or Type 2 (for uses with limited risk of human contact). Due to the potential for human contact, supplies for this project would have to be treated to Type 1 quality standards. If approved for use, the reclaimed water would have to be sampled and analyzed a minimum of twice per week.

Cost Analysis

Costs associated with future expanded reuse for irrigation have not yet been determined but are expected to be minimal, as much of the treatment and transmission infrastructure is currently in place. Implementation of this project would result in additional annual costs for increased volume of advanced treatment, pumping energy, and operations and maintenance, although increased annual costs for a project of the scale specified are likely minimal. As this project includes the use of a future water supply that does not result in additional infrastructure cost, no project cost is included for the strategy.

Water Management Strategy Evaluation

Based on the analysis provided above, the River Plantation Reuse project was evaluated across 12 different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	Proposed project is expected to deliver at a very low cost due to limited need for additional infrastructure.
Location	5	Source located near points of demand with minimal conveyance infrastructure required.
Water Quality	3	No known issues regarding water quality.

CRITERIA	RATING	EXPLANATION
Environmental Land and Habitat	5	No impacts / minimal impacts.
Environmental Flows	2	Minor reduction in environmental flows.
Local Preference	4	Project identified in prior studies. No known opposition.
Institutional Constraints	3	Minimal permitting challenges or opposition expected.
Development Timeline	5	Project development, including permitting, could be accomplished in approximately five years or less.
Sponsorship	4	Project is identified as a component of the sponsors' GRP.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	2	Serves sponsor entity and supports a limited number of associated systems.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

The River Plantation Reuse project includes no additional pipeline construction for subsequent phases of conversion. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

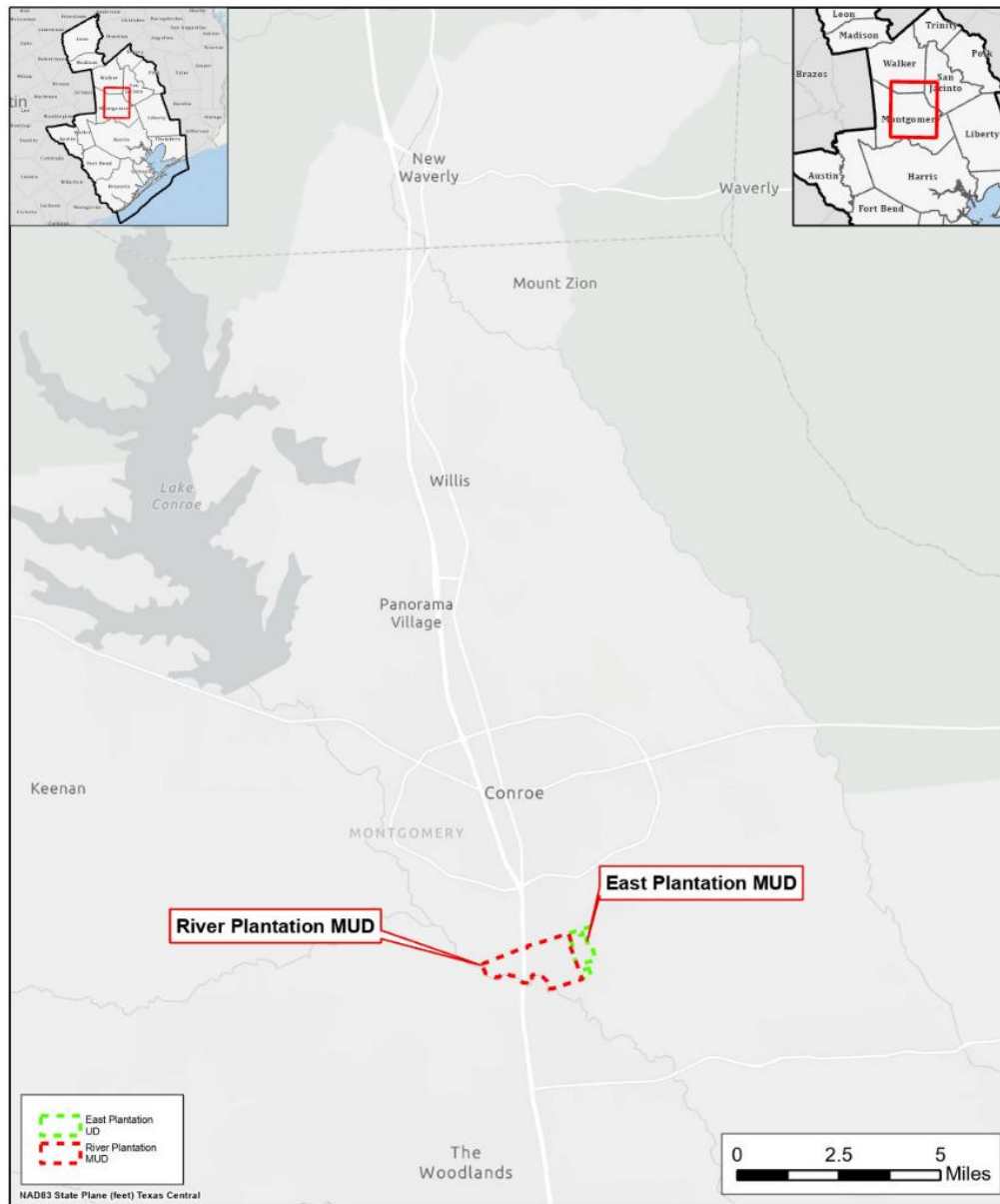
Determination of the Water User Groups (WUGs) to which the River Plantation Reuse project may be applied was evaluated based on the entities identified in the GRP document. This information was considered in context of the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the project as well as other factors that may relate to the applicability of the project to the WUGs served.

CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use.
Size	Overall project supply volume is relatively small but is appropriate to the target greenspace and golf course irrigation demands.
Water Quality	This project provides a high-quality raw water source that may be used to meet greenspace and golf course demands.
Unit Cost	The cost of this project is minimal and appropriate to the target use.
Other Factors	Some reuse permitting or permit amendment effort may be necessary for the sponsor WUGs to implement this project.

References

Bleyl and Associates, *River Plantation Municipal Utility District, East Plantation Utility District, River Plantation Country Club Joint Groundwater Reduction Plan*, prepared for River Plantation MUD, March 2011.

Location Map



River Plantation Reuse Location Map



Texas

THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	San Jacinto Basin Regional Return Flows
Project ID:	REUS-007
Project Type:	Reuse
Potential Supply Quantity (Rounded):	87,996 – 116,913 ac-ft/yr (78.5 to 104.3 mgd)
Implementation Decade:	2030
Development Timeline:	5 years
Project Capital Cost:	\$0 (Sept. 2023)
Unit Water Cost (Rounded):	\$0 per ac-ft

Strategy Description

Lake Houston is located at the confluence of the East and West Forks of the San Jacinto River and receives flow from an extensive network of streams within the San Jacinto Basin. This entire area is anticipated to undergo considerable growth over the upcoming decades which will inevitably contribute to increased return flows to Lake Houston and its contributing streams, which serves as ideal locations for capturing available flows for use as an additional water supply.

Several existing water right permits dictate the use of water diverted from Lake Houston. These rights are owned by the City of Houston (COH) and the San Jacinto River Authority (SJRA); some benefit from storage in Lake Houston while others are run-of-the-river diversions that share a diversion point with the reservoir. These rights are summarized in *Table 1*, below. Water Right 4964 serves SJRA's Highlands System and is diverted from Lake Houston although it does not benefit from storage in the reservoir. Water Right 4965 is the original right associated with Lake Houston and both permits and benefits from the reservoir's substantial storage capacity. In 2003, COH and SJRA jointly permitted excess yield identified in Lake Houston totaling 32,500 ac-ft/yr. In addition, 80,000 ac-ft/yr of excess flows were also permitted for diversion when available. Conceptually, this permit allows for the diversion of return flows from the upper portion of the basin. However, since these return flows are not specifically called out in the permit, they are not considered in the firm yield analysis for Region H. SJRA's Water Right 5809 permits the use of return flows from wastewater treatment plants in The Woodlands in Montgomery County up to 14,944 ac-ft/yr. Finally, COH's permit 5827 includes diversion of as much as 12,770 ac-ft/yr (11.4 mgd) of return flows from the Kingwood Central and Kingwood West Wastewater Treatment Plants (WWTPs).

Table 1 – Existing Water Rights at Lake Houston

Permit	Priority Year	Diversion (Ac Ft/Yr)	Owner(s)	Lake Houston Storage?
4964	1942/44	55,000	SJRA	No
4965	1940/44	168,000	COH	Yes
5807	2003	28,200	COH/SJRA	Yes
5808	2003	80,000	COH/SJRA	No
5809	2003	14,944	SJRA	No
5827	2004	12,770*	COH	No

**Includes only the portion of WR 5827 that may be diverted at Lake Houston, which is the permitted discharge of the City of Houston's Kingwood West and Kingwood Central WWTPs as referenced in WR 5827.*

Besides permits for diversions from Lake Houston, several reuse permits already exist in the San Jacinto River Basin. SJRA and the City of Conroe obtained permits to use up to 10 mgd (11,200 ac-ft/yr) of return flows generated by the City of Conroe, which are discharged to the West Fork of the San Jacinto River upstream of Lake Houston. Other permits for use of return flows in the San Jacinto River Basin include indirect/direct reuse permits owned by the City of Huntsville in Walker County and Montgomery County MUDs 8 and 9, River Plantation MUD, the City of Panorama Village, and The Woodlands in Montgomery County. All return flows modeled by Region H as available for use under existing permits would have to be deducted from a Regional Return Flows permit.

As the regional population grows, return flows are expected to increase along with development and overall water use. In developing its Groundwater Reduction Plan (GRP), SJRA contractually retained the right to return flows related to surface water provided to its customers. The City of Conroe has also pursued indirect reuse opportunities and has applied for and received a permit for the groundwater-sourced portion of its effluent. North Harris County Regional Water Authority (NHCRWA) has also contractually retained the right to return flows related to surface water provided to its customers.

This project aims to capture, on a firm yield basis, return flows associated with current unpermitted wastewater discharges and future growth in the San Jacinto River Basin above Lake Houston.

Strategy Analyses

The project analyses for San Jacinto Basin Regional Return Flows include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Identification of potential return flows was aided by the existence of a Geographic Information System (GIS) layer of spatial location of projected population growth throughout Harris and Montgomery Counties used for the development of population projections at the census block level. This is a similar layer to the one used for the development of population and demand projections for the 2026 Region H Regional Water Plan (RWP) and the Joint Regulatory Plan Review (JRPR) performed by Harris-Galveston Subsidence District (HGSD) and Fort Bend Subsidence District (FBSD). For contributing

basin area in counties outside of the JRPR study area, a ratio of project contributing area coverage to total WUG area was applied to Regional Planning population projections. Population projections at the most detailed level available were intersected with the Region H WUG spatial dataset and drainage sub-areas of the San Jacinto River Basin to determine estimated population in each section of the project contributing area. Intersected areas with a density less than a threshold of 0.75 persons per acre (a value based on records of on-site septic systems in the Lake Conroe watershed) were assumed to use on-site treatment and therefore not to generate return flows until the projected population density exceeded that threshold. Per-capita demand values were determined for each municipal WUG after application of Advanced Municipal Conservation and Water Loss Reduction strategies. In areas meeting or exceeding the population density threshold, populations were then multiplied by the post-conservation per-capita demand values to estimate projected water demand associated with the project area.

A return flow factor of 40 percent was applied to estimate effluent generated that could potentially be permitted. Although return flow ratios to demand are typically higher than 40 percent in many parts of the greater Houston area, the selected factor is similar to observed return flows from suburban growth north of Houston where most of the contributing demands for this project occur.

As noted previously, not all return flows generated within the project contributing area will be available to the project due to pre-existing reuse authorizations. Flows for existing reuse authorizations were deducted from the project availability estimate. An additional five percent loss factor was applied to account for channel losses. Return flow availability estimates for the strategy are summarized in *Table 2*. The project supply volume includes projected effluent originating from both surface water and groundwater-based supplies, the proportions of which will change over time. The project supply listed in *Table 2* reflects the highest level of supply available to the project; any additional constraints applied to an associated reuse permit could impact project yield.

Table 2 – Summary of Reuse Authorizations and Availability

Component	Flow Volume (ac ft/yr)					
	2020	2030	2040	2050	2060	2070
Post-Conservation Water Demand ^a	341,748	359,015	384,124	401,149	419,135	432,209
Total Return Flows	123,615	127,551	149,441	155,702	162,520	167,296
Availability Reductions ^b	35,619	36,931	42,522	45,377	47,849	50,383
Maximum Project Supply	87,996	90,620	106,919	110,325	114,671	116,913

a. Projected demands after reductions based on recommended strategies: Advanced Municipal Conservation and Water Loss Reduction.

b. Availability reductions for existing authorizations and channel loss.

Environmental Considerations

Environmental impacts of the project would be examined in detail during the TCEQ permitting process. The San Jacinto Basin is subject to environmental flow requirements, including those established in accordance with 30 TAC §298 which establishes seasonal requirements for flows. As the measurement points associated with 30 TAC §298 pulse flow requirements are located between the discharge locations and Lake Houston, return flows associated with this project would be conveyed through the associated channels regardless of the project diversion and should therefore not reduce frequency of pulse flow target achievement. Furthermore, these flows should increase

with population growth over time.

Diversions from the current level of return flows could potentially show some impacts below Lake Houston. Environmental analysis would be performed during the permitting phase, with impacts dependent on permit terms. During the development of the 2016 Region H Regional Water Plan, Region H examined the potential impacts of the Regional Return Flows project on bay and estuary inflows using the TCEQ Water Availability Models (WAMs). A worst-case analysis assuming full consumptive use of diverted return flows indicated that for most moisture conditions and seasons, impacts of the project would be limited and attainment of flow requirements under 30 TAC §298 would be achieved.

Since no construction or soil disturbance would occur, permitting and/or coordination with the U.S. Army Corps of Engineers and Texas Historical Commission would not be required. Also, no impacts to threatened or endangered species due to construction or soils disturbance are anticipated.

Permitting and Development

This project would require a water right permit from TCEQ to establish legal authorization over the source return flows. Due to the location-specific nature of reuse authorizations, exact permit requirements would be determined by TCEQ during the application review process. At a minimum the permit would, by the nature of its water right priority date, be subject to existing environmental flow requirements including those established in accordance with 30 TAC §298. A permit would also be expected to include water conservation plan requirements as well as specified monitoring and reporting requirements.

Also, any permit granted would be limited in volume to the authorized discharge of source wastewater treatment plants (WWTPs). Authorized discharge capacity within the study area currently exceeds the strategy volume identified for initial decades. As such, the Regional Return Flows project could be initiated under current discharge permit volumes. Later in the planning horizon, when anticipated available project supply exceeds authorized discharge amounts, a permit amendment would be required in order to capture additional availability.

Cost Analysis

The costs associated with developing this project are included under other infrastructure projects that will make use of the supply developed by this strategy.

Water Management Strategy Evaluation

Based on the analysis provided above, the San Jacinto Basin Regional Return Flows project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	This project provides a raw water supply though permit that would rely upon other infrastructure to perfect it as a source of supply.

CRITERIA	RATING	EXPLANATION
Location	4	Conveyance may be performed through existing and potential future conveyances considered under separate projects.
Water Quality		Project takes advantage of existing and planned discharges in the San Jacinto basin and does not contribute additional wastewater flows.
Environmental Land and Habitat	5	No direct impacts from permit-based project. Some impacts may occur under other more localized projects to utilize the supply created by permitting return flows.
Environmental Flows		
Local Preference	3	No known opposition to the proposed project.
Institutional Constraints		
Development Timeline	5	Permit could be developed in a relatively short period of time.
Sponsorship	3	Potential sponsors are engaged in permit application for a regional return flows concept.
Vulnerability	5	Minimal risk to availability of supply.
Regionalization	5	Supports numerous systems and expands upon existing multiple regionalized supplies.
Impacts on Other WMS	5	The project would provide substantial additional supply which could be utilized by other projects.

San Jacinto Basin Regional Return Flows are not anticipated to affect vulnerable species or agricultural land and production. This project may potentially reduce return flows to the San Jacinto River Basin by as much as 116,913 ac-ft/yr of surface water from various basins. Additionally, this appropriation would be bound by the limits of instream and bay and estuary flow requirements in place for the San Jacinto River Basin.

Water User Group Application

The San Jacinto Basin Regional Return Flows project 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.

CRITERIA	WUG SUITABILITY
Proximity	
Size	This project is easily scaled to meet needs of various sizes.
Water Quality	
Unit Cost	The project is a low-cost project although other infrastructure projects would be required to fully utilize its potential.
Other Factors	There is potential for the availability of this source to increase over time.

References

Texas Commission on Environmental Quality, Water Right Permit Number 3960, March 1986.

Texas Commission on Environmental Quality, Water Right Permit Number 4964, February 1987.

Texas Commission on Environmental Quality, Water Right Permit Number 4965, February 1987.

Texas Commission on Environmental Quality, Water Right Permit Number 5807, December 2008.

Texas Commission on Environmental Quality, Water Right Permit Number 5808, September 2009.

Texas Commission on Environmental Quality, Water Right Permit Number 5809A, July 2012.

Texas Commission on Environmental Quality, Water Right Permit Number 5827, May 2011.

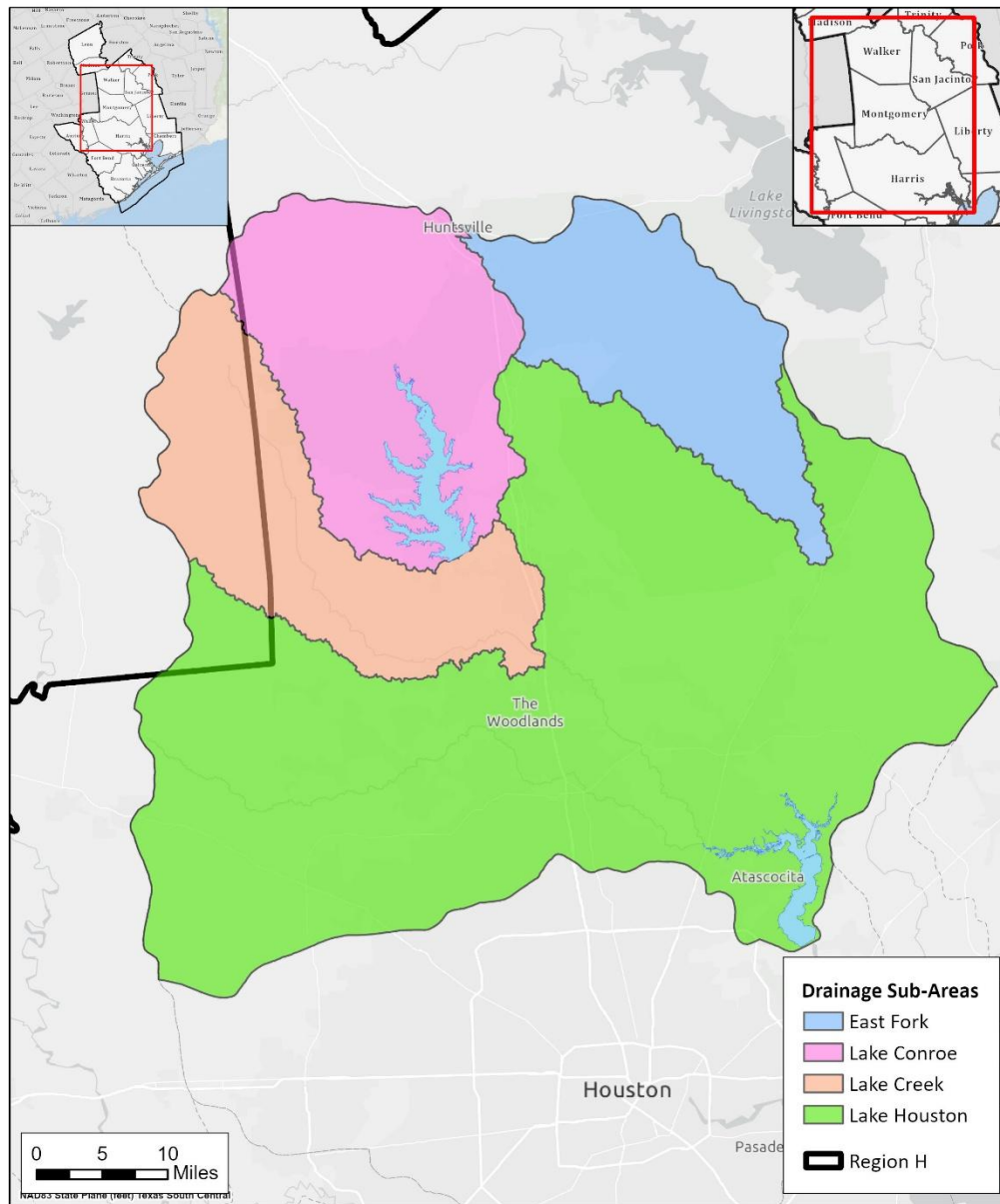
Texas Commission on Environmental Quality, Water Right Permit Number 12510, August 2017.

Texas Commission on Environmental Quality, Water Right Permit Number 12754, August 2017.

Texas Commission on Environmental Quality, Water Right Permit Number 12788, August 2018.

Texas Commission on Environmental Quality, Water Right Permit Number 13183, May 2019.

Location Map



San Jacinto Basin Regional Return Flows Location Map



Texas

THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Texas City Industrial Complex Reuse
Project ID:	REUS-008
Project Type:	Reuse
Potential Supply Quantity (Rounded):	11,200 ac-ft/yr (10 mgd)
Implementation Decade:	2040
Development Timeline:	<5 years
Project Capital Cost:	\$47,509,000 (Sept. 2023)
Unit Water Cost (Rounded):	\$385 per ac-ft (during loan period) \$87 per ac-ft (after loan period)

Strategy Description

Gulf Coast Water Authority (GCWA) supplies a number of industrial and agricultural customers in Galveston County with surface water from the Brazos River Basin and San Jacinto-Brazos Coastal Basin. GCWA holds several water rights in these basins and supplies its customers with surface water from these rights as well as contractual supplies purchased from the Brazos River Authority (BRA). In addition to these surface water sources, GCWA is evaluating a wastewater reclamation project for the treatment and reuse of industrial wastewater by customers in Galveston County.

Strategy Analyses

The project analyses for Texas City Industrial Complex Reuse include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The Texas City Industrial Complex Reuse project is in the concept development process. For the purposes of the 2026 Region H Regional Water Plan (RWP), a yield of 10 mgd has been assumed from available wastewater discharges from likely project participants. Treated industrial discharges in the Texas City industrial area would subsequently be conveyed to additional treatment infrastructure and finished to quality standards as required by the end users before being conveyed back to participating GCWA industrial customers.

Environmental Considerations

Infrastructure development may result in some construction disturbance. However, conveyance infrastructure is expected to follow existing easements in a developed area and is unlikely to impact habitat.

Permitting and Development

Use of reclaimed wastewater effluent requires approval and permitting by the TCEQ under the requirements of 30 Texas Administrative Code (TAC) §210. TCEQ classifies reclaimed industrial water as Level 1 (certain on-site uses) or Level 2 (off-site use, mixed domestic and industrial wastewater, and other categories). Due to the removal of effluent to off-site treatment, supplies for this project would likely be categorized as Level 2 reclaimed water. If approved for use, the reclaimed water would have to be regularly sampled and analyzed. Additional minor permitting may be associated with construction activities.

Cost Analysis

Costs were developed for the project based on the estimated cost and infrastructure capacity data provided by the project sponsor, in conjunction with standard Regional Water Planning costing procedures and assumptions. Costs for easements and mitigation are anticipated to be minimal and were assumed to be included in the costs provided by the sponsor. Annualized debt service, pumping energy costs, and costs of operation and maintenance were estimated using standard assumptions for Region H. Costs are presented in September 2023 equivalent costs in *Table 1*.

Table 1 – Texas City Industrial Complex Reuse Estimated Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$33,935,000	\$33,935,000
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$10,859,200	\$10,859,200
3	LAND AND EASEMENTS	1	LS	\$0	\$0
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$2,714,800	\$2,714,800
PROJECT CAPITAL COST					\$47,509,000

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$3,342,784	\$3,342,784	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$744,800	\$744,800	\$744,800	\$744,800	\$744,800
3	PUMPING ENERGY COSTS	\$0	\$224,734	\$224,734	\$224,734	\$224,734	\$224,734
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$0	\$4,312,319	\$4,312,319	\$969,534	\$969,534	\$969,534

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$4,312,319	\$4,312,319	\$969,534	\$969,534	\$969,534
2	YIELD	-	11,200	11,200	11,200	11,200	11,200
3	UNIT COST	\$0	\$385	\$385	\$87	\$87	\$87
TOTAL UNIT COST		\$206					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$27,030,000	\$27,030,000
2	PIPELINES	1	LS	\$2,405,000	\$2,405,000
3	WATER STORAGE TANKS	1	LS	\$4,500,000	\$4,500,000
PROJECT COST					\$33,935,000

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$27,030,000	\$675,750
2	PIPELINES	1.0	%	\$2,405,000	\$24,050
3	WATER STORAGE TANKS	1.0	%	\$4,500,000	\$45,000
ANNUAL OPERATION AND MAINTENANCE COST					\$744,800

Water Management Strategy Evaluation

Based on the analysis provided above, the Texas City Industrial Complex Reuse project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	4	Project provides treated water at a low to moderate cost.
Location	4	Some infrastructure will be required to convey treated water to end users.

CRITERIA	RATING	EXPLANATION
Water Quality		No known water quality issues.
Environmental Land and Habitat	4	Minimal impacts anticipated.
Environmental Flows	2	Project would reduce local bay inflow through the reduction of return flows, but would not reduce instream flows.
Local Preference	3	Local preference is unknown.
Institutional Constraints	3	Permits expected with minimal problems. Property is available.
Development Timeline	5	Project can be developed within five years.
Sponsorship	4	Sponsors are identified and are investigating project options.
Vulnerability	5	Minimal risk from natural and man-made disasters.
Regionalization	3	Project would serve multiple industrial entities.
Impacts on Other WMS	3	This project is not expected to impact other WMS.

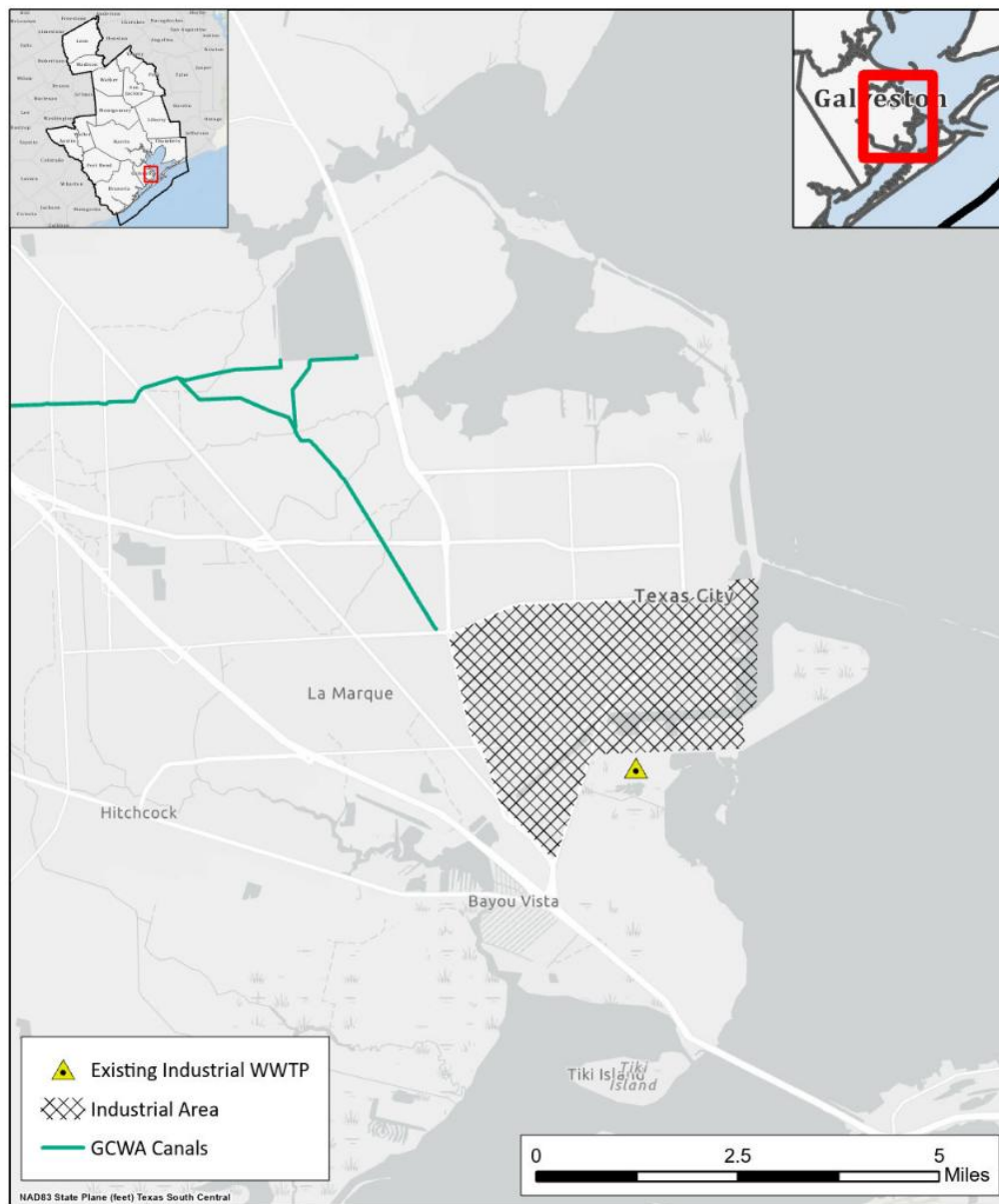
Development of the Texas City Industrial Complex Reuse project is anticipated to cause minimal impacts to habitat, due to construction within a heavily industrialized area. The project may potentially reduce bay inflows by as much as 11,200 ac-ft/yr. Because the source return flows are currently returned directly to the bay system, the project would not directly impact instream flows. It should also be noted that the reduction in bay return flows may also correlate to a reduction in diversions of surface water from other basins. The project is not anticipated to impact agricultural land or production.

Water User Group Application

The Texas City Industrial Complex Reuse project 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is located relatively near industrial demands served from the lower Brazos River Basin.
Size	Project provides a substantial volume of supply to meet the needs of wholesale, industrial users.

CRITERIA	WUG SUITABILITY
Water Quality	Project will treat wastewater to a quality suitable for industrial use.
Unit Cost	Unit cost is suitable for industrial applications.
Other Factors	Project is intended for use by current and potential future industrial customers of GCWA.

Location Map**Texas City Industrial
Complex Reuse
Location Map**

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Wastewater Reclamation for Industry
Project ID:	REUS-009
Project Type:	Reuse
Potential Supply Quantity (Rounded):	67,200 ac-ft/yr (60 mgd)
Implementation Decade:	2060
Development Timeline:	10 years
Project Capital Cost:	\$559,325,814 (Sept. 2023)
Unit Water Cost (Rounded):	\$1,221 per ac-ft (during loan period) \$636 per ac-ft (after loan period)

Strategy Description

The City of Houston (COH) holds Water Right Permit 5827 that allows the diversion and reuse of up to 580,923 ac-ft/yr in the San Jacinto River Basin or in the Trinity, Trinity-San Jacinto, and San Jacinto-Brazos basins through interbasin transfer. This permit relates to more than 30 individual wastewater treatment plant (WWTP) discharges located on the Houston Ship Channel, Greens Bayou, Buffalo Bayou, Cole Creek, Berry Bayou, Keegans Bayou, Brickhouse Gully, White Oak Bayou, Evans Gully, and Lake Houston. In an effort to protect and maintain freshwater inflows to Galveston Bay, the permit limits diversions to 50% of the volume discharged on a daily basis from each wastewater treatment plant.

In addition to other alternatives for reclaimed water use, this permit may also be used for service to industrial customers. One concept for service to industry has existed in the Region H Regional Water Plan (RWP) since the first plan in 2001. This approach considers using reclaimed wastewater effluent to replace existing surface water supplies that serve industrial demands for process and boiler feed waters. Under this project, municipal wastewater currently discharged to Buffalo Bayou will receive further treatment and will be offered as a high-quality water supply to industries. Reclaimed wastewater will be superior in quality to the raw water currently supplied, thus allowing industrial consumers to significantly reduce or eliminate their onsite water treatment costs. This project is applied within the industrial corridor of State Highway 225 and the Houston Ship Channel (San Jacinto Basin).

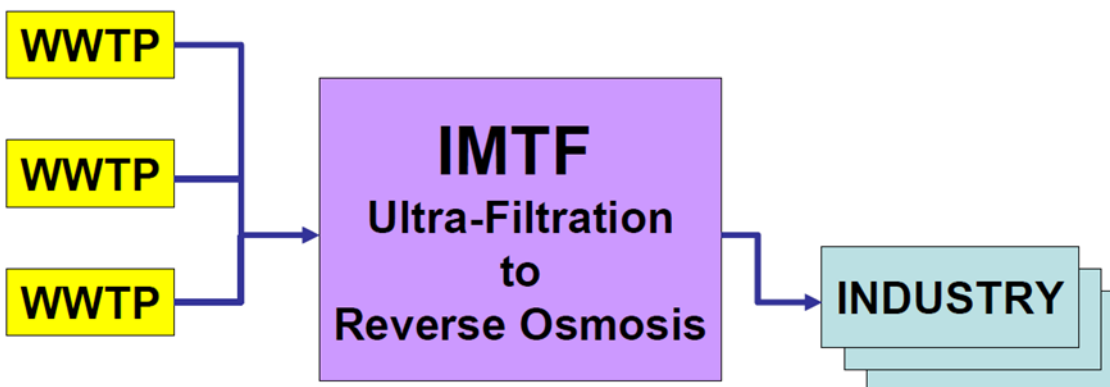
Strategy Analyses

The project analyses for Wastewater Reclamation for Industry include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Effluent from three of the City's wastewater treatment plants (Sims North, Sims South, and 69th Street) would be utilized. Secondary effluent would be pumped to an Integrated Membrane Treatment Facility (IMTF) as shown in *Figure 1*. After treatment, the reclaimed water would be piped to the industrial users along the south side of the Houston Ship Channel corridor.

Figure 1 – Proposed Reuse Project



Environmental Considerations

Effluent currently being discharged to Buffalo Bayou, Sims Bayou, and the Houston Ship Channel would be diverted to the new IMTF. A discharge of brine concentrate from the IMTF into the Houston Ship Channel could affect water quality, although the proposed discharge would be into the dredged channel below the saline elevation. Reclaiming effluent will reduce the impacts of the current WWTP discharges. Less effluent will be discharged into the receiving stream. However, these issues were addressed during the permitting of WR 5827. Minimal impact to the terrestrial habitats and terrestrial organisms adjacent to these bayous is expected as a result of the reduction of wastewater treatment plant discharges.

Current levels of wastewater discharge by industries into the Houston Ship Channel would remain unchanged. There are no water rights on the Houston Ship Channel that would be negatively impacted by this project. This project will treat 83 mgd of effluent to produce 60 mgd of delivered high-quality water (the other 23 mgd being brine discharge). This will offset an existing raw water demand which is currently met from other City of Houston surface water sources in the Trinity and San Jacinto basins.

Permitting and Development

Water rights permitting for this project has already been accomplished under Water Right Permit 5827. The terms of this permit specify the diversion rates and other terms for utilization of this supply. It should be noted that, since the identified supply would be taken directly from the plants without entry into waters of the state, the instream flow targets for diversion are not applicable. However, the 50 percent provision for bay and estuary inflows would be applied and would serve to protect baseflows from wastewater plants contributing to Galveston Bay.

Cost Analysis

Estimated costs for the project are shown in *Table 1*. Capital costs were scaled to a September 2023 equivalent cost using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. The costs presented in this memorandum do not include the purchase cost of water.

Table 1 – Wastewater Reclamation for Industry Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$338,550,000	\$338,550,000
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$115,058,500	\$115,058,500
3	LAND AND EASEMENTS	1	LS	\$11,693,000	\$11,693,000
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$10,630,000	\$10,630,000
5	INTEREST DURING CONSTRUCTION	1	LS	\$83,394,314	\$83,394,314
PROJECT CAPITAL COST					\$559,325,814

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$0	\$0	\$39,354,767	\$39,354,767	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$0	\$0	\$40,840,550	\$40,840,550	\$40,840,550
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$1,880,873	\$1,880,873	\$1,880,873
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$0	\$0	\$0	\$82,076,189	\$82,076,189	\$42,721,423

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$0	\$0	\$82,076,189	\$82,076,189	\$42,721,423
2	YIELD	-	-	-	67,200	67,200	67,200
3	UNIT COST	\$0	\$0	\$0	\$1,221	\$1,221	\$636
TOTAL UNIT COST							\$1,026

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$30,150,000	\$30,150,000
2	PIPELINES	1	LS	\$44,540,000	\$44,540,000
3	PIPELINE CROSSINGS	1	LS	\$24,140,000	\$24,140,000
4	WASTEWATER RECLAMATION PLANTS	1	LS	\$239,720,000	\$239,720,000
PROJECT COST					\$338,550,000

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$30,150,000	\$753,750
2	PIPELINES	1.0	%	\$44,540,000	\$445,400
3	PIPELINE CROSSINGS	1.0	%	\$24,140,000	\$241,400
4	WASTEWATER RECLAMATION PLANTS	1.0	LS	\$39,400,000	\$39,400,000
ANNUAL OPERATION AND MAINTENANCE COST					\$40,840,550

This project has a unique cost dynamic. The industries will participate in this project only if it can be proven that their specific total water cost can be reduced. Reclamation saves an equivalent quantity of existing City of Houston Trinity River water supplies. The exact cost benefit of this project can only be determined through negotiation of firm supply contracts with the industry customers.

Substitution of reclaimed wastewater would potentially increase the industries' cost of water. However, the reclaimed water could save the industries money since reclaimed water will require less

treatment (and in many cases no additional treatment) after it is delivered to the industrial consumers. The use of reclaimed municipal wastewater may be an economical alternative to current supplies.

Water Management Strategy Evaluation

Based on the analysis provided above, the Wastewater Reclamation for Industry project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	High costs related to treatment of water prior to delivery. However, this may be offset through water rate for providing higher quality water to industry.
Location	4	Conveyance required for project implementation.
Water Quality	4	Proposed project would provide a higher quality water to industrial customers.
Environmental Land and Habitat	4	Majority of projects are to be constructed in already-developed areas or existing rights-of-way.
Environmental Flows	2	Project will reduce the level of flows returned to streams to a level planned for during permitting process.
Local Preference	3	Mixed support between COH and industrial stakeholders.
Institutional Constraints	3	Property acquisition required for project development.
Development Timeline	4	Project will require lead time to get stakeholders on board, develop final project concept, and design and construct the project.
Sponsorship	3	COH requires support from industrial stakeholders in order to push the project forward.
Vulnerability	4	Potential impacts related to damage to critical infrastructure.
Regionalization	3	Project would serve multiple industrial entities.
Impacts on Other WMS	2	This project competes with water that may be utilized by the COH Reuse project.

The Wastewater Reclamation for Industry concept includes up to 22 miles of pipelines for collection of effluent and distribution to industries. The majority of this development will be in urbanized areas with limited impacts to habitat such as existing industrial facilities. The project may potentially reduce return flows to the Houston Ship Channel by as much as 67,200 ac-ft/yr. However, this reduction in return flows may also correlate to a reduction in diversions of surface water from other basins. These diversions are already permitted for consumptive use under the City of Houston's Water Right 5827 which accounts for environmental flows. Wastewater Reclamation for Industry is not anticipated to impact agricultural land or production.

Water User Group Application

The Wastewater Reclamation for Industry project 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is intended to serve customers along the Houston Ship Channel.
Size	The capacity of this project is intended to serve a portion of water demands by industry and may allow for reapplication of their current raw water supplies to other users.
Water Quality	This project provides treated but non-potable water for industrial use. This represents an improvement over the raw water currently sold to the target industries and may reduce their treatment burden.
Unit Cost	This high unit cost may be offset by reduced needs for treatment. However, the cost makes this water suitable only for industrial purposes.
Other Factors	The reliability of this supply is potentially higher than the current raw water supplies that may be curtailed by drought conditions, making it more attractive to industry.

The map displays the Sims Bayou area in Harris County, Texas, highlighting industrial facilities and water reuse infrastructure. Key features include:

- Industrial Facilities:** Represented by red dots along the Sims Bayou corridor.
- Reuse System:**
 - Collection to IMTF:** Shown as a black dashed line.
 - IMTF to Industry:** Shown as a purple dashed line.
 - IMTF RO Concentrate:** Shown as a yellow solid line.
- Wastewater Treatment Plants (WWTP):**
 - 69th Street WWTP:** Located on the left side of the map.
 - Sims Bayou North WWTP:** Located in the center-right.
 - Sims Bayou South WWTP:** Located on the right side.
 - Integrated Membrane Treatment Facility:** Located near the Sims Bayou North WWTP.
- Geographic Context:**
 - Inset Map 1 (Top Left):** Shows Harris County and surrounding areas (Montgomery, Liberty, Fort Bend, Brazoria, Galveston).
 - Inset Map 2 (Bottom Left):** Shows the location of the study area within Harris County.
 - Scale:** 0 to 5 miles.



Wastewater Reclamation for Industry Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Wastewater Reclamation for Municipal Irrigation
Project ID:	REUS-010
Project Type:	Reuse
Potential Supply Quantity (Rounded):	1,750 – 15,139 ac-ft/yr (1.6 – 13.5 mgd)
Implementation Decade:	2030
Development Timeline:	1 – 3 years
Project Capital Cost:	\$310,466,162 (Sept. 2023)
Unit Water Cost (Rounded):	Varies by WUG

Strategy Description

Population growth in Region H over recent decades has included the development of a large number of master-planned communities (MPCs) near the urbanized areas in the region. A number of these communities have adopted direct wastewater reuse technology to assist in meeting water demands from golf courses and greenspace. Wastewater reuse for municipal irrigation of golf courses and maintenance of green spaces and amenity ponds in new MPCs provides a potential means of utilizing reclaimed supplies. With growth expected to increase by several million people in the metropolitan area of Region H over the next 50 years, it can be expected that new master-planned communities will be developed in many of the urbanizing areas within Brazoria, Chambers, Fort Bend, Harris, Liberty, Montgomery, and Waller Counties, and this growth will also provide possible candidates for reclaimed wastewater.

Strategy Analyses

The project analyses for Wastewater Reclamation for Municipal Irrigation include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

This study examined the potential for development of direct wastewater reuse supplies to meet municipal irrigation water demands in Brazoria, Chambers, Fort Bend, Harris, Liberty, Montgomery, and Waller Counties. Population growth in future MPCs was identified as the most likely candidate for using this project. Future MPCs are assumed to represent a portion of the growth within County-Other water user groups (WUGs) in the region. There is additional potential for MPC development within the boundaries of the regional water authorities in Region H, including the North Harris County Regional Water Authority (NHCRWA), West Harris County Regional Water Authority (WHCRWA),

Central Harris County Regional Water Authority (CHCRWA), and North Fort Bend Water Authority (NFBWA) WUGs.

Potential growth within MPCs was analyzed through a Geographic Information System (GIS) analysis of the portion of estimated recent growth associated with existing MPCs as part of the analyses for the 2021 RWP. The results of this analysis indicated that approximately 45.4 percent of projected year 2010–2020 population growth in Fort Bend County was associated with MPCs. This value, which is substantially higher than the estimate of 25.64 percent MPC development estimated for prior Region H RWPs, reflects an increasing prevalence of MPC development over recent years. Since Fort Bend County leads the state in the number of MPCs, it was assumed that a value of approximately 45.4 percent would be representative of the growing trend toward master-planned development within Region H. This percentage was then applied to the total population growth in County-Other and regional water authority WUGs within the growing suburban areas of Region H to determine the population that would be expected to occur in MPCs.

In earlier RWP cycles, golf courses predicted for future development within Region H MPCs were considered as a potential demand center for utilization of direct reuse supplies. Due to gradual changes in land use patterns in the Region, this assumption was reassessed beginning with the 2021 RWP. An examination of location, size, and development period data for golf courses within Fort Bend County indicates that development of new golf course facilities has been extremely limited over the past 20 years. Therefore, potential golf course demand was not included in the analysis of wastewater reclamation for municipal irrigation for the 2026 RWP.

For the 2006 RWP, the acreage of green space areas projected to accompany future development was estimated from GIS data for Cinco Ranch and Greatwood MPCs in Fort Bend County. The area of irrigated esplanades and parks was compared to the total population of each development at ultimate development to find the average per-capita acreage of green space for the two communities. Subsequently, MPC total acreage and green space data from the Fort Bend Economic Development Council was examined in conjunction with detailed population projection data to identify potential changes in per-capita green space development. The results of this analysis indicate that per-capita green space development in MPCs has increased approximately sevenfold from the results of the 2006 RWP. However, recent land use trends include a focus on natural areas including forested parks and stands of native vegetation in addition to more traditional irrigated green space. Therefore, the green space acreage per-capita rate from previous RWPs was retained for this project. This per-capita rate was applied to the percentage of County-Other growth expected within MPCs to determine the projected green space acreage for each county through 2080.

Irrigation demands for the expected green space acreage were determined from evapotranspiration and precipitation data obtained from the Texas Water Development Board (TWDB) using a method adapted from Richard Duble of Texas Cooperative Extension. This methodology yielded the ideal average annual application rate for turfgrass irrigation and was used with the projected acreage found above to determine the projected irrigation water demands for green spaces throughout the planning period. This value for the ideal application rate was determined for the 2006 RWP and is retained for this planning round.

Water demands from amenity lakes associated with population growth in MPCs were estimated from well data from the Fort Bend Subsidence District. Wells that were associated with amenity lakes and were located within named WUGs were identified. The population associated with these WUGs, as reported by TWDB, was compared to the annual pumpage for the wells to determine a per-capita amenity lake demand. This per-capita demand was then applied to the portion of population growth

within County-Other that was expected to occur within MPCs. This value for per-capita amenity lake demand was determined for the 2006 RWP and is retained for this planning round.

The projected demands for reclaimed wastewater in each county are shown below in *Table 1*.

Table 1 – Projected Potential Demands for Reclaimed Wastewater

County	Potential Reuse Application	Wastewater Reuse Demands (ac ft/yr)					
		2030	2040	2050	2060	2070	2080
Brazoria	Green Spaces	20	52	90	107	126	147
	Amenity Lakes	22	58	102	121	143	166
	Total	42	110	192	228	269	313
Chambers	Green Spaces	10	59	132	201	276	362
	Amenity Lakes	12	67	149	228	313	409
	Total	22	126	281	429	589	771
Fort Bend	Green Spaces	242	852	1,495	2,027	2,566	3,056
	Amenity Lakes	275	965	1,694	2,299	2,906	3,461
	Total	517	1,817	3,189	4,326	5,472	6,517
Harris	Green Spaces	400	758	993	1,122	1,357	1,525
	Amenity Lakes	452	858	1,126	1,271	1,536	1,727
	Total	852	1,616	2,119	2,393	2,893	3,252
Liberty	Green Spaces	31	108	203	306	406	514
	Amenity Lakes	35	124	231	347	460	583
	Total	66	232	434	653	866	1,097
Montgomery	Green Spaces	101	393	687	915	1,088	1,205
	Amenity Lakes	114	445	778	1,037	1,232	1,365
	Total	215	838	1,465	1,952	2,320	2,570
Waller	Green Spaces	17	43	92	153	219	290
	Amenity Lakes	19	49	104	174	249	329
	Total	36	92	196	327	468	619
Total Potential Reuse Demands		1,750	4,831	7,876	10,308	12,877	15,139

The amount of wastewater that could potentially be reclaimed for non-potable uses is subject to both the potential demands for and the supply of treated wastewater. Because wastewater treatment plant discharge is often lowest during summer months when irrigation demands are at their highest, it is important to apply conservative assumptions in evaluating potential source availability for non-potable reuse for irrigation. Decadal per-capita demands for the target WUGs were adjusted to reflect the impacts of recommended advanced municipal conservation and water loss reduction water management strategies. A conservative return flow factor of 40 percent based on analyses from the 2016 RWP was then applied to County-Other and regional water authority adjusted demand projections to generate a decadal estimate of available effluent for direct non-potable reuse. Resultant post-conservation wastewater discharge rates for the target WUGs ranged from 23 to 71 gallons per capita per day. Estimated available effluent from this analysis is intended to be exclusive of return flows utilized in other potential reuse projects in the 2026 RWP. Based on the above methodology, the projected availability of reclaimed wastewater throughout the planning period within each county is shown in *Table 2*.

Table 2 – Projected Potential Supplies for Reclaimed Wastewater

County	Wastewater Reuse Supply (ac ft/yr)					
	2030	2040	2050	2060	2070	2080
Brazoria	124	310	518	607	703	789
Chambers	45	256	551	815	1,086	1,379
Fort Bend	1,660	5,399	9,035	11,831	14,552	16,804
Harris	2,423	4,331	5,694	6,383	7,719	8,568
Liberty	148	510	924	1,346	1,738	2,123
Montgomery	501	1,886	3,238	4,223	4,930	5,367
Waller	83	206	429	699	979	1,262
Total Potential Reuse Supplies	4,984	12,898	20,389	25,904	31,707	36,292

As noted previously, application of this project is limited not only by the available supply but by the potential demands. Therefore, the potential reclaimed water supply for irrigation in a given county and decade would be the lesser of the available effluent supply (*Table 2*) and the demand for that effluent (*Table 1*). The resultant usable project supply volume is shown in *Table 3*.

Table 3 – Projected Useable Reclaimed Wastewater Supply

County	Wastewater Reuse Supply (ac ft/yr)					
	2030	2040	2050	2060	2070	2080
Brazoria	42	110	192	228	269	313
Chambers	22	126	281	429	589	771
Fort Bend	517	1,817	3,189	4,326	5,472	6,517
Harris	852	1,616	2,119	2,393	2,893	3,252
Liberty	66	232	434	653	866	1,097
Montgomery	215	838	1,465	1,952	2,320	2,570
Waller	36	92	196	327	468	619
Total Usable Reuse Supplies	1,750	4,831	7,876	10,308	12,877	15,139

Environmental Considerations

Because the supply source for this project is based on return flow from future growth rather than existing development, this project would not be expected to reduce instream flows below current levels.

Infrastructure required for implementation of this project would consist primarily of reclamation facilities located at MPC wastewater treatment plants and conveyance infrastructure to connect to points of use. Because wastewater reclamation infrastructure would presumably be constructed concurrently with other community water and wastewater facilities, proper planning would minimize habitat impacts beyond those inherently associated with MPC development.

Permitting and Development

Construction of direct wastewater reuse facilities as part of overall MPC development would likely allow for a simplified construction permitting process relative to retrofitting direct reuse components into a preexisting system. At a minimum, MPC construction would require a Stormwater Pollution Prevention Plan (SWPPP) and a TCEQ Construction General Permit (TXR 150000).

Use of reclaimed wastewater effluent requires approval and permitting by the TCEQ under the requirements of 30 TAC §210. TCEQ classifies reclaimed water as Type 1 (higher quality for use where public contact is likely) or Type 2 (for uses with limited risk of human contact). Due to the potential for human contact, supplies for this project would have to be treated to Type 1 quality standards. If approved for use, the reclaimed water would have to be sampled and analyzed a minimum of twice per week.

Cost Analysis

A preliminary planning level cost estimate was prepared for the Wastewater Reclamation for Municipal Irrigation project using default costing methods for regional plan development. Costs were developed based on basic costing guidelines as outlined by TWDB guidance. For purposes of this assessment, it was assumed that each WWTP within the participating MPCs would have an average production based on the decadal increase of potential reuse demand volumes in each WUG and would require one mile of pipeline to reach points of use. Because the project is not implemented completely within one decade but rather increases in volume over time as more MPCs implement direct reuse, cost estimates developed for the project reflect incremental development of infrastructure and supply capacity. For this reason, annualized costs vary across the planning period as some users retire debt service and others begin project development. While overall annual costs increase across the planning period, unit costs decrease as more project supply volume is added with the development of new MPCs. *Table 4* summarizes the component costs of key facilities. Costs are presented in September 2023 dollars.

Table 4 – Wastewater Reclamation for Municipal Irrigation Project Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST						September 2023
ITEM	DESCRIPTION		QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY						
1	CONSTRUCTION COST		1	LS	\$216,429,382	\$216,429,382
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES		1	LS	\$73,407,023	\$73,407,023
3	LAND AND EASEMENTS		1	LS	\$473,560	\$473,560
4	ENVIRONMENTAL - STUDIES AND MITIGATION		1	LS	\$900,000	\$900,000
5	INTEREST DURING CONSTRUCTION		1	LS	\$19,256,197	\$19,256,197
PROJECT CAPITAL COST						\$310,466,162

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$3,389,639	\$7,194,750	\$7,591,623	\$7,389,689	\$7,263,840	\$7,260,295
2	OPERATION AND MAINTENANCE (O&M)	\$2,129,035	\$4,781,674	\$7,400,455	\$9,750,696	\$12,173,367	\$14,537,454
3	PUMPING ENERGY COSTS	\$31,571	\$88,028	\$143,668	\$187,420	\$233,788	\$274,519
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$5,550,245	\$12,064,452	\$15,135,746	\$17,327,805	\$19,670,995	\$22,072,267

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$5,550,245	\$12,064,452	\$15,135,746	\$17,327,804	\$19,670,995	\$22,072,268
2	YIELD	1,750	4,831	7,876	10,308	12,877	15,139
3	UNIT COST	\$3,172	\$2,497	\$1,922	\$1,681	\$1,528	\$1,458
TOTAL UNIT COST		\$1,740					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$39,356,800	\$39,356,800
2	PIPELINES	1	LS	\$46,865,217	\$46,865,217
3	WATER STORAGE TANKS	1	LS	\$71,009,231	\$71,009,231
4	WASTEWATER RECLAMATION PLANTS	1	LS	\$59,198,134	\$59,198,134
PROJECT COST					\$216,429,382

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$39,356,800	\$983,920
2	PIPELINES	1.0	%	\$46,865,217	\$468,652
3	WATER STORAGE TANKS	1.0	%	\$71,009,231	\$710,092
4	WASTEWATER RECLAMATION PLANTS	1.0	LS	\$12,374,789	\$12,374,789
ANNUAL OPERATION AND MAINTENANCE COST					\$14,537,454

Water Management Strategy Evaluation

Based on the analysis provided above, the Wastewater Reclamation for Municipal Irrigation project was evaluated across twelve different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Project cost is relatively high but potentially reduces development of other costly water supplies for municipal irrigation.
Location	5	Direct reuse infrastructure would be located in close proximity to points of water use.
	3	No known impacts to water quality. The project is expected to produce Type 1 effluent suitable for the intended use.
Environmental Land and Habitat	5	Impacts from project are unlikely to exceed regular land development impacts for master planned communities.
	2	Project will reduce the level of flows returned to streams.
Local Preference	3	No known opposition to the proposed project.
	3	Permits expected to be obtainable with minimal problems.
Development Timeline	5	Project could be developed in a relatively short period of time.
Sponsorship	3	Various stakeholders, many of which are not identified as named WUGs in the RWP, have implemented similar projects and this trend is expected to continue.
Vulnerability	5	Minimal risk to availability of supply.
Regionalization	3	This project serves multiple Master Planned Communities in the Region to meet water demands of greenspace
Impacts on Other WMS	3	The project would be developed in such a way to prevent detrimental impacts to other projects under development.

Wastewater Reclamation for Municipal Irrigation is not anticipated to affect acreage or vulnerable species, but actual impacts will depend upon local development of each potential project. The projects may potentially reduce return flows to various basins by as much as 15,139 ac-ft/yr. However, this reduction in return flows may also correlate to a reduction in diversions of surface water from other basins. Wastewater Reclamation for Municipal Irrigation is not anticipated to impact agricultural land or production.

Water User Group Application

The Wastewater Reclamation for Municipal Irrigation project 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 project as well as other factors that may relate

to the suitability of the project to the WUGs served.

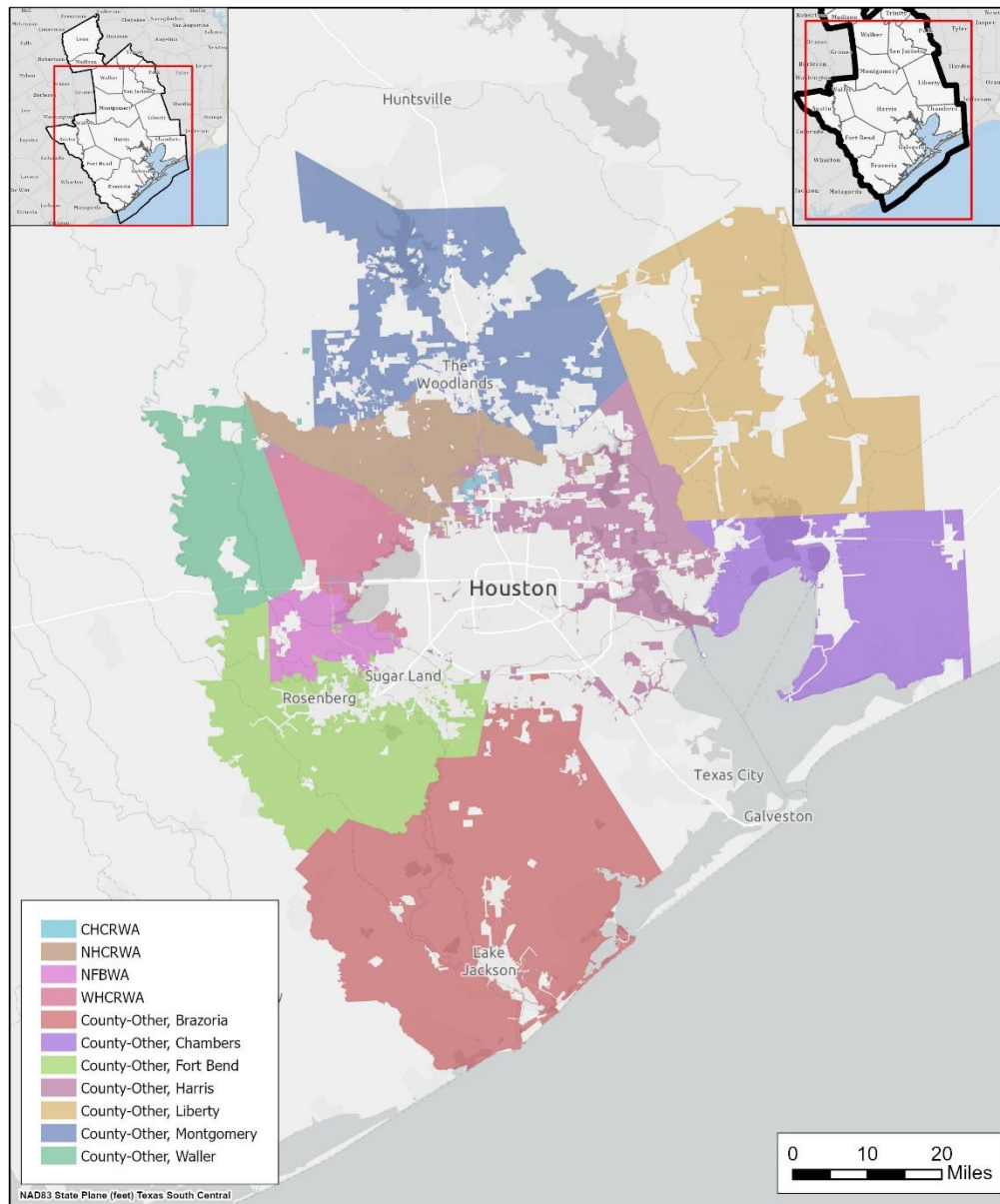
CRITERIA	WUG SUITABILITY
Proximity	This project provides water to new MPC developments (County-Other and regional water authority WUGs) in Brazoria, Fort Bend, Harris, and Montgomery Counties.
Size	This project is easily scaled with the size of the implementing MPCs.
Water Quality	This project provides a high-quality raw water source that may be used to meet greenspace and amenity pond water demands.
Unit Cost	This project is of relatively high cost but potentially reduces demand for development of expensive new supplies for amenity use. Unit costs for individual MPCs will decrease substantially after closure of debt service.
Other Factors	This project provides water to new MPC developments (County-Other and regional water authority WUGs) in Brazoria, Fort Bend, Harris, and Montgomery Counties.

References

Fort Bend County Economic Development Council - Business Resources & County Data.
www.fortbendcounty.com/resources/#maps. Accessed 10 May 2019.

Texas Commission on Environmental Quality, https://www.tceq.texas.gov/assistance/water/reclaimed_water.html, Accessed May 23, 2019.

Location Map



Wastewater Reclamation for Municipal Irrigation Location Map



Texas

THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Westwood Shores MUD Reuse
Project ID:	REUS-011
Project Type:	Reuse
Potential Supply Quantity (Rounded):	150 ac-ft/yr (0.13 mgd)
Implementation Decade:	2030
Development Timeline:	<5 years
Project Capital Cost:	\$2,491,536 (Sept. 2023)
Unit Water Cost (Rounded):	\$2,292 per ac-ft (during loan period) \$1,123 per ac-ft (after loan period)

Strategy Description

Westwood Shores Municipal Utility District (MUD) is a water and wastewater utility provider located adjacent to Lake Livingston in Trinity County. Currently, irrigation for the Westwood Shores Golf Course, operated by the Westwood Shores Property Owners Association (POA) is supplied by up to 155 ac-ft/yr of raw water diverted from Lake Livingston to Westwood Lake. Westwood Shores MUD has proposed a reuse project to replace some of the raw water diversions with up to 150 ac-ft/yr of reclaimed water from the MUD's wastewater treatment plant (WWTP).

Strategy Analyses

The project analyses for Westwood Shores MUD Reuse include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Westwood Shores MUD anticipates providing 150 ac-ft/yr of reclaimed water for golf course irrigation.

Environmental Considerations

The reuse of effluent is intended to directly replace raw water diversions from Lake Livingston. Because the WWTP discharges into Lake Livingston near the intake point for current raw water diversions, no impact on streamflow is expected.

Permitting and Development

Use of reclaimed wastewater effluent requires approval and permitting by the TCEQ under the

requirements of 30 TAC §210. TCEQ classifies reclaimed water as Type 1 (higher quality for use where public contact is likely) or Type 2 (for uses with limited risk of human contact). Due to the potential for human contact, supplies for this project would have to be treated to Type 1 quality standards. If approved for use, the reclaimed water would have to be sampled and analyzed a minimum of twice per week.

Cost Analysis

An estimate of the project capital cost is available in the Clean Water State Revolving Fund Intended Use Plan for State Fiscal Year 2020. This cost was assumed to include all capital cost components except for interest during construction, including costs associated with construction, land acquisition, easements, and environmental studies and mitigation. It is anticipated that the project will include enhancements to the WWTP, a reuse pump station, and minor conveyance infrastructure. The cost of interest during construction and annualized costs of debt service, operation and maintenance, and pumping energy were estimated using standard regional planning assumptions. Estimated costs are presented in September 2023 dollars in *Table 1*.

Table 1 – Westwood Shores MUD Reuse Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$1,701,812	\$1,701,812
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$563,589	\$563,589
3	LAND AND EASEMENTS	1	LS	\$7,055	\$7,055
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$64,546	\$64,546
5	INTEREST DURING CONSTRUCTION	1	LS	\$154,534	\$154,534
PROJECT CAPITAL COST					\$2,491,536

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$175,307	\$175,307	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$165,815	\$165,815	\$165,815	\$165,815	\$165,815	\$165,815
3	PUMPING ENERGY COSTS	\$2,704	\$2,704	\$2,704	\$2,704	\$2,704	\$2,704
TOTAL ANNUAL COST		\$343,827	\$343,827	\$168,519	\$168,519	\$168,519	\$168,519

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$343,827	\$343,827	\$168,519	\$168,519	\$168,519	\$168,519
2	YIELD	150	150	150	150	150	150
3	UNIT COST	\$2,292	\$2,292	\$1,123	\$1,123	\$1,123	\$1,123
TOTAL UNIT COST		\$1,513					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$489,388	\$489,388
2	PIPELINES	1	LS	\$640,895	\$640,895
3	WASTEWATER RECLAMATION PLANTS	1	LS	\$571,528	\$571,528
PROJECT COST					\$1,701,812

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$489,388	\$12,235
2	PIPELINES	1.0	%	\$640,895	\$6,409
3	WASTEWATER RECLAMATION PLANTS	1.0	LS	\$147,171	\$147,171
ANNUAL OPERATION AND MAINTENANCE COST					\$165,815

Water Management Strategy Evaluation

Based on the analysis provided above, the Westwood Shores MUD Reuse project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Cost is high but decreases after completion of debt service.
Location	5	Reclaimed water source is located very near to point of use.

CRITERIA	RATING	EXPLANATION
Water Quality	3	The project is expected to produce Type 1 effluent suitable for the intended use.
Environmental Land and Habitat	4	Minimal impacts anticipated.
Environmental Flows	3	No impacts anticipated.
Local Preference	3	No known opposition to the proposed project.
Institutional Constraints	3	Permits expected with minimal problems.
Development Timeline	5	Project could be developed in a relatively short period of time.
Sponsorship	5	Sponsor is identified and has applied for project funding.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	1	Would serve a single water system.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

Westwood Shores MUD Reuse is not anticipated to affect vulnerable species or to impact agricultural land or production.

Water User Group Application

The Westwood Shores MUD Reuse project 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 anticipated that the project will only serve Westwood Shores MUD.

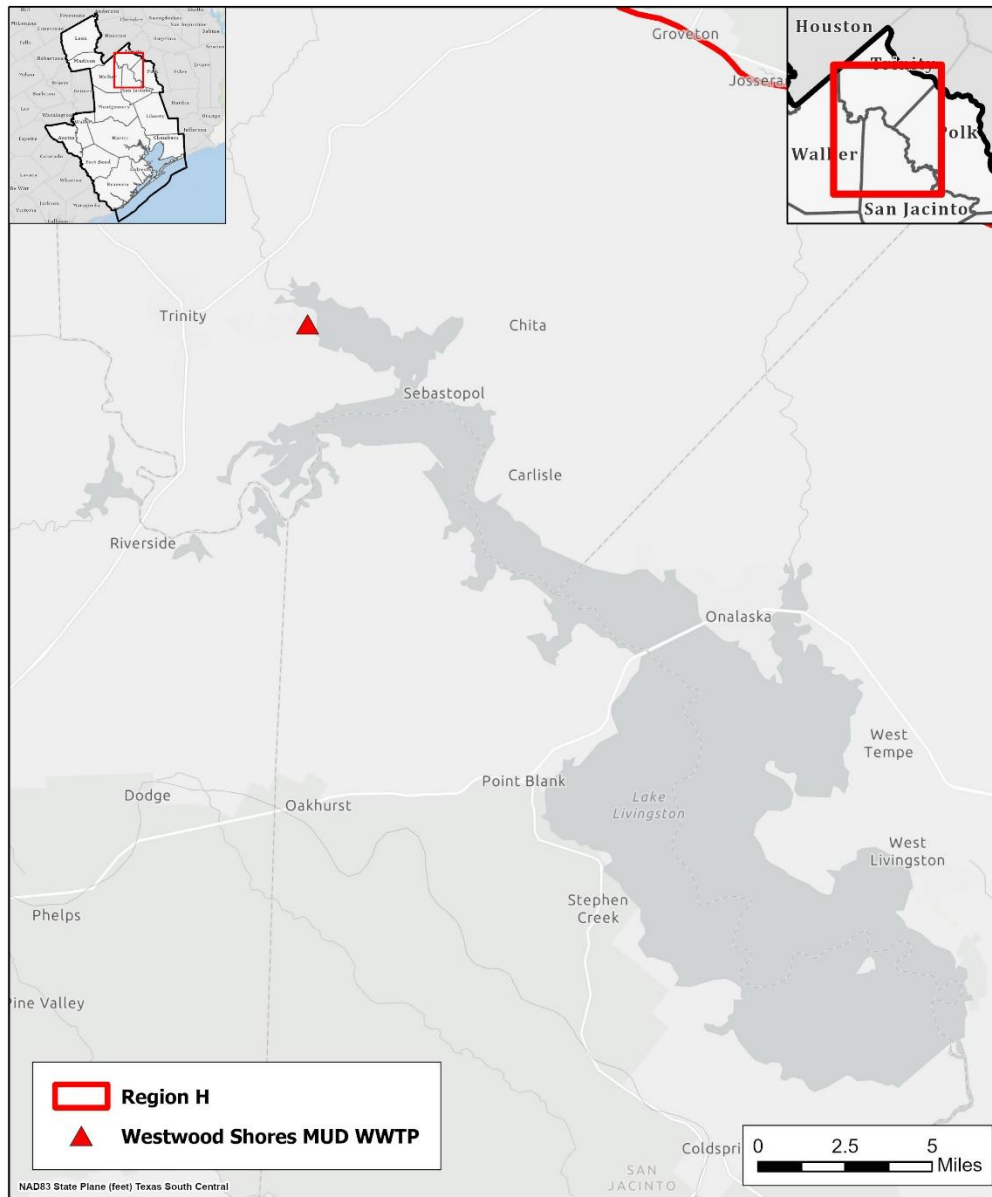
CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use.
Size	Overall project supply volume is appropriate to the intended use.
Water Quality	The project is expected to produce Type 1 effluent suitable for the intended use.
Unit Cost	Cost is high but decreases after completion of debt service.

CRITERIA	WUG SUITABILITY
Other Factors	Implementation of supply from this project requires permitting through TCEQ.

References

Texas Water Development Board. *Intended Use Plan: Clean Water State Revolving Fund, SFY 2020*, July 2019.

Location Map



Westwood Shores MUD Reuse Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Allens Creek Reservoir
Project ID:	SWDV-001
Project Type:	New Surface Water Source
Potential Supply Quantity (Rounded):	99,650 ac-ft/yr (89 mgd)
Implementation Decade:	2040
Development Timeline:	15 years
Project Capital Cost:	\$493,919,561 (Sept. 2023)
Unit Water Cost (Rounded):	\$279 per ac-ft (during loan period) \$47 per ac-ft (after loan period)

Strategy Description

Allens Creek Reservoir is a proposed off-channel water supply reservoir located in Austin County north of the City of Wallis. The reservoir will be created by a 4.25-mile embankment on Allens Creek adjacent to the Brazos River. The proposed reservoir has an authorized storage of 145,333 acre-feet with a surface area of 7,000 acres. Most of the water impounded in the reservoir will be pumped from the Brazos River, although a small portion of the inflow will originate from the Allens Creek watershed, outside of the reservoir footprint. Permit 2925, as amended, authorizes the storage in the reservoir, diversion of up to 202,000 acre-feet per year from the Brazos River into the reservoir, and diversion and use of 99,650 acre-feet per year from the reservoir for municipal, industrial and irrigation purposes in the Brazos, San Jacinto-Brazos, and San Jacinto Basins. Diversions from the Brazos River are authorized at a maximum rate of 2,200 cfs or approximately 1,400 mgd. The reservoir will be owned and operated by the Brazos River Authority (BRA). The project is expected to be online by 2040.

The Allens Creek site was originally intended to provide cooling water for a nuclear power plant. However, this project was abandoned and the permit for the project was allowed to expire. A new permit for the project was issued to the Texas Water Development Board (TWDB), City of Houston, and BRA; TWDB was a partner in this project through its state participation process. This permit has been amended twice to authorize the current storage and diversion amounts, as well as to establish environmental flows and other special conditions. In May 2022, the Brazos River Authority purchased the full rights to the reservoir from the City of Houston and TWDB.

In addition to providing much needed water supply, Allens Creek Reservoir will be key in increasing the reliability and flexibility of BRA's water supply operations in the lower Brazos Basin.

Strategy Analyses

The project analyses for the Allens Creek Reservoir include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The supply from Allens Creek Reservoir is specified in Permit 2925 issued by the Texas Commission on Environmental Quality (TCEQ). Allens Creek Reservoir is also part of BRA's Permit 5851, also known as the System Operation Permit. Additional yield in excess of the 99,650 acre-feet per year authorized in the Allens Creek permit may be realized through combined operation with the other system reservoirs included in the System Operation Permit. However, the volume of this additional yield is subject to assumptions regarding other uses in the BRA system. To be conservative, for the purposes of this evaluation the yield of Allens Creek Reservoir was limited to its individual water right.

Permit 2925 was issued in 2000. In 2017, BRA completed a drought study which evaluated BRA water rights using an extended hydrologic period of record (1940 to 2015). Based on the 2017 drought study, there had been no new drought of record for Allens Creek Reservoir, and the permitted yield of 99,650 acre-feet per year is estimated to be fully reliable in the RWP.

Environmental Considerations

A key environmental consideration is the potential impact of the project on threatened and endangered species. *Table 1* lists the threatened and endangered species of Austin County as well as other species of concern.

Table 1 – Rare, Threatened, and Endangered Species of Austin County

AMPHIBIANS		FEDERAL STATUS	STATE STATUS
Eastern tiger salamander	<i>Ambystoma tigrinum</i>		
Houston toad	<i>Anaxyrus houstonensis</i>	E	E
Southern crawfish frog	<i>Lithobates areolatus areolatus</i>		
Strecker's chorus frog	<i>Pseudacris streckeri</i>		
Woodhouse's toad	<i>Anaxyrus woodhousii</i>		

BIRDS		FEDERAL STATUS	STATE STATUS
Attwater's greater prairie-chicken	<i>Tympanuchus cupido attwateri</i>	E	E
Bald eagle	<i>Haliaeetus leucocephalus</i>	DL	
Bank swallow	<i>Riparia riparia</i>		
Black rail	<i>Laterallus jamaicensis</i>	T	T
Brewer's blackbird	<i>Euphagus cyanocephalus</i>		
Chestnut-collared longspur	<i>Calcarius ornatus</i>		
Common grackle	<i>Quiscalus quiscula</i>		
Common nighthawk	<i>Chordeiles minor</i>		
Franklin's gull	<i>Leucophaeus pipixcan</i>		
Henslow's sparrow	<i>Centronyx henslowii</i>		
Interior least tern	<i>Sternula antillarum athalassos</i>	DL	E
Least tern	<i>Sternula antillarum</i>	DL	
Loggerhead shrike	<i>Lanius ludovicianus</i>		
Mottled duck	<i>Anas fulvigula</i>		
Northern bobwhite	<i>Colinus virginianus</i>		
Piping plover	<i>Charadrius melodus</i>	T	T
Rufa red knot	<i>Calidris canutus rufa</i>	T	T
Sanderling	<i>Calidris alba</i>		
Snowy plover	<i>Charadrius nivosus</i>		
Sprague's pipit	<i>Anthus spragueii</i>		
Swallow-tailed kite	<i>Elanoides forficatus</i>		T
Western burrowing owl	<i>Athene cunicularia hypugaea</i>		
White-faced ibis	<i>Plegadis chihi</i>		T
White-tailed hawk	<i>Buteo albicaudatus</i>		T
Whooping crane	<i>Grus americana</i>	E	E
Willet	<i>Tringa semipalmata</i>		
Wilson's warbler	<i>Cardellina pusilla</i>		
Wood stork	<i>Mycteria americana</i>		T
Yellow rail	<i>Coturnicops noveboracensis</i>		
Yellow-billed cuckoo	<i>Coccyzus americanus</i>	T	

FISH		FEDERAL STATUS	STATE STATUS
Blackspot shiner	<i>Notropis atrocaudalis</i>		
Mississippi silvery minnow	<i>Hybognathus nuchalis</i>		
Silver chub	<i>Macrhybopsis storeriana</i>		
Silverband shiner	<i>Notropis shumardi</i>		
Spotted sucker	<i>Minytrema melanops</i>		

INSECTS		FEDERAL STATUS	STATE STATUS
American bumblebee	<i>Bombus pensylvanicus</i>		
[No accepted common name]	<i>Sparbarus couchatta</i>		
[No accepted common name]	<i>Plauditus texanus</i>		
[No accepted common name]	<i>Pseudocentropiloides morihari</i>		

MAMMALS		FEDERAL STATUS	STATE STATUS
Big free-tailed bat	<i>Nyctinomops macrotis</i>		
Eastern spotted skunk	<i>Spilogale putorius</i>		
Hoary bat	<i>Lasiurus cinereus</i>		
Mountain lion	<i>Puma concolor</i>		
Plains spotted skunk	<i>Spilogale interrupta</i>		
Seminole bat	<i>Lasiurus seminolus</i>		
Tricolored bat	<i>Perimyotis subflavus</i>	PE	

MOLLUSKS		FEDERAL STATUS	STATE STATUS
Brazos heelsplitter	<i>Potamilus streckersoni</i>		T
Lilliput	<i>Toxolasma parvum</i>		
Mapleleaf	<i>Quadrula quadrula</i>		
Pimpleback	<i>Cyclonaias pustulosa</i>		
Pistolgrip	<i>Tritogonia verrucosa</i>		
Tampico pearlymussel	<i>Cyrtonaias tampicoensis</i>		
Tapered pondhorn	<i>Uniomereus declivis</i>		
Texas fawnsfoot	<i>Truncilla macrodon</i>	T	T

REPTILES		FEDERAL STATUS	STATE STATUS
American alligator	<i>Alligator mississippiensis</i>	SAT	
Common garter snake	<i>Thamnophis sirtalis</i>		
Eastern box turtle	<i>Terrapene carolina</i>		
Prairie skink	<i>Plestiodon septentrionalis</i>		
Slender glass lizard	<i>Ophisaurus attenuatus</i>		
Smooth softshell	<i>Apalone mutica</i>		
Texas horned lizard	<i>Phrynosoma cornutum</i>		T
Texas map turtle	<i>Graptemys versa</i>		
Western box turtle	<i>Terrapene ornata</i>		
Western chicken turtle	<i>Deirochelys reticularia miaria</i>		

PLANTS		FEDERAL STATUS	STATE STATUS
Heartleaf evening-primrose	<i>Oenothera cordata</i>		
Mohlenbrock's sedge	<i>Cyperus grayoides</i>		
Panicled indigobush	<i>Amorpha paniculata</i>		
Texas meadow-rue	<i>Thalictrum texanum</i>		
Texas pinkroot	<i>Spigelia texana</i>		
Texas sandmint	<i>Rhododon ciliatus</i>		
Texas seymeria	<i>Seymeria texana</i>		
Texas sunnysbell	<i>Schoenolirion wrightii</i>		
Texas tauschia	<i>Tauschia texana</i>		

LE, LT - Federally Listed Endangered/Threatened; SAE, SAT - Federally Listed Endangered/Threatened by Similarity of Appearance; C - Federal Candidate for Listing; DL, PDL - Federally Delisted/Proposed for Delisting; NL - Not Federally Listed; PT - Federal Proposed for Listing; T - State Listed Endangered/Threatened; "blank" - Rare, but with no regulatory listing status.

Large surface water diversion facilities such as those associated with the Allens Creek Reservoir project have potential to influence sediment transport and nutrient loading in the source stream. This could reduce nutrient loading for some downstream habitat, but also offers potential to improve water quality in areas with excessive nutrient loading or turbidity. Potential water quality management and mitigation options for large surface water diversion projects include controlled sediment releases, downstream nutrient and sediment load monitoring, and development of selective diversion structures to allow replication of natural sediment flow regimes.

Permitting and Development

A minimum ten-year schedule is estimated for permitting activities associated with the project. However, the schedule may be accelerated depending on coordination with regulating entities and the proposed project approach.

Based on a desktop investigation, the following permitting activities are likely to apply:

- U.S. Army Corps of Engineers (USACE) Section 404 Permit – Reservoir development will involve modifications to waters of the U.S. As such, the project must be federally permitted under Section 404 of the Clean Water Act. Due to the magnitude of impacts, construction of this reservoir would require a Section 404 Individual Permit.
- National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS) – An EIS will likely be required as part of the Section 404 Permitting process.
- Cultural Resources Survey and National Register of Historic Places (NRHP) Testing – As part of the Section 404 Permit processing and EIS development, cultural resources surveys and NRHP testing will likely need to be completed.
- Mitigation Plan – A mitigation plan will be required as part of the Section 404 Permit. Mitigation will most likely involve purchase of mitigation bank credits or construction of mitigation sites to offset impacts to waters of the U.S. Due to substantial impacts to wetlands and other waters of the U.S., mitigation credits may be limited and mitigation may require permittee-responsible mitigation.
- U.S. Fish and Wildlife Service (USFWS) and Texas Parks and Wildlife Department (TPWD)

Ancillary Studies – USFWS and TPWD are stakeholders in the Section 404 Permitting process, and, as such, they will require ancillary studies to be completed. These studies will include surveys for federal threatened and endangered species and habitat modeling to assess impacts of the proposed project.

The project already has a state water right. Commencing near the end of the permitting phase, design and construction periods of three to five years are anticipated to bring the project to completion at the end of an overall 15-year development period.

Cost Analysis

A detailed update to the reservoir cost estimate, including new costs for the impoundment, pump station, and conveyance facilities, was prepared for the 2016 RWP. Quantities of embankment fill, slurry trench, and soil cement were updated from the original estimates in the 2021 RWP. Estimates for erosion protection along the Brazos River were also updated in the 2021 RWP. Costs for the pump station and conveyance conceptual design were based on current and previous design studies. In the 2026 RWP, costs for these infrastructure elements, as well as the reservoir, have been scaled to September 2023 dollars based on the Engineering News Record (ENR) Construction Cost Index (CCI) and the Producer Price Index (PPI). Because the project site is already held by a sponsoring entity, land costs included in this estimate are limited to costs for survey and a limited amount of purchase or easement costs for associated appurtenances. However, additional land costs to purchase property for mitigation may be required, which are not included in this estimate. The estimated mitigation cost shown below is based on standard guidance outlined by TWDB on reservoir mitigation costs, where mitigation cost is assumed to be the land cost multiplied by the reservoir footprint. Rural land cost in Austin County is \$11,839.00 and the reservoir footprint is 7,000 acres.

Table 2 summarizes the component costs of key facilities. Costs are presented in September 2023 dollars and include a contingency of 35% including professional services. Based on these costs as presented and assuming full utilization of the reservoir yield of 99,650 acre-feet per year, the unit cost for water from the project is approximately \$279 per acre-foot during the debt term and \$47 per acre-foot following the retirement of the debt on the project (40 years).

Table 2 – Allens Creek Reservoir Project Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$252,484,237	\$252,484,237
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$88,369,483	\$88,369,483
3	LAND AND EASEMENTS	1	LS	\$1,330,627	\$1,330,627
4	MITIGATION	1	LS	\$82,873,000	\$82,873,000
5	ENVIRONMENTAL - STUDIES	1	LS	\$9,151,547	\$9,151,547
6	INTEREST DURING CONSTRUCTION	1	LS	\$59,710,668	\$59,710,668
PROJECT CAPITAL COST					\$493,919,561

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$23,128,911	\$23,128,911	\$23,128,911	\$23,128,911	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$3,832,891	\$3,832,891	\$3,832,891	\$3,832,891	\$3,832,891
3	PUMPING ENERGY COSTS	\$0	\$863,237	\$863,237	\$863,237	\$863,237	\$863,237
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$0	\$27,825,039	\$27,825,039	\$27,825,039	\$27,825,039	\$4,696,128

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$27,825,039	\$27,825,039	\$27,825,039	\$27,825,039	\$4,696,128
2	YIELD	-	99,650	99,650	99,650	99,650	99,650
3	UNIT COST	\$0	\$279	\$279	\$279	\$279	\$47
TOTAL UNIT COST							\$233

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$76,990,742	\$76,990,742
2	APPROACH CHANNEL	1	LS	\$8,205,529	\$8,205,529
3	DISCHARGE CONVEYANCE	1	LS	\$8,278,808	\$8,278,808
4	OFF-CHANNEL RESERVOIRS	1	LS	\$89,278,755	\$89,278,755
5	EROSION PROTECTION	1	LS	\$40,409,757	\$40,409,757
6	RELOCATIONS	1	LS	\$29,320,645	\$29,320,645
PROJECT COST					\$252,484,237

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$76,990,742	\$1,924,769
2	APPROACH CHANNEL	1.0	%	\$8,205,529	\$82,055
3	DISCHARGE CONVEYANCE	1.0	%	\$8,278,808	\$82,788
4	OFF-CHANNEL RESERVOIRS	1.5	%	\$89,278,755	\$1,339,181
5	EROSION PROTECTION	1.0	%	\$40,409,757	\$404,098
6	RELOCATIONS	0.0	%	\$29,320,645	\$0
ANNUAL OPERATION AND MAINTENANCE COST					\$3,832,891

Water Management Strategy Evaluation

Based on the analysis provided above, the Allens Creek Reservoir project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	The project provides raw water at a highly competitive cost for future water supplies from the Brazos River Basin.
Location	4	The project is located upstream of significant future needs identified in the lower Brazos Basin. Some conveyance may be required to serve users in the western portion of Region H.
Water Quality	3	No known water quality issues impacted by the project.
Environmental Land and Habitat	4	Project has been configured in such a way to minimize impacts. Off-channel location is preferable to on-channel reservoir development.
Environmental Flows	3	The project will reduce peak flows in the Brazos Basin, but releases will improve dry-weather baseflows downstream.
Local Preference	4	The project is recognized as a priority in the lower Brazos River Basin and the western portion of Region H for meeting future needs.
Institutional Constraints	4	Project has received a water right permit, and land for reservoir site is already purchased.

CRITERIA	RATING	EXPLANATION
Development Timeline	4	The project may be developed within 15 years due to steps that have already been undertaken to further the project.
Sponsorship	4	Project sponsor has been identified and is taking steps to further project development.
Vulnerability	2	Some risk from natural and man-made disasters due to impoundment of water.
Regionalization	4	The project will serve multiple water systems across an extensive area in the western portion of Region H.
Impacts on Other WMS	5	Project has the potential to benefit the overall yield of the BRA System Operation Permit by maximizing the utility of storage in the lower basin.

Allens Creek Reservoir will impact over 7,000 acres of land. The footprint has been modified from the original proposed footprint to prevent impacts to notable wetland features. The project may potentially reduce instream flows in the lower Brazos River by as much as 202,000 ac-ft/yr. Actual impacts are provided for by permit and will be bounded by environmental flow standards for the basin. Pump station and pipeline facilities have not yet been purchased and set aside for the project and may impact current agricultural operations in a limited manner.

Water User Group Application

The Allens Creek Reservoir project 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.

CRITERIA	WUG SUITABILITY
Proximity	The location of the project provides for service to needs in the lower Brazos Basin through bed and banks transfer. Its position in the basin allows the Brazos River Authority to make more efficient delivery of water to customers. Also, the reservoir may serve customers in multiple counties in the western portion of Region H.
Size	The magnitude of the project makes it adequate for serving large demands through the sale of water to WWPs that serve a large geographic area.
Water Quality	The project will produce raw water that may be treated through additional projects to provide for treated, potable water.
Unit Cost	The unit cost for the project is relatively low for a reservoir project and highly competitive with other projects from the lower Brazos River basin.

References

Brazos River Authority. (2017). Drought Study Report. Available at <<https://brazos.org/about-us/water-supply/system-operations>>.

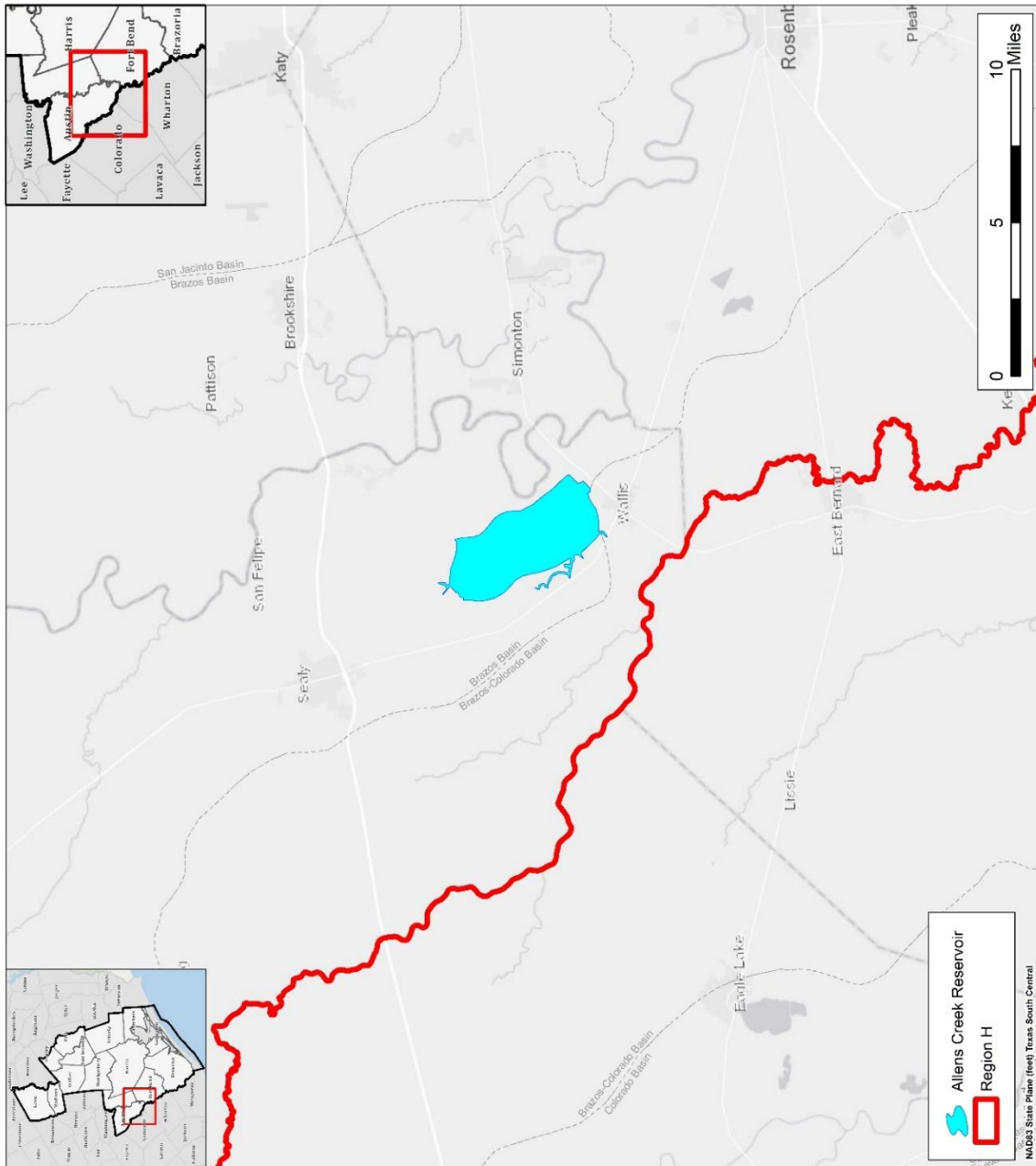
Brazos River Authority website <https://brazos.org/allenscreek>. Accessed October 2024.

Texas Commission on Environmental Quality, Brazos Water Availability model.

Permit 2925 as amended from TCEQ Water Rights Viewer
gisweb.tceq.texas.gov/WRRetrieveRights/?ID=WRPERM2925. Accessed October 2024.

Texas Parks and Wildlife, <https://tpwd.texas.gov/gis/rtest/>. Accessed October 2024.

Location Map



Allens Creek Reservoir Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	BWSC Reservoir and Pump Station Expansion
Project ID:	SWDV-002
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	80,000 ac-ft/yr (71.4 mgd)
Implementation Decade:	2030
Development Timeline:	5 years
Project Capital Cost:	\$564,553,742 (Sept. 2023)
Unit Water Cost (Rounded):	\$566 per ac-ft (during loan period) \$70 per ac-ft (after loan period)

Strategy Description

The Brazosport Water Supply Corporation (BWSC) plans to increase the total raw water pumping and storage capacity available for municipal and industrial use in the Freeport, Texas area. BWSC provides water supply service to the Brazosport Water Authority (BWA) and Dow Inc. Increasing the capacity of the existing Harris Reservoir and building an associated new river intake and pump station would give more flexibility in managing raw water resources and would provide protection during drought conditions when pumping from the Brazos River is limited or curtailed. This project does not require a new water right appropriation because it is intended to firm up existing water rights held by Dow Inc. and the Brazosport Water Authority to meet manufacturing and municipal demands in Brazoria County. The proposed reservoir would provide an additional firm yield supply quantity of 80,000 acre-feet/year.

Strategy Analyses

The project analyses for the BWSC Reservoir and Pump Station Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Dow pumps raw water supply from the Brazos River to meet the manufacturing demands of its industrial site, manufacturing demands of fence line partners, and municipal demands of the Brazosport Water Authority (BWA) and its customers. Water is diverted by Dow under Dow's water rights and on behalf of BWA under the authority's water rights. The proposed project would increase the amount of associated off-channel reservoir storage capacity by approximately 50,000 acre-feet and would provide a 4- to 8-month supply during the driest months of the critical drought, allowing Dow to meet more of its current raw water demand and the demands of the municipal customers of

the BWA. A new raw water intake and pump station, with a pumping capacity of 150,000 gpm, will make efficient use of the additional storage capacity and allow an additional 80,000 acre-feet per year of firm supply when used in conjunction with Dow's and the BWA's existing water rights as well as additional supply contracted from the Brazos River Authority.

Environmental Considerations

The project would impact approximately 2,000 acres of land, which was previously used for agricultural production and grazing. Although a number of federal and state endangered and threatened species are listed for Brazoria County, the existing disturbed condition of the proposed site suggests that impacts to listed species essentially have already occurred, and any additional impacts will be moderate to low. As part of the project development and permitting process, a proposed mitigation plan has been developed for agency consideration. Large changes in nearby property values are not anticipated due to the rural nature of the existing area. Recreational use of the reservoir will be closely managed by project sponsors and is anticipated to include fishing and bird watching.

Large surface water diversion facilities such as those associated with the BWSC Reservoir and Pump Station Expansion project have potential to influence sediment transport and nutrient loading in the source stream. This could reduce nutrient loading for some downstream habitat but also offers potential to improve water quality in areas with excessive nutrient loading or turbidity. Potential water quality management and mitigation options for large surface water diversion projects include controlled sediment releases, downstream nutrient and sediment load monitoring, and development of selective diversion structures to allow replication of natural sediment flow regimes.

Permitting and Development

The development of a project of this nature will require the study and consideration of many issues. These will include, but are not necessarily limited to: environmental assessments of the intake and pump station and reservoir sites, Sand, Gravel and Marl permit from the Texas Parks and Wildlife Department (TPWD), compliance with the Texas Commission on Environmental Quality (TCEQ) dam safety regulations including reviews and construction approvals, revisions to Federal Emergency Management Agency (FEMA) floodplain mapping for the Oyster Creek and Brazos River floodplains, utility relocations, new electrical power supply to the pump station site, road relocations, sediment removal (permitting and facility design), Storm Water Pollution Prevention Plans for construction operations, and site security. The U. S. Army Corps of Engineers issued a Record of Decision for the project in 2023. Amendment of the associated water right permit for additional off-channel storage capacity has been granted by the TCEQ.

Cost Analysis

Costs were developed for the reservoir expansion project based on the estimated cost and infrastructure capacity data provided by the project sponsors, in conjunction with standard Regional Water Planning costing procedures and assumptions. Construction, engineering, legal, contingency, land, and mitigation costs were obtained from sponsor data and scaled to a September 2023 equivalent cost using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. Because the project is a major surface water impoundment, the costing estimate developed for the Regional Water Plan calls out mitigation for the 2,000 acre project footprint separately from environmental studies and land acquisition. Costs for environmental studies and

interest during construction were assumed to be reflected in other capital components. Annualized costs for debt service and operations and maintenance were estimated using standard Regional Planning costing reference data. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs are presented in *Table 1*.

Table 1 – BWSC Reservoir and Pump Station Expansion Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$333,441,647	\$333,441,647
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$146,219,844	\$146,219,844
3	LAND AND EASEMENTS	1	LS	\$75,126,000	\$75,126,000
4	MITIGATION	1	LS	\$9,766,251	\$9,766,251
5	ENVIRONMENTAL - STUDIES	1	LS	\$0	\$0
6	INTEREST DURING CONSTRUCTION	1	LS	\$0	\$0
PROJECT CAPITAL COST					\$564,553,742

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$39,722,609	\$39,722,609	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$5,565,179	\$5,565,179	\$5,565,179	\$5,565,179	\$5,565,179	\$5,565,179
3	PUMPING ENERGY COSTS	\$29,201	\$29,201	\$29,201	\$29,201	\$29,201	\$29,201
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$45,316,990	\$45,316,990	\$5,594,381	\$5,594,381	\$5,594,381	\$5,594,381

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$45,316,990	\$45,316,990	\$5,594,381	\$5,594,381	\$5,594,381	\$5,594,381
2	YIELD	80,000	80,000	80,000	80,000	80,000	80,000
3	UNIT COST	\$566	\$566	\$70	\$70	\$70	\$70
TOTAL UNIT COST		\$235					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$56,355,472	\$56,355,472
2	OFF-CHANNEL RESERVOIRS	1	LS	\$277,086,175	\$277,086,175
PROJECT COST					\$333,441,647

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$56,355,472	\$1,408,887
2	OFF-CHANNEL RESERVOIRS	1.5	%	\$277,086,175	\$4,156,293
ANNUAL OPERATION AND MAINTENANCE COST					\$5,565,179

Water Management Strategy Evaluation

Based on the analysis provided above, the BWSC Reservoir and Pump Station Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	4	Reservoir improvements result in a low-cost project for enhancing yields from the Brazos River.
Location	5	Reservoir is already in proximity to demands through existing infrastructure.
Water Quality	4	Water supply quality is enhanced through the development of additional raw water that is less impacted by intrusion of saltwater in lower reaches of the Brazos River.
Environmental Land and Habitat	4	Limited environmental impacts associated with identified site.
Environmental Flows	2	Reduction in instream flows during periods when the reservoir is filled. These diversions are currently within the limits of the existing water right.
Local Preference	5	Widespread support and opportunity to enhance manufacturing and municipal water supplies.
Institutional Constraints	4	Property acquired and limited permitting in progress.
Development Timeline	5	Project development within five years.
Sponsorship	5	BWSC is identified as project sponsor and the project is moving forward.
Vulnerability	3	Some risk from natural and man-made disasters due to impoundment of water.
Regionalization	4	Supports multiple customer systems and expands upon existing regionalized supplies.
Impacts on Other WMS	4	Project provides additional surface water availability from Dow and BWA water rights.

The BWSC Reservoir and Pump Station Expansion will impact 2,000 acres of land that was previously under agricultural production and will have limited environmental impacts. The project will not directly impact environmental flows, as it will utilize existing diversions in the basin that are already permitted.

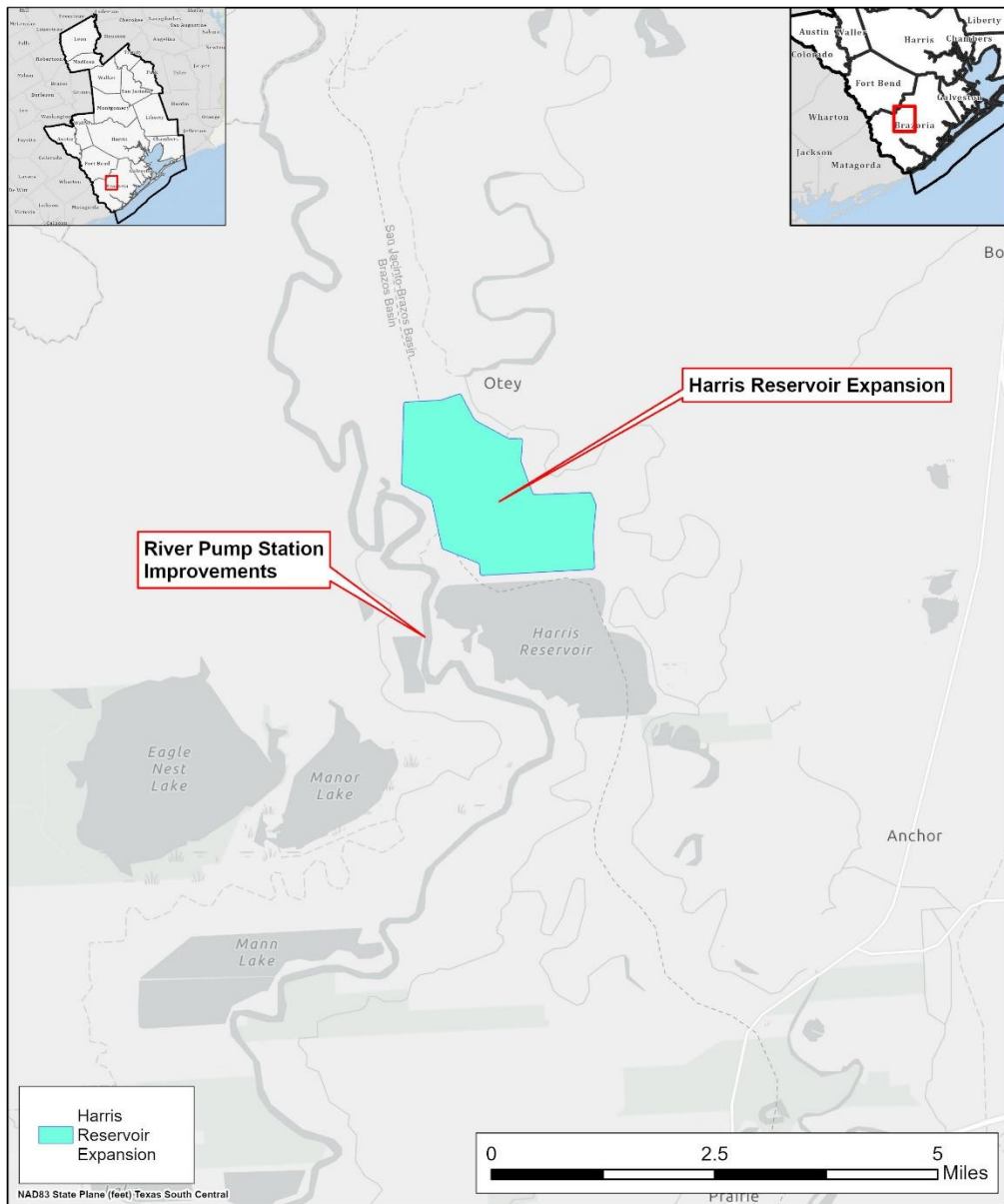
Water User Group Application

The BWSC Reservoir and Pump Station Expansion project 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.

CRITERIA	WUG SUITABILITY
Proximity	Location of the project suits it to serving existing customers of the Dow and BWA systems.
Size	Project supply capacity is a considerable benefit to large deficits traditionally associated with the lower Brazos River Basin.
Water Quality	Project produces raw water for use by customers who require raw water or are already prepared to treat raw water for other uses.
Unit Cost	Unit cost is reasonable for municipal and industrial needs.
Other Factors	Project is being sponsored by BWSC and is intended to serve the needs of current and future customers.

Location Map



BWSC Reservoir and Pump Station Expansion Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	GCWA Coastal Desalination
Project ID:	SWDV-003
Project Type:	New Surface Water Source
Potential Supply Quantity (Rounded):	Up to 22,400 ac-ft/yr (20.0 mgd)
Implementation Decade:	2040
Development Timeline:	10 years
Project Capital Cost:	\$283,297,581 (Sept. 2023)
Unit Water Cost (Rounded):	\$2,207 per ac-ft (during loan period) \$1,317 per ac-ft (after loan period)

Strategy Description

The Gulf Coast Water Authority (GCWA) is a major water provider to municipal, manufacturing, and irrigation users in the San Jacinto-Brazos Coastal Basin, with customers in Brazoria, Fort Bend, and Galveston Counties. GCWA has recognized seawater desalination as a potential alternative for meeting current and future treated water needs within its service area. Additionally, because of the end-of-basin location of GCWA's service area in the region and its wide network of water transmission and distribution infrastructure, a large-scale seawater desalination facility creates opportunities for leveraging existing water resources through conjunctive water resource management, which would further enhance regional water supplies.

This memorandum summarizes a conceptual coastal seawater desalination project for GCWA. GCWA is currently conducting a feasibility study to assess regional seawater desalination project alternatives. As part of these feasibility study, GCWA is actively collaborating with other regional partners, including the Brazos River Authority (BRA) and the Harris Galveston Subsidence District (HGSD).

Strategy Analyses

The project analyses for GCWA Costal Desalination include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The concept for the project assumes a new seawater desalination facility located in or adjacent to GCWA's existing service area. This enables GCWA to augment their existing water supplies with a reliable, high-quality water supply from an alternative, drought-proof water source. The treated water from a seawater desalination facility could offset the current supplies that GCWA provides to industrial, agricultural, and municipal customers, including diversion rights from the Brazos River.

The strategy concept assumes an initial 20 mgd reverse osmosis (RO) treatment facility to treat raw seawater. An additional 20 mgd treatment module could be added in the future to increase the total capacity of the treatment facility to 40 mgd. Additional conceptual project components assumed include a seawater intake pump station and raw water pipeline, saline water storage, and a pipeline and diffuser system to dispose of brine created from the desalination process.

A specific location for this facility has not yet been identified. Project siting is being evaluated as part of the ongoing feasibility study. If possible, the project location would benefit from the following:

- Access to utilize pre-existing infrastructure to reduce costs and expedite project implementation.
- Access to saline and fresh water sources and discharge points.
- Pre-existing permits for withdrawal and discharge.
- Options to discharge into the Gulf of Mexico, which presents fewer environmental concerns than a system discharging into a bay system.

Conservatively, it was assumed that the intake would be sized to feed a seawater desalination facility operating at 50 percent recovery. Considering recovery rates of the other unit treatment processes and process water, the facility would require a raw seawater intake of approximately 43.5 mgd. A 54-inch diameter pipeline was assumed to convey raw seawater from the intake to the treatment facility. A saline water reservoir could potentially be used as part of the intake and raw water conveyance system to mitigate sudden water quality changes and provide GCWA with flexibility to capture excess Brazos River water, which could facilitate conjunctive conveyance and operation of saline and freshwater sources.

A seawater desalination facility requires pretreatment prior to the desalination process to remove dissolved solids or salts. Pretreatment for desalination is similar to the process described for a conventional surface water treatment plant and is designed to deliver a high-quality feed of water to the RO trains. The level of pretreatment required will be dependent upon the quality of the source water.

Brine created from the desalination process, which could have a solids concentration nearly twice that of incoming seawater, would be discharged from the site. Brine concentrate disposal options include mixing the effluent with existing discharges, such as treated wastewater or industrial cooling water, open disposal in areas of high mixing potential, or submerged diffuse discharges. The most viable disposal option will be dependent on the characteristics of the selected site and will require further study.

Environmental Considerations

Direct environmental impacts associated with this project will be dependent on the site of the facility. If the facility is located on or near one a site that is already developed, environmental impacts could be mitigated. For example, locating the facility in a developed area would limit impacts of surface disturbance and minimize impacts to habitat and wildlife. Utilizing existing discharge points would minimize additional impacts to water resources in the area. Discharge of brine impacts salinity levels localized areas, which could modify water chemistry and impact habitat in the vicinity of the discharge locations. The discharge water will be blended with and diluted by other water before discharge. Project development and permitting would include assessment of impacts and potential mitigation or impact reduction strategies. This project could potentially result in increases in streamflow via return

flows from points of use, which would benefit the Brazos River and potentially some of its tributaries. This project will have the potential effect of reducing groundwater pumping and mitigating subsidence potential.

Permitting and Development

Permit requirements for the implementation of the project will be dependent on the facility location. If the facility is co-located on or near one of GCWA's existing facility sites, it could minimize impacts on species, wetlands, and other environmental factors.

Permits for seawater withdrawals would be needed to allow for the plant's operation. Waste-stream discharge will require a separate Texas Pollutant Discharge Elimination System (TPDES) discharge permit. Pipe alignments could be designed to follow existing pipelines wherever possible, minimizing environmental impacts along these rights-of-way.

Cost Analysis

Planning level cost estimates have been developed for the Region H Plan based on cost estimates provided by GCWA. Capital costs were scaled to a September 2023 equivalent cost using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. Additional cost components, such as interest during construction, annualized debt service, and annualized operations and maintenance costs, were assumed using standard Regional Planning costing assumptions. Estimated costs are presented in *Table 1*.

Table 1 – GCWA Coastal Desalination Project Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$196,650,264	\$196,650,264
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$68,827,592	\$68,827,592
3	LAND AND EASEMENTS	1	LS	\$130,229	\$130,229
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$118,390	\$118,390
5	INTEREST DURING CONSTRUCTION	1	LS	\$17,571,106	\$17,571,106
PROJECT CAPITAL COST					\$283,297,581

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$19,933,123	\$19,933,123	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$29,497,540	\$29,497,540	\$29,497,540	\$29,497,540	\$29,497,540
TOTAL ANNUAL COST		\$0	\$49,430,662	\$49,430,662	\$29,497,540	\$29,497,540	\$29,497,540

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$49,430,662	\$49,430,662	\$29,497,540	\$29,497,540	\$29,497,540
2	YIELD	-	22,400	22,400	22,400	22,400	22,400
3	UNIT COST	\$0	\$2,207	\$2,207	\$1,317	\$1,317	\$1,317
TOTAL UNIT COST							\$1,673

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	WATER TREATMENT PLANTS	1	LS	\$196,650,264	\$196,650,264
PROJECT COST					\$196,650,264

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	WATER TREATMENT PLANTS	1.0	LS	\$29,497,540	\$29,497,540
ANNUAL OPERATION AND MAINTENANCE COST					\$29,497,540

Water Management Strategy Evaluation

Based on the analysis provided above, the GCWA Coastal 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 results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	High cost, but the project represents a drought-proof, high quality water supply.
Location	3	Conveyance likely required to meet demands, but is dependent on project site and location of future municipal and industrial development in the lower Brazos River Basin.
Water Quality	3	No known water quality issues. Additional assessment of water quality will be required once a site is identified.

CRITERIA	RATING	EXPLANATION
Environmental Land and Habitat	3	Limited environmental concerns associated with project development. Additional assessment of environmental impacts will be required once a site is identified.
Environmental Flows	4	No anticipated impact on local environmental flows. Some potential for increases in streamflow via return flows from points of use.
Local Preference	3	Local support for desalination development.
Institutional Constraints	2	Extensive permitting required but not yet initiated. Depending on the selected site, some property acquisition may be necessary.
Development Timeline	4	Anticipated development timeline of ten years. Development timeline could be shortened if able to leverage existing infrastructure.
Sponsorship	3	Sponsor(s) identified.
Vulnerability	3	Risk to project related to natural disasters within proximity to the coast. However, this risk could be mitigated through existing, developed infrastructure.
Regionalization	4	Supports existing regional systems and water users supplied by GCWA.
Impacts on Other WMS	4	No direct impacts on other projects. Could allow greater flexibility in use of some existing sources.

Potential effects to acreage or vulnerable species will be dependent on the selected project site. If the GCWA Coastal Desalination project is located on or near an existing, developed site, is anticipated to have a minimal Impact to acreage and have no impact to vulnerable species. The project may increase return flows to streams by approximately 50 percent of the potential project yield of 22,400 ac-ft/yr and is not anticipated to impact agricultural land or production.

Water User Group Application

The GCWA Coastal Desalination project 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.

CRITERIA	WUG SUITABILITY
Proximity	The proposed project will ideally be sited to serve needs in the GCWA service area.
Size	The project may be scaled from 20 MGD to 40 MGD based on the concept outlined making it adaptable for a number of potential water needs.
Water Quality	The water from this project would be a high-quality, RO-treated supply that would be appropriate for municipal or extremely high-quality industrial use.
Unit Cost	The unit cost for this project may be prohibitive to most users with alternatives available. However, implementation of this project may be reasonable for uses requiring a supply that is protected from effects of drought.
Other Factors	Needs in the immediate vicinity of the project are currently planned to be met with alternative water supplies in the near-term.

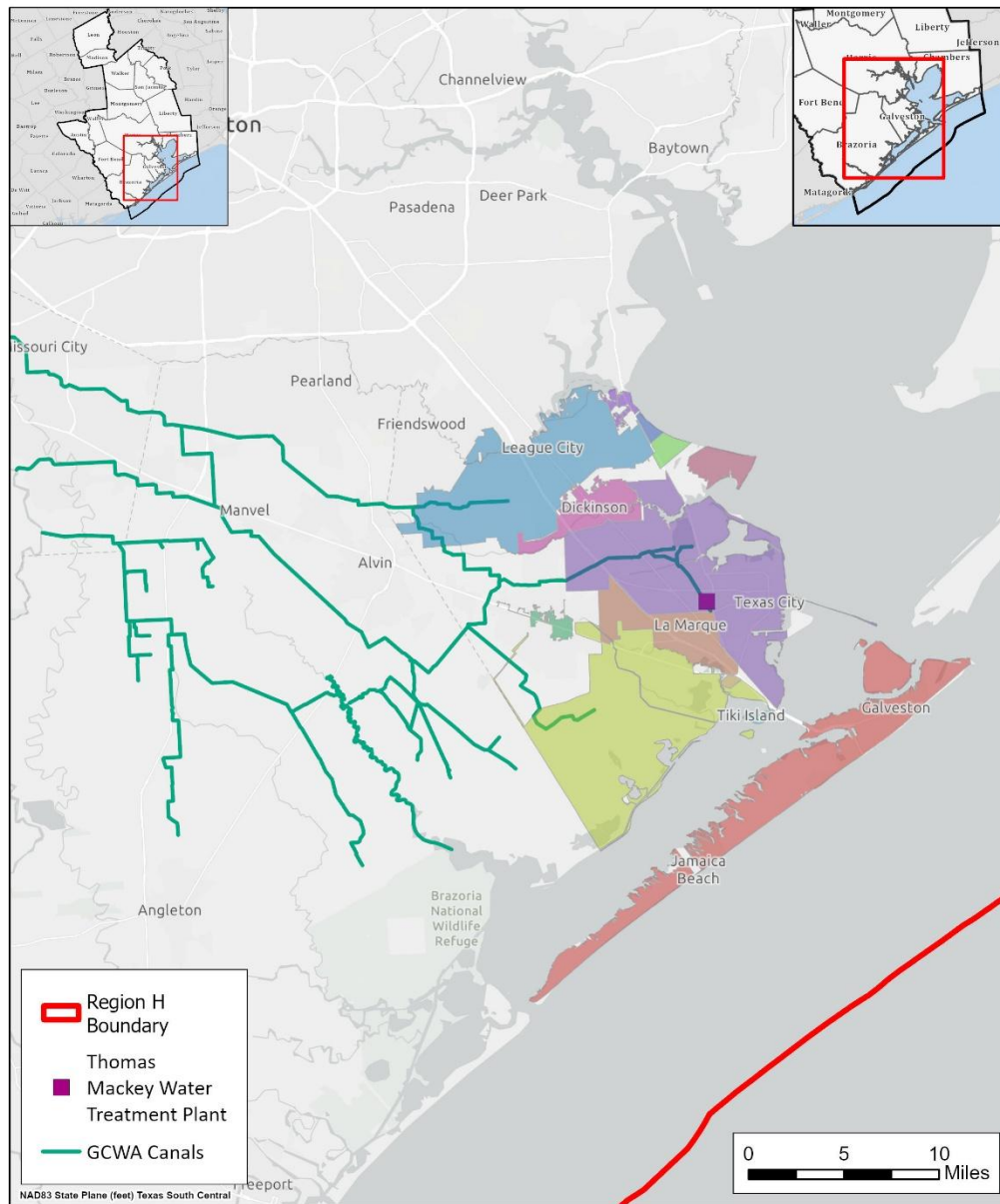
References

Gulf Coast Water Authority. *Regional Seawater Desalination Feasibility Study Grant Application, Response to Bureau of Reclamation Notice of Funding Opportunity No. R23AS00076*. 2023.

Texas Water Development Board. *The Future of Desalination in Texas, Volume 1 – Biennial Report on Seawater Desalination*. 2004.

Texas Water Development Board. *The Future of Desalination in Texas: 2018 Biennial Report to the Texas Legislature on Seawater and Brackish Groundwater Desalination*. 2018.

Location Map



GCWA Coastal Desalination Location Map



Texas

THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Lake Somerville Augmentation
Project ID:	SWDV-004
Project Type:	New Surface Water Source
Potential Supply Quantity (Rounded):	Up to 20,000 ac-ft/yr (17.9 mgd)
Implementation Decade:	2050
Development Timeline:	<10 years
Project Capital Cost:	\$498,006,241 (Sept. 2023)
Unit Water Cost (Rounded):	\$1,998 per ac-ft (during loan period) \$246 per ac-ft (after loan period)

Strategy Description

The Brazos River and its tributaries serve as a major source of water supply for entities in Regional Water Planning Areas (RWPAs) G and H. Due to the natural variability of flows in the basin, reservoirs have played an important role in capturing and storing high flows to generate more reliable water supplies. Through the Regional Planning process and other planning efforts, a number of supply concepts to increase Brazos River Basin supplies through increased use of storage have been considered. One potential option is the use of available storage capacity in Lake Somerville to store flows diverted from the main channel of the Brazos River and conveyed to the lake by pipeline.

Strategy Analyses

The project analyses for Lake Somerville Augmentation include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Lake Somerville, which is located on Yegua Creek, is operated by the US Army Corps of Engineers (USACE) and through contract serves as a water supply impoundment for the Brazos River Authority (BRA). One concept to increase firm water supplies in the Brazos Basin is the development of a pump station and pipeline to divert high flows from the Brazos River to utilize available storage in Lake Somerville and potentially increase the firm yield of the reservoir. The lake is currently permitted for diversions of up to 48,000 ac-ft per year for multiple uses under Certificate of Adjudication (COA) 12-5164. A potential strategy yield of up to 20,000 ac-ft/yr is based upon analyses by BRA.

Environmental Considerations

Due to the conceptual nature of this project, a detailed project-specific environmental assessment or

field survey has not been performed. Any project of this magnitude will include environmental challenges to be resolved during planning, design, and construction. Specific environmental obstacles would be identified during routing studies of the proposed alignment and other infrastructure. Construction of pipeline and pump station facilities would create some degree of surface disturbance, although disturbance and associated impacts would likely be limited for the conceptual pipeline route, which largely follows existing roadway alignments. Overall habitat impacts for the project would be expected to be far less than those necessary for the development of a new reservoir.

As with any new appropriation or transfer of surface water, there is the potential for impact to instream flows and habitat. However, several factors likely mitigate potential impacts for the Lake Somerville Augmentation project. The project would derive yield largely from diversions captured during periods of high flow in the river. Additionally, the proposed project does not involve an interbasin transfer of water but rather utilizes an impoundment on a tributary which flows into the river south of the diversion point. The concept as modeled would also be junior to the Senate Bill 3 environmental flow standards adopted for the Brazos River Basin.

Permitting and Development

A number of permitting steps are required for the development of this project. A new appropriation of surface water would require water right permitting through the TCEQ. Additionally, because Lake Somerville is operated by USACE, coordination and permitting through that agency would be required as well. Permitting and mitigation would also be required for physical development of infrastructure, potentially including permitting through Section 404 of the Clean Water Act administered by the USACE. These permitting requirements may require various studies for application including environmental impact or assessment studies, a wildlife habitat mitigation plan, an assessment of impacts to species, and cultural resource studies.

Cost Analysis

Preliminary planning level cost estimates were prepared for the Lake Somerville Augmentation project using standard regional planning costing assumptions and adjusted to a cost reference of September 2023 dollars as required by TWDB. Costs were developed for a 200-mgd pump station with an intake structure and an estimated 18.4 miles of pipeline. Due to the conceptual nature of the project, cost estimation for this analysis was limited to the major pump station and pipeline components and does not include other components including individual appurtenances, pipeline crossings, relocations, or other infrastructure. A summary of the project cost estimate is provided below in *Table 1*.

Table 1 – Lake Somerville Augmentation Project Cost Estimate (200 mgd Pump Station)

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$355,473,436	\$355,473,436
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$109,695,533	\$109,695,533
3	LAND AND EASEMENTS	1	LS	\$1,344,725	\$1,344,725
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$604,460	\$604,460
5	INTEREST DURING CONSTRUCTION	1	LS	\$30,888,088	\$30,888,088
PROJECT CAPITAL COST					\$498,006,241

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$0	\$35,040,255	\$35,040,255	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$0	\$4,470,785	\$4,470,785	\$4,470,785	\$4,470,785
3	PUMPING ENERGY COSTS	\$0	\$0	\$458,496	\$458,496	\$458,496	\$458,496
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$0	\$0	\$39,969,537	\$39,969,537	\$4,929,281	\$4,929,281

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$0	\$39,969,537	\$39,969,537	\$4,929,281	\$4,929,281
2	YIELD	-	-	20,000	20,000	20,000	20,000
3	UNIT COST	\$0	\$0	\$1,998	\$1,998	\$246	\$246
TOTAL UNIT COST							\$1,122

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$61,070,048	\$61,070,048
2	PIPELINES	1	LS	\$294,403,388	\$294,403,388
PROJECT COST					\$355,473,436

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$61,070,048	\$1,526,751
2	PIPELINES	1.0	%	\$294,403,388	\$2,944,034
ANNUAL OPERATION AND MAINTENANCE COST					\$4,470,785

Water Management Strategy Evaluation

Based on the analysis provided above, the Lake Somerville Augmentation project was evaluated across twelve different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Project has a high unit cost, but annual costs decrease considerably after debt service.
Location	4	Project requires extensive pipeline conveyance.
Water Quality	3	No known issues related to water quality.

Environmental Land and Habitat	3	Environmental impacts associated with the project can be mitigated.
Local Preference	3	No known significant opposition to project.
Development Timeline	4	Approximate ten-year development timeline.
Vulnerability	4	Slight risk from natural and man-made disasters.
Impacts on Other WMS	4	Project has potential to be integrated into System Operation Permit though enhancing overall basin storage.

The Lake Somerville Augmentation project includes up to 18 miles of pipeline. The majority of this impact will be in rural areas with potential limited impacts to habitat and agriculture. The project may potentially reduce instream flows by approximately 20,000 ac-ft/yr, on average. Actual impacts will be determined by the water right permit and bounded by environmental flow standards for the basin.

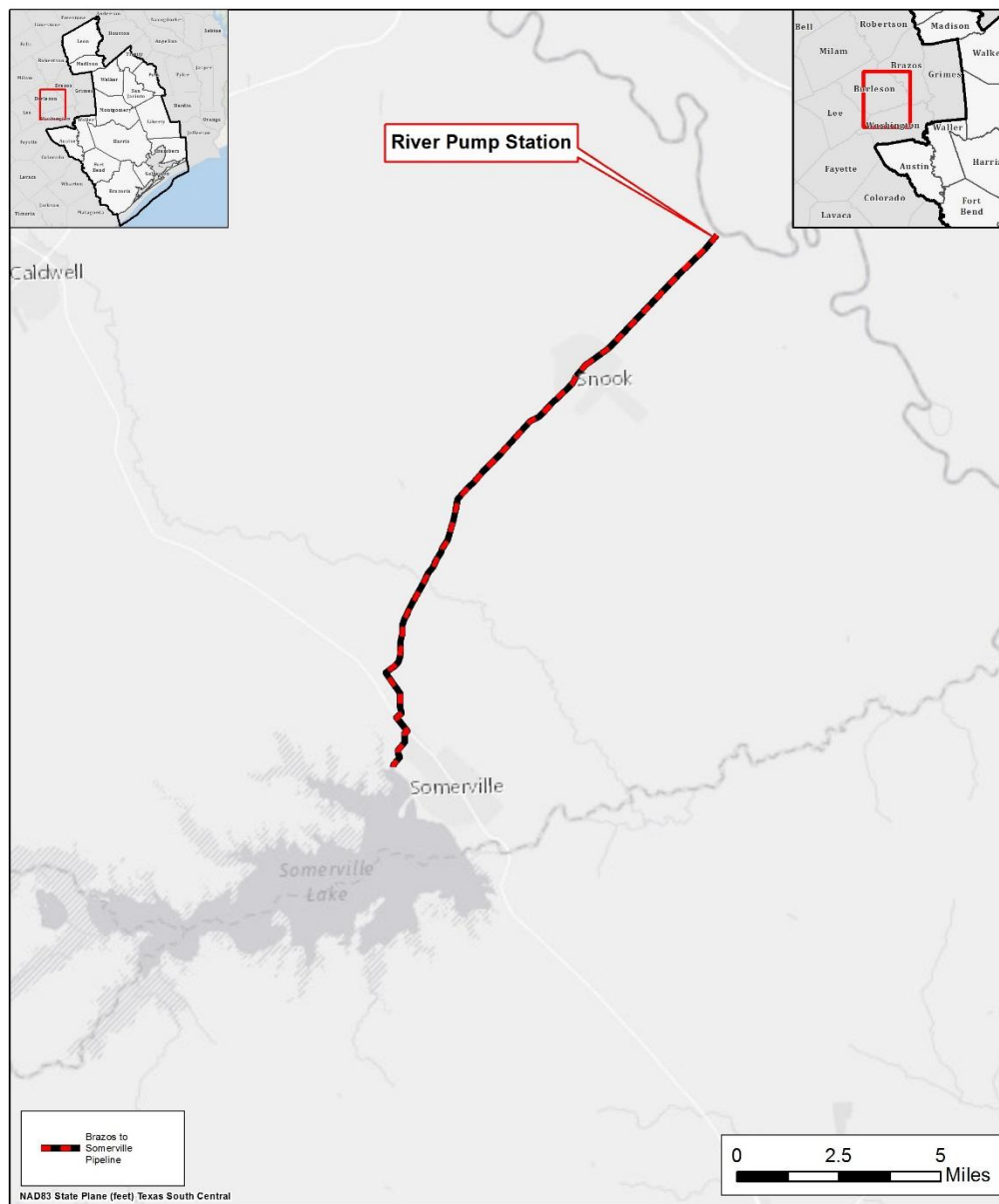
Water User Group Application

The Lake Somerville Augmentation project 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is intended to serve customers in the lower Brazos River Basin.
Size	The magnitude of the project makes is adequate for serving moderately large demands through the sale of water to WWPs that serve a large geographic area.
Water Quality	The project will produce raw water that may be treated through additional projects to provide for treated, potable water.

CRITERIA	WUG SUITABILITY
Unit Cost	The unit cost for the project is moderately high during debt service but unit cost declines substantially afterward.
Other Factors	Project may provide benefit to overall system operation.

Location Map



Lake Somerville Augmentation Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	BAWA East SWTP Expansion
Project ID:	TRET-001
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	13,440 ac-ft/yr (12 mgd)
Implementation Decade:	2030
Development Timeline:	2 years
Project Capital Cost:	\$124,515,458 (Sept. 2023)
Unit Water Cost (Rounded):	\$868 per ac-ft (during loan period) \$217 per ac-ft (after loan period)

Strategy Description

Baytown Area Water Authority (BAWA) is a wholesale provider of treated water to municipal water systems in eastern Harris and western Chambers Counties in Region H, including the City of Baytown and multiple Fresh Water Supply Districts and Municipal Utility Districts. BAWA utilizes surface water obtained under contract from the City of Houston and diverted from two take points on the Coastal Water Authority canal system. This raw water is treated at BAWA's original Fritz Langham Surface Water Treatment Plant (SWTP) as well as the newer East SWTP before being distributed through the BAWA and City of Baytown transmission and distribution systems. In order to meet the needs of current and future customers, BAWA has identified the need to expand the treatment capacity of the BAWA East SWTP. The new treatment infrastructure will be developed on the existing East SWTP site, limiting the required permitting and the need for development of additional conveyance. This project does not require a new water right appropriation because it is associated with infrastructure related to the use of existing rights.

Strategy Analyses

The project analyses for the BAWA East SWTP Expansion project include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

This project is supplied by contractual agreements for supply from existing water rights. The BAWA East SWTP Expansion project will increase deliverable supplies from existing sources and will not require a new water right appropriation. The proposed infrastructure will increase treatment capacity to allow an increased volume of contracted surface water supply to be used by BAWA's customers. Major project components include development of additional treatment units and storage in order to increase treatment capacity, with an initial phase increasing the facility's capacity from 6 mgd to 12

mgd by 2030, resulting in an additional 6 mgd (6,720 ac ft/yr) of treated water capacity. A subsequent expansion phase is anticipated to expand the facility by another 6 mgd by 2040.

Environmental Considerations

The enhanced infrastructure will facilitate an increase in treatment capacity for the BAWA system. Impacts on instream flows and bay and estuary flows are anticipated to be minimal, as the proposed project increases usable supply from contractual supplies based upon existing water rights and existing canal conveyance; the project does not develop new surface water sources. Infrastructure development may result in some limited surface disturbance from construction; however, this is expected to be minimal as the proposed infrastructure has a limited footprint and will be developed on BAWA's existing SWTP site adjacent to existing facilities.

Permitting and Development

The development of this strategy may require some permitting due to surface disturbance from the construction of treatment infrastructure. This is expected to be minimal, as construction is anticipated to occur on the sponsor's existing SWTP site. Because the supply source is provided by existing water rights and diverted from the existing Coastal Water Authority canal system, permitting of new water rights or amendment of existing rights will not be required.

Cost Analysis

Planning level cost estimates for this strategy are included in the table below. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. An estimated capital cost for the expansion of the SWTP was provided by BAWA and was scaled to a September 2023 equivalent cost in accordance with TWDB guidance (*Table 1*). The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Certain costs presented in *Table 1*, including environmental studies and mitigation, estimated interest during construction, and annual costs such as debt service and costs for operations and maintenance, were calculated using standard cost estimation procedures for Region H.

Table 1 – BAWA East SWTP Expansion Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$80,272,638	\$80,272,638
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$36,040,776	\$36,040,776
3	LAND AND EASEMENTS	1	LS	\$43,560	\$43,560
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$435,600	\$435,600
5	INTEREST DURING CONSTRUCTION	1	LS	\$7,722,884	\$7,722,884
PROJECT CAPITAL COST					\$124,515,458

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (2030 PHASE)	\$4,380,521	\$4,380,521	\$0	\$0	\$0	\$0
2	DEBT SERVICE (2040 PHASE)	\$0	\$4,380,521	\$4,380,521	\$0	\$0	\$0
3	OPERATION AND MAINTENANCE (2030 PHASE)	\$1,454,906	\$1,454,906	\$1,454,906	\$1,454,906	\$1,454,906	\$1,454,906
4	OPERATION AND MAINTENANCE (2040 PHASE)	\$0	\$1,454,906	\$1,454,906	\$1,454,906	\$1,454,906	\$1,454,906
5	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
6	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$5,835,426	\$11,670,853	\$7,290,332	\$2,909,811	\$2,909,811	\$2,909,811

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$5,835,426	\$11,670,853	\$7,290,332	\$2,909,811	\$2,909,811	\$2,909,811
2	YIELD	6,720	13,440	13,440	13,440	13,440	13,440
3	UNIT COST	\$868	\$868	\$542	\$217	\$217	\$217
TOTAL UNIT COST		\$454					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	WATER TREATMENT PLANTS (2030 PHASE)	1	LS	\$40,136,319	\$40,136,319
2	WATER TREATMENT PLANTS (2040 PHASE)	1	LS	\$40,136,319	\$40,136,319
PROJECT COST					\$80,272,638

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	WATER TREATMENT PLANTS (2030 PHASE)	1.0	LS	\$1,454,906	\$1,454,906
2	WATER TREATMENT PLANTS (2040 PHASE)	1.0	LS	\$1,454,906	\$1,454,906
ANNUAL OPERATION AND MAINTENANCE COST					\$2,909,811

Water Management Strategy Evaluation

Based on the analysis provided above, the BAWA East SWTP Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

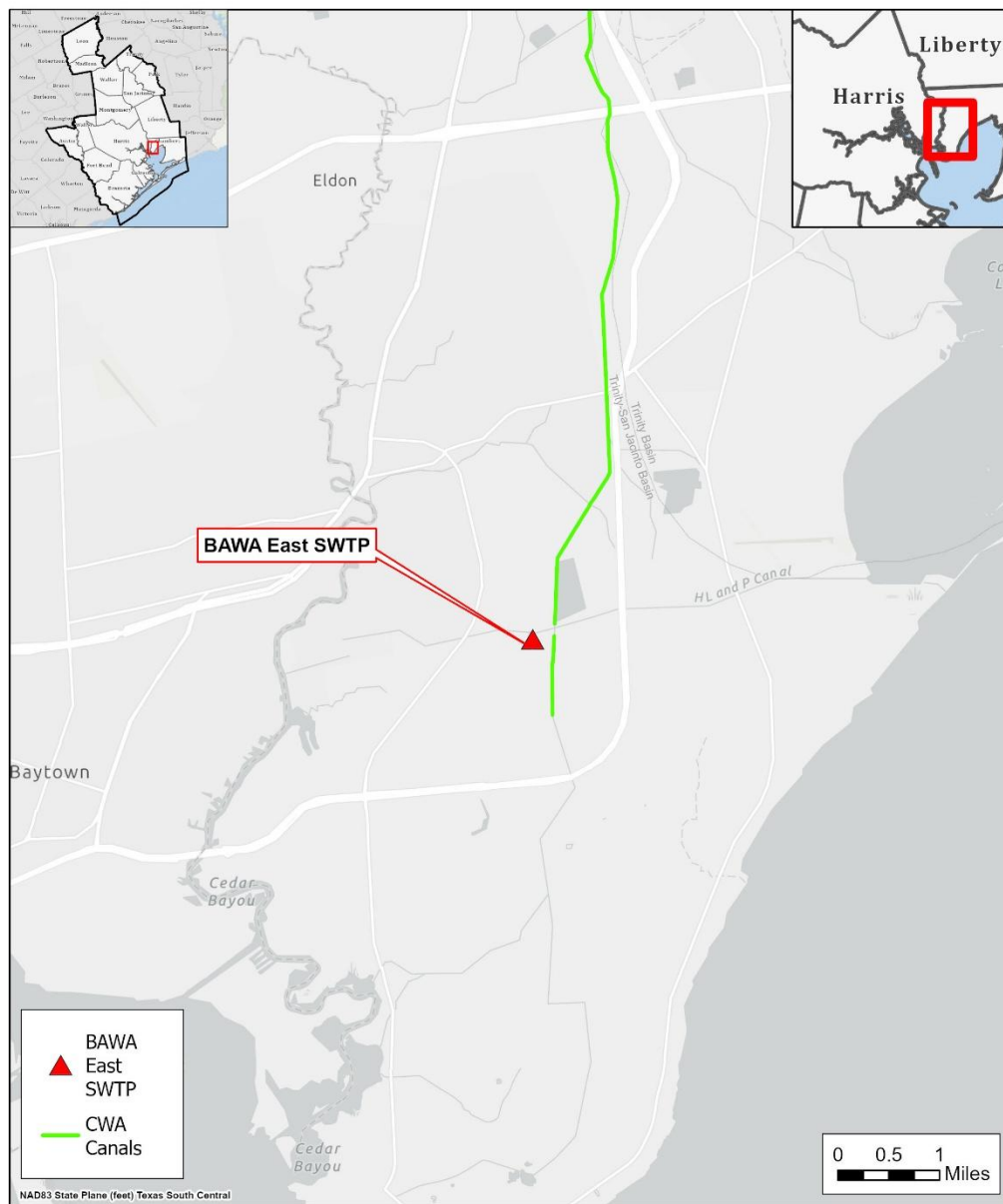
CRITERIA	RATING	EXPLANATION
Cost	3	Costs are moderate during debt service but are reduced considerably after completion of debt service
Location	5	Project is associated with an existing treatment plant site and conveyance infrastructure serving a large area.
Water Quality	3	No known issues related to water quality.
Environmental Land and Habitat	4	Expansion to be constructed on existing plant site. Minimal impacts anticipated.
Environmental Flows	3	Project does not directly impact flows. Increased diversions from canal conveyance are associated with existing water rights.
Local Preference	4	No known significant opposition.
Institutional Constraints	5	Property and facilities to be expanded already owned by sponsor.
Development Timeline	5	Project can be developed in a relatively short period of time.
Sponsorship	5	The project sponsor is committed to the project and is actively engaged in planning and design activities.
Vulnerability	4	Minor risks from natural and man-made disasters associated with source availability.
Regionalization	2	Serves sponsor entity and a limited number of customers.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

The BAWA East SWTP Expansion will facilitate diversions made from existing water rights. The project is not anticipated to impact agricultural land and production or to impact vulnerable species.

Water User Group Application

The BAWA East SWTP Expansion project 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use.
Size	The project is sized in accordance with the treatment infrastructure needs and available source water identified by the project sponsor.
Water Quality	This project provides treated surface water for a variety of uses.
Unit Cost	Costs are moderate during debt service but are reduced considerably after completion of debt service.
Other Factors	This project meets demands in a rapidly growing area and also helps reduce potential demand on groundwater sources.

Location Map**BAWA East SWTP Expansion
Location Map**

Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Brazosport Water Authority Conventional Treatment Expansion
Project ID:	TRET-002
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	8,960 ac-ft/yr (8.0 mgd)
Implementation Decade:	2030
Development Timeline:	5 years
Project Capital Cost:	\$23,517,647 (Sept. 2023)
Unit Water Cost (Rounded):	\$385 per ac-ft (during loan period) \$200 per ac-ft (after loan period)

Strategy Description

The Brazosport Water Authority (BWA) serves seven communities in the southern Brazoria County area and provides potable service to Dow Inc., two Texas Department of Criminal Justice (TDCJ) units, as well as the City of Rosenberg. In December of 2013, BWA concluded a Texas Water Development Board (TWDB) Regional Facility Planning Grant study to examine the potential for serving the current BWA service area as well as other portions of Brazoria County in the future. In addition to the development of a reverse osmosis (RO) water treatment plant (WTP) at the site of the current BWA surface water treatment plant, the study also recommended expansion of BWA's conventional surface water treatment capacity in order to accommodate additional growth within and surrounding the existing service area of the facility.

Strategy Analyses

The project analyses for BWA Conventional Treatment Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The proposed project will include the expansion of BWA's 20 mgd conventional filtration treatment plant by an additional 8.0 mgd. This project will work in conjunction with the proposed brackish groundwater and RO facilities to provide adequate supplies to meet future needs to be served by BWA.

Environmental Considerations

It is anticipated that the BWA WTP Expansion will be developed within the confines of the existing plant site. This is expected to minimize additional environmental impacts.

Permitting and Development

Permitting will be required for components external to the scope of any initial permitting process conducted for the BWA WTP site.

Cost Analysis

Preliminary cost estimates for the proposed project were provided by BWA and adjusted for use in regional planning. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. These costs are summarized below in *Table 1*.

Table 1 – BWA Conventional Treatment Expansion Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023	
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL	
PROJECT CAPITAL COST SUMMARY						
1	CONSTRUCTION COST	1	LS	\$16,340,000	\$16,340,000	
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$5,719,000	\$5,719,000	
3	LAND AND EASEMENTS	1	LS	\$0	\$0	
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0	
5	INTEREST DURING CONSTRUCTION	1	LS	\$1,458,647	\$1,458,647	
PROJECT CAPITAL COST					\$23,517,647	

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$1,654,727	\$1,654,727	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$1,792,685	\$1,792,685	\$1,792,685	\$1,792,685	\$1,792,685	\$1,792,685
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$3,447,412	\$3,447,412	\$1,792,685	\$1,792,685	\$1,792,685	\$1,792,685

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$3,447,412	\$3,447,412	\$1,792,685	\$1,792,685	\$1,792,685	\$1,792,685
2	YIELD	8,960	8,960	8,960	8,960	8,960	8,960
3	UNIT COST	\$385	\$385	\$200	\$200	\$200	\$200
TOTAL UNIT COST		\$262					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL	
CONSTRUCTION COST SUMMARY						
1	PUMP STATIONS	1	LS	\$2,270,000	\$2,270,000	
2	WATER TREATMENT PLANTS	1	LS	\$14,070,000	\$14,070,000	
PROJECT COST					\$16,340,000	

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL	
OPERATION AND MAINTENANCE (O&M) COST SUMMARY						
1	PUMP STATIONS	2.5	%	\$2,270,000	\$56,750	
2	WATER TREATMENT PLANTS	1.0	LS	\$1,735,935	\$1,735,935	
ANNUAL OPERATION AND MAINTENANCE COST					\$1,792,685	

Water Management Strategy Evaluation

Based on the analysis provided above, the BWA Conventional Treatment Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative

strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	4	Project provides treated water at a moderately low cost, which decreases further after completion of debt service.
Location	3	Conveyance required to provide water to diverse BWA service area.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	5	Very limited impacts associated with existing BWA plant site.
Environmental Flows	3	No change in river diversions directly associated with project.
Local Preference	4	Local support from BWA customers.
Institutional Constraints	3	Minimal permitting effort associated with project.
Development Timeline	5	Project can be implemented in a relatively short time period.
Sponsorship	5	Project is under development.
Vulnerability	4	No substantial risk from natural and man-made disasters.
Regionalization	4	Supports multiple customer systems and expands upon existing regionalized supplies.
Impacts on Other WMS	5	Project works in conjunction with BWA brackish groundwater project to provide a reliable water supply.

The BWA Conventional Treatment Expansion is not anticipated to affect acreage or vulnerable species. Development is anticipated to be on the existing plant site with limited potential for impact. The plant expansion will not directly impact environmental flows. The project will utilize existing diversions in the basin that are already permitted. The project is not anticipated to impact agricultural land or production.

Water User Group Application

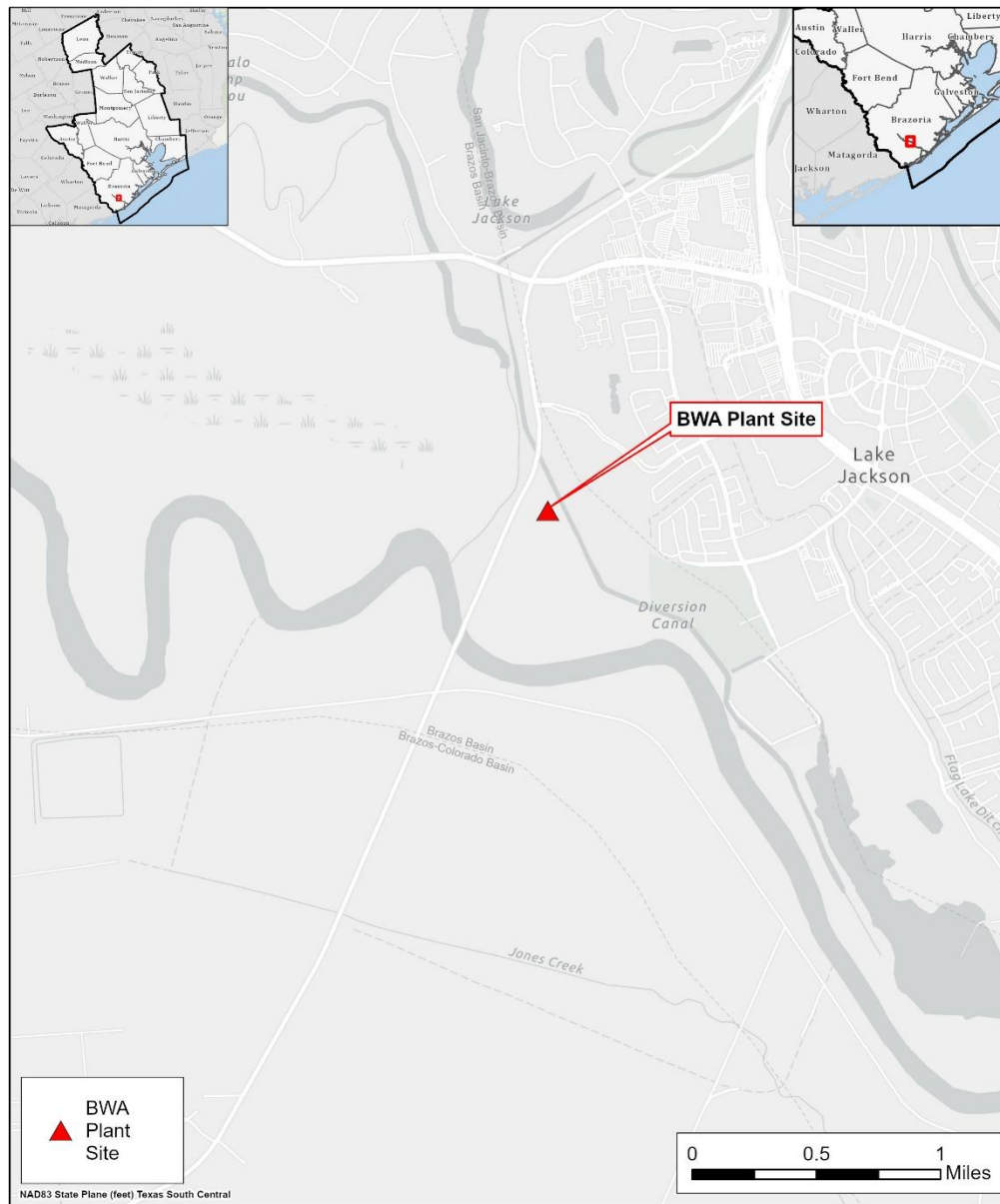
The BWA Conventional Treatment Expansion project was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is positioned to provide water within the current BWA customer service area.
Size	Project is sized to provide adequate dry-year supply for BWA customer use.
Water Quality	Project will provide treated potable water for municipal and industrial use.
Unit Cost	Unit cost is suited to use for municipal supply.
Other Factors	Project is identified for BWA service area.

References

CDM-Smith. *Brazoria County Regional Water Facility Study*. May 2013.

Location Map



Brazosport Water Authority Conventional Treatment Plant Expansion Location Map



THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	City of Houston EWPP Enhancement
Project ID:	TRET-003
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	336,000 ac-ft/yr (300 mgd)
Implementation Decade:	2040
Development Timeline:	<10 years
Project Capital Cost:	\$4,105,236,905 (Sept. 2023)
Unit Water Cost (Rounded):	\$979 per ac-ft (during loan period) \$120 per ac-ft (after loan period)

Strategy Description

The City of Houston (COH) operates three major surface water treatment plants in Harris County. Collectively, these facilities provide treated water to the COH distribution system as well as a number of regional partners and contract customers. The facilities provide an important tie between raw water supplies in the Trinity and San Jacinto River Basins and demands as far west as the Brazos River Basin in Fort Bend County. The treated supply from these facilities enables COH and its customers to meet the groundwater reduction requirements of the Harris-Galveston Subsidence District (HGSD) and Fort Bend Subsidence District (FBSD). As demand increases in both the Houston service area and among wholesale customers of COH, additional treatment capacity will be required.

COH has identified the need for a project to substantially increase treatment capacity at the City's East Water Purification Plant (EWPP) to help meet this demand. The EWPP is a major surface water treatment facility located in eastern Houston near the confluence of Hunting Bayou and Buffalo Bayou. The plant primarily utilizes water associated with the Lake Livingston water right in the Trinity River Basin as well as from Lake Houston, with source water conveyed to the site through the Coastal Water Authority (CWA) canal system. The EWPP treats water for use by COH and wholesale customers, including industry and municipalities. The facility also serves as a source of treated surface water for several regional water authorities, including North Channel Water Authority, North Fort Bend Water Authority, and West Harris County Regional Water Authority.

The project will involve the construction of a new large-scale treatment facility at the EWPP site and adjacent to the existing treatment plant. The new infrastructure is not intended as a replacement for the existing EWPP infrastructure and will be utilized in conjunction with existing facilities to greatly increase the total EWPP treatment capacity. This expansion will allow COH and the entities it serves to utilize a greater amount of water supply from existing and potential future sources to meet growing demands and groundwater reduction requirements. The project also supports the City's One Water Houston approach to integrated, sustainable management of water resources.

Strategy Analyses

The project analyses for City of Houston EWPP Enhancement include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The projected plant capacity was developed based on COH's assessment of current and future treated water demands. The new treatment facility, which will be located adjacent to and operated in conjunction with existing EWPP treatment infrastructure, is anticipated to have a peak capacity of 360 mgd (403,200 ac-ft/yr). Average annual supply anticipated from the facility is approximately 300 mgd (336,000 ac-ft/yr). Major project components are anticipated to include new treatment infrastructure, associated appurtenances, and on-site storage.

The project will be supplied primarily by the existing Lake Livingston water right in the Trinity River Basin as well as Lake Houston in the San Jacinto River Basin, with supplies continuing to be conveyed westward to the EWPP through the CWA Canal system. The project will increase treated supplies from existing sources and will not require a new water right appropriation. Due to the extensive and highly regionalized nature of the COH system, the project will support not only the City but its many wholesale customers, and will facilitate multiple WMS including the COH Groundwater Reduction Plan (GRP). For purposes of the RWP, the project is estimated to facilitate up to 300 mgd in additional future supply.

Environmental Considerations

The project will create an increase in treatment capacity of the COH system and increase overall usable amount of existing water sources. Impacts on instream flows and bay and estuary inflows are expected to be minimal, as the proposed project increases the usable supply from sources associated with existing water rights and conveyance. The project does not develop new surface water sources. Infrastructure development may result in some limited surface disturbance from construction and COH is planning environmental surveys to assess potential for impacts to natural and cultural resources; however, this is expected to be minimal as the proposed infrastructure will be developed at the existing EWPP site.

Permitting and Development

The development of this strategy may require some permitting due to surface disturbance from the construction of treatment infrastructure. This is expected to be minimal, as construction is anticipated to occur on the sponsor's existing EWPP site. Because the supply source is provided by existing water rights and conveyance, permitting of new water rights or amendment of existing rights will not be required.

Cost Analysis

Costs were developed for the City of Houston EWPP Enhancement project based on the estimated cost and infrastructure capacity data provided by the project sponsor, in conjunction with standard Regional Water Planning costing procedures and assumptions. Construction, engineering, legal, and contingency costs were obtained from sponsor data and scaled to a September 2023 equivalent cost

using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. Due to the development of the majority of associated project infrastructure on an existing, pre-disturbed site in an urban setting, land and environmental study and mitigation costs are expected to be minimal and are assumed to be included as part of construction, engineering, and contingency costs. Interest during construction is additionally estimated to be covered under the other capital cost categories noted. Annualized costs for debt service and operations and maintenance were estimated using standard Regional Planning costing reference data. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs are presented in *Table 1*.

Table 1 – City of Houston EWPP Enhancement Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023	
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL	
PROJECT CAPITAL COST SUMMARY						
1	CONSTRUCTION COST	1	LS	\$3,141,648,770	\$3,141,648,770	
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$963,588,135	\$963,588,135	
3	LAND AND EASEMENTS	1	LS	\$0	\$0	
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0	
5	INTEREST DURING CONSTRUCTION	1	LS	\$0	\$0	
PROJECT CAPITAL COST					\$4,105,236,905	

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$0	\$288,848,889	\$288,848,889	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$0	\$40,166,192	\$40,166,192	\$40,166,192	\$40,166,192	\$40,166,192
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$0	\$329,015,081	\$329,015,081	\$40,166,192	\$40,166,192	\$40,166,192

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$0	\$329,015,081	\$329,015,081	\$40,166,192	\$40,166,192	\$40,166,192
2	YIELD	-	336,000	336,000	336,000	336,000	336,000
3	UNIT COST	\$0	\$979	\$979	\$120	\$120	\$120
TOTAL UNIT COST							\$463

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	WATER TREATMENT PLANTS	1	LS	\$3,141,648,770	\$3,141,648,770
PROJECT COST					\$3,141,648,770

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	WATER TREATMENT PLANTS	1.0	LS	\$40,166,192	\$40,166,192
ANNUAL OPERATION AND MAINTENANCE COST					\$40,166,192

Water Management Strategy Evaluation

Based on the analysis provided above, the City of Houston EWPP Enhancement project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table

below.

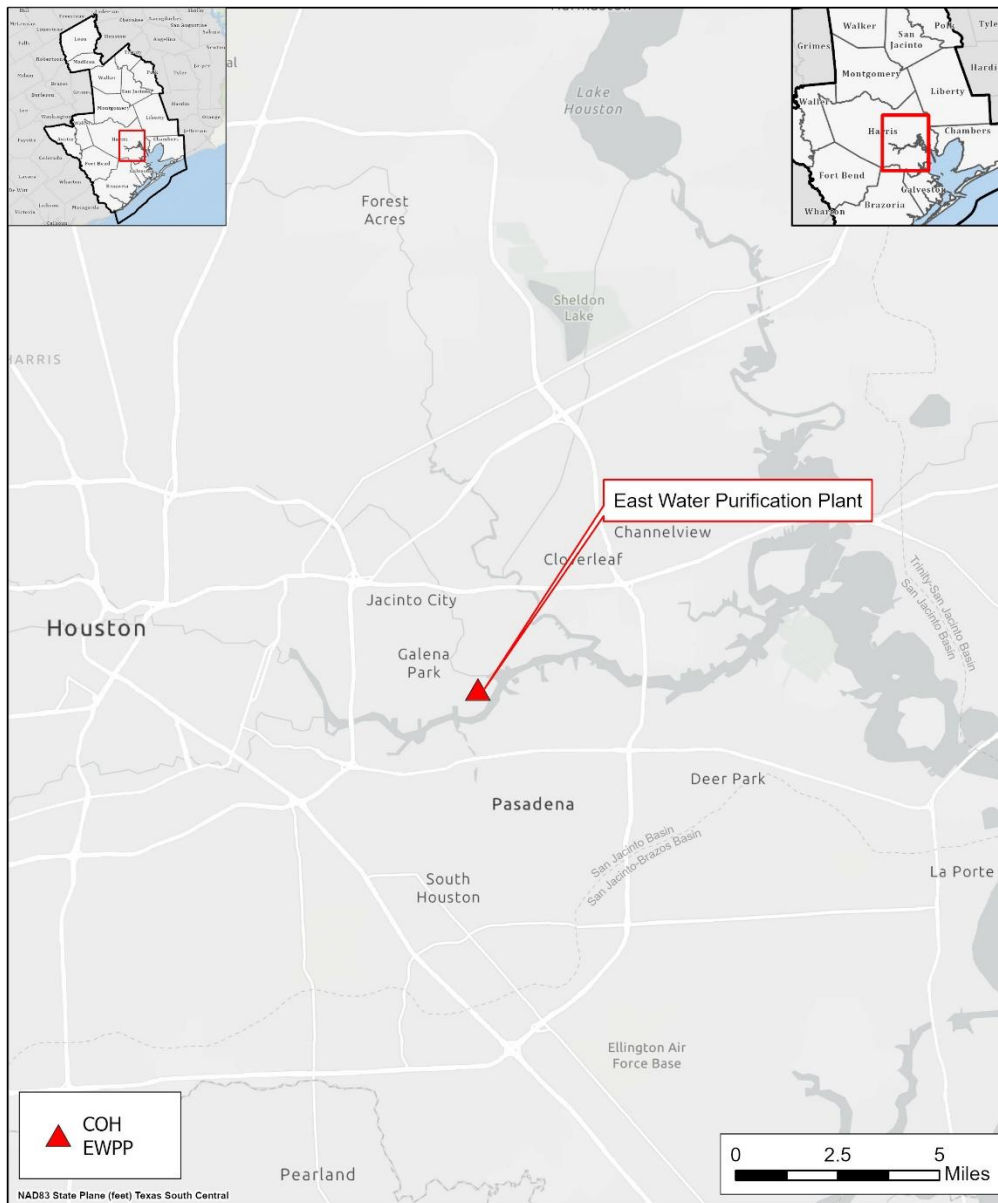
Criteria	Rating	Explanation
Cost		Costs are moderately high during debt service but are reduced considerably after completion of debt service.
Location	5	Project is associated with development of a new plant at an existing treatment plant site and conveyance infrastructure serving a large area.
Water Quality		No known issues related to water quality.
Environmental Land and Habitat	4	New facility to be constructed on existing plant site, adjacent to existing infrastructure. Minimal impacts anticipated.
Environmental Flows	3	Project does not directly impact flows. Increased diversions from existing conveyance are associated with existing water rights.
Local Preference	4	No known significant opposition.
Institutional Constraints	5	Property for treatment site already owned by sponsor.
Development Timeline	4	Project development timeline of less than 10 years.
Sponsorship	5	The project sponsor is committed to the project and is actively engaged in planning, design, and funding procurement activities.
Vulnerability	4	Minor risks from natural and man-made disasters associated with source availability.
Regionalization	4	Supports multiple customer systems and expands upon existing regionalized supplies.
Impacts on Other WMS	5	The project increases the overall treatment capacity of the City of Houston system, supporting WMS including the City of Houston Groundwater Reduction Plan and contractual supplies to other entities.

The City of Houston EWPP Enhancement is not anticipated to affect acreage or vulnerable species. The City of Houston EWPP Enhancement will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The City of Houston EWPP Enhancement project 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.

Criteria	WUG Suitability
Proximity	The project is located in close proximity to intended points of use and can be made available to meet demands in the immediate vicinity of the plant or conveyed to other demand areas.
Size	The project is sized in accordance with the treatment infrastructure needs and available source water identified by the project sponsor.
Water Quality	The project provides treated surface water for potable uses such as for meeting municipal demands.
Unit Cost	The unit cost of this project makes it an acceptable project for municipal and other potable water demands.
Other Factors	The sponsor has been identified and is moving forward with project development, which will meet demands in a rapidly growing area and also help reduce potential demand on groundwater sources.

Location Map

City of Houston
East Water Purification Plant
Enhancement Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Harris County MUD 50 SWTP
Project ID:	TRET-004
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	560 ac-ft/yr (0.5 mgd)
Implementation Decade:	2030
Development Timeline:	<5 years
Project Capital Cost:	\$22,804,420 (Sept. 2023)
Unit Water Cost (Rounded):	\$4,994 per ac-ft (during loan period) \$2,129 per ac-ft (after loan period)

Strategy Description

Harris County Municipal Utility District (MUD) 50 is located in eastern Harris County and serves the Barrett Station community and surrounding areas. Overall regional growth and the development of new transportation infrastructure have led to increasing population in the eastern portion of Harris County, with this growth projected to continue into the future. The Harris-Galveston Subsidence District (HGSD) has established requirements for entities within its boundaries to limit groundwater pumpage to a specified percentage of total water use to address the issue of land surface subsidence caused by prolonged, excess pumping from the Gulf Coast Aquifer; as demands are expected to grow with time, the allowable percentage from groundwater is scheduled to decrease. In order to address the combination of increasing demand and the regulation of groundwater, Harris County MUD 50 will, in the future, need to develop additional water supply. The MUD has secured a contract for 0.5 mgd (560 ac-ft/yr) of raw surface water from the San Jacinto River Authority (SJRA). The conveyance infrastructure for SJRA's Highlands System crosses through the MUD 50 service area, reducing the infrastructure needed to access the supply. MUD 50 has previously investigated various concepts for development of surface water treatment infrastructure to meet needs within its service area. New treatment infrastructure would be developed within an urbanized area, limiting the required permitting and the need for development of additional conveyance. This project does not require a new water right appropriation because it is associated with infrastructure related to the use of existing rights.

Strategy Analyses

The project analyses for the Harris County MUD 50 Surface Water Treatment Plant (SWTP) project include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Harris County MUD 50 currently holds a contract for up to 0.5 mgd of raw water supply from SJRA. This project concept utilizes the contractual agreements for supply from existing water rights and would develop treated supplies from existing sources and will not require a new water right appropriation. Major project components would be anticipated to include a pump station with intake, approximately one mile of pipeline, and a conventional surface water treatment plant.

Environmental Considerations

The primary impact associated with the implementation of this water management project is the increase in diversions for the SJRA Highlands system. Increased diversion of water will result in some minimal decreases in instream flow downstream of the intake point. However, these diversions would be made from existing water rights owned by a wholesale water provider, contracted by Harris County MUD 50, and no new water rights permits would be required for this project.

Permitting and Development

The development of this strategy may require some permitting due to surface disturbance from the construction of treatment infrastructure. This is expected to be minimal, as construction is anticipated to occur within a pre-disturbed urbanized area. Because the supply source is provided by existing water rights and diverted from an existing conveyance system, permitting of new water rights or amendment of existing rights will not be required.

Cost Analysis

Planning level cost estimates for this strategy are estimated for a 0.5 mgd concept. Development of the project was assumed to require a pump station with intake, conventional surface water treatment plant, and approximately one mile of conveyance pipeline. Capital costs for these elements, along with environmental studies and mitigation, estimated interest during construction, and annual costs such as debt service and costs for operations and maintenance, were calculated using standard cost estimation procedures for Region H. Estimated costs are presented in *Table 1* and are shown in September 2023 dollars in accordance with TWDB guidance.

Table 1 – Harris County MUD 50 SWTP Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$15,798,607	\$15,798,607
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$5,485,154	\$5,485,154
3	LAND AND EASEMENTS	1	LS	\$13,527	\$13,527
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$92,723	\$92,723
5	INTEREST DURING CONSTRUCTION	1	LS	\$1,414,410	\$1,414,410
PROJECT CAPITAL COST					\$22,804,420

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$1,604,544	\$1,604,544	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$1,181,415	\$1,181,415	\$1,181,415	\$1,181,415	\$1,181,415	\$1,181,415
3	PUMPING ENERGY COSTS	\$10,794	\$10,794	\$10,794	\$10,794	\$10,794	\$10,794
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$2,796,753	\$2,796,753	\$1,192,209	\$1,192,209	\$1,192,209	\$1,192,209

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$2,796,753	\$2,796,753	\$1,192,209	\$1,192,209	\$1,192,209	\$1,192,209
2	YIELD	560	560	560	560	560	560
3	UNIT COST	\$4,994	\$4,994	\$2,129	\$2,129	\$2,129	\$2,129
TOTAL UNIT COST		\$3,084					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$4,248,000	\$4,248,000
2	PIPELINES	1	LS	\$887,175	\$887,175
3	WATER TREATMENT PLANTS	1	LS	\$10,663,432	\$10,663,432
PROJECT COST					\$15,798,607

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$4,248,000	\$106,200
2	PIPELINES	1.0	%	\$887,175	\$8,872
3	WATER TREATMENT PLANTS	1.0	LS	\$1,066,343	\$1,066,343
ANNUAL OPERATION AND MAINTENANCE COST					\$1,181,415

Water Management Strategy Evaluation

Based on the analysis provided above, the Harris County MUD 50 SWTP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Costs are high due to limited economy of scale of project.

CRITERIA	RATING	EXPLANATION
Location	4	Some conveyance infrastructure may be necessary to access contractual supplies.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	5	Limited or no known impacts.
Environmental Flows	2	Minor reduction in environmental flows.
Local Preference	4	No known significant opposition.
Institutional Constraints	3	Contractual surface water source is procured. Project site would require permitting and procurement.
Development Timeline	5	Project can be developed in a relatively short period of time.
Sponsorship	2	Sponsor has previously investigated project, but current commitment level is uncertain.
Vulnerability	4	Minor risks from natural and man-made disasters associated with source availability.
Regionalization	1	Would serve a single water system.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

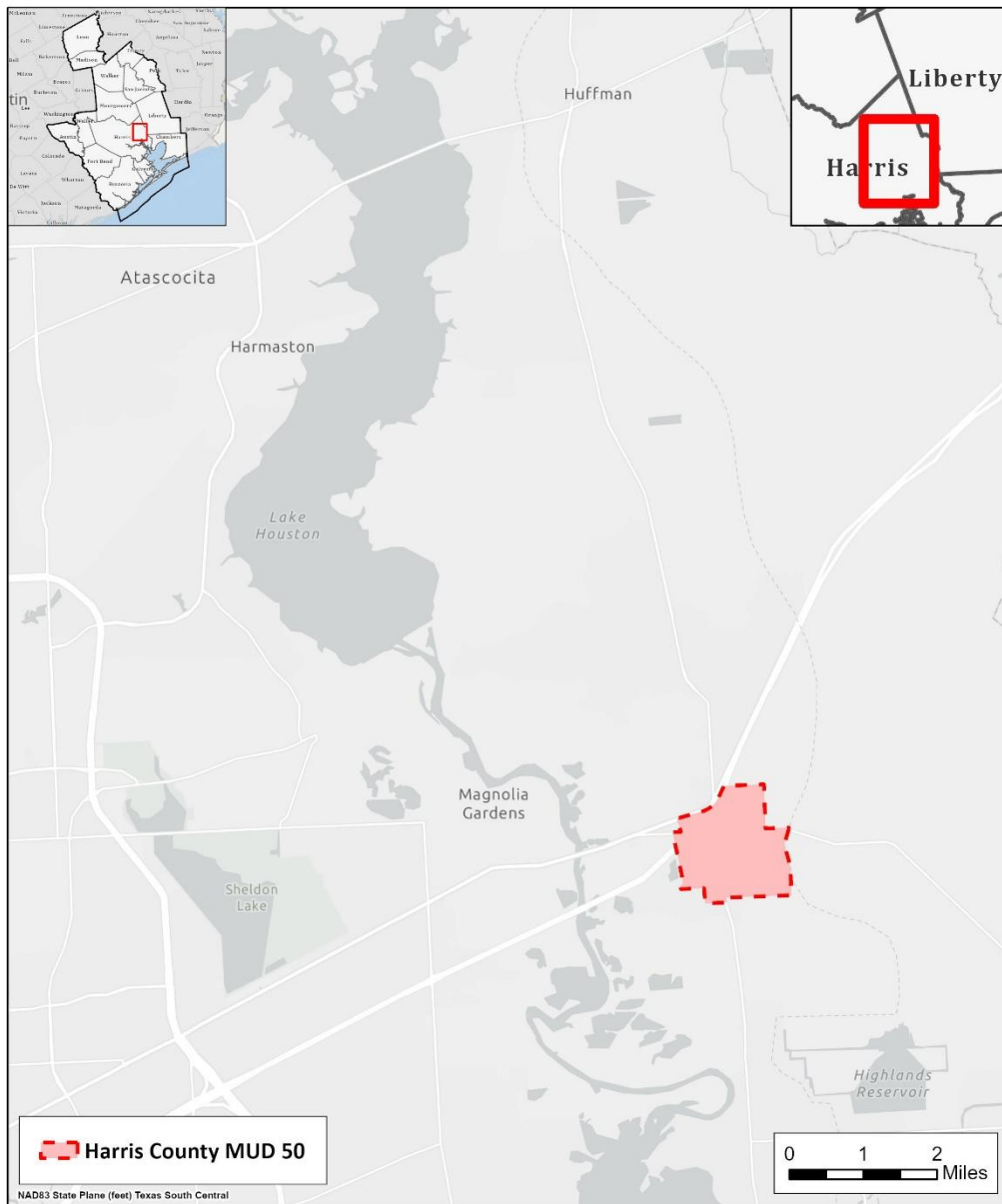
The Harris County MUD 50 SWTP will facilitate diversions made from existing water rights. The project is not anticipated to impact agricultural land and production or to impact vulnerable species.

Water User Group Application

The Harris County MUD 50 SWTP project 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 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.

CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use.
Size	The project is sized in accordance with the treatment infrastructure needs and available source water identified by the project sponsor.
Water Quality	This project provides treated surface water for a variety of uses.

CRITERIA	WUG SUITABILITY
Unit Cost	Costs are high due to limited economy of scale, but correspond to an area with few current strategy options.
Other Factors	This project meets demands in a growing area and also helps reduce potential demand on groundwater sources.

Location Map**Harris County MUD 50 SWTP
Location Map**

Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Northeast Water Purification Plant Expansion
Project ID:	TRET-005
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	380,800 ac-ft/yr (340 mgd)
Implementation Decade:	2030 (2025) for Phase 2
Development Timeline:	<5 years
Project Capital Cost:	\$2,362,128,750 (Sept. 2023)
Unit Water Cost (Rounded):	\$535-824 per ac-ft (during loan period) \$387 per ac-ft (after loan period)

Strategy Description

The Northeast Water Purification Plant (NEWPP) is a 160 mgd treatment facility located in northeast Harris County. The plant diverts water from nearby Lake Houston and treats it for use by the City of Houston (COH), North Harris County Regional Water Authority (NHCRWA), and Central Harris County Regional Water Authority (CHCRWA). The facility serves as the sole source of treated surface water for NHCRWA and CHCRWA, enabling them to meet the groundwater reduction requirements of the Harris-Galveston Subsidence District (HGSD).

The NEWPP will continue to serve these users with treated surface water as their demands and conversion requirements increase over time. Sponsors of this project to help meet additional water needs include NHCRWA, CHCRWA, North Fort Bend Water Authority (NFBWA), West Harris County Regional Water Authority (WHCRWA), and COH. Meeting these future conversion targets will require the combined benefit of the individual authorities' Groundwater Reduction Plans (GRPs) and their associated infrastructure, the expanded NEWPP, and the Luce Bayou transfer project, which was completed in 2019. The project also supports the City's One Water Houston approach to integrated, sustainable management of water resources.

Strategy Analyses

The project analyses for Northeast Water Purification Plant Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The projected plant capacity was developed based on demands estimated by the project participants. Phase 1 was completed in 2023, with the addition of an 80 mgd module, bringing the total existing facility treatment capacity to 160 mgd. Three additional 80 mgd modules will be constructed during

Phase 2, to be completed by 2025. The shares of demand for Phase 2 of the project are shown below in *Table 1*. COH is investigating a potential third expansion phase of up to 100 mgd capacity for development by 2035, bringing the total capacity of the NEWPP to as much as 500 mgd.

Table 1 – NEWPP Phase 2 Pro Rata Shares

Participant	Pro Rata Share (mgd)
NHCRWA	84.75
CHCRWA	3.66
NFBWA	51.375
WHCRWA	61.815
COH	38.40
TOTAL	240.00

Environmental Considerations

The NEWPP site was fully acquired during the development of the original 80 mgd treatment plant. Impacts will be associated with the development of property that is already included within the project footprint. Improvements to the intake structure and pipeline conveyance to the plant may also involve mitigation efforts.

Permitting and Development

Permitting will be required for components external to the scope of the initial permitting process conducted for the NEWPP site.

Cost Analysis

Maximum project price and shares of total capital cost assigned to each sponsor were provided by COH for Phases 2 and 3 of the project. For regional planning purposes, the provided maximum project cost estimate was assumed to be inclusive of all capital components, including construction, engineering, design, environmental studies, land acquisition and easement cost, and interest during construction. Values were scaled to a September 2023 equivalent cost using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. Annual costs, including debt service and operation and maintenance, were developed using standard regional planning assumptions based on TWDB guidance. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs for Phases 2 and 3 are shown in *Table 2*.

Table 2 – Northeast Water Purification Plant Expansion Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$2,181,547,397	\$2,181,547,397
2	ENGINEERING, FINANCIAL, AND LEGAL SERVICES AND CONTINGENCIES	1	LS	\$180,581,353	\$180,581,353
3	LAND AND EASEMENTS	1	LS	\$0	\$0
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0
5	INTEREST DURING CONSTRUCTION	1	LS	\$0	\$0
PROJECT CAPITAL COST					\$2,362,128,750

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (PHASE 2)	\$109,913,061	\$109,913,061	\$0	\$0	\$0	\$0
2	DEBT SERVICE (PHASE 3)	\$0	\$56,288,861	\$56,288,861	\$0	\$0	\$0
3	OPERATION AND MAINTENANCE (PHASE 2)	\$91,393,217	\$91,393,217	\$91,393,217	\$91,393,217	\$91,393,217	\$91,393,217
4	OPERATION AND MAINTENANCE (PHASE 3)	\$0	\$56,000,000	\$56,000,000	\$56,000,000	\$56,000,000	\$56,000,000
5	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
6	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$201,306,278	\$313,595,139	\$203,682,078	\$147,393,217	\$147,393,217	\$147,393,217

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$201,306,278	\$313,595,139	\$203,682,078	\$147,393,217	\$147,393,217	\$147,393,217
2	YIELD	268,800	380,800	380,800	380,800	380,800	380,800
3	UNIT COST	\$749	\$824	\$535	\$387	\$387	\$387
TOTAL UNIT COST		\$534					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	WATER TREATMENT PLANTS (PHASE 2)	1	LS	\$1,292,962,380	\$1,292,962,380
2	WATER TREATMENT PLANTS (PHASE 3)	1	LS	\$800,000,000	\$800,000,000
3	SUBSTATION IMPROVEMENTS (PHASE 2)	1	LS	\$88,585,017	\$88,585,017
PROJECT COST					\$2,181,547,397

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	WATER TREATMENT PLANTS (PHASE 2)	7.0	%	\$1,292,962,380	\$90,507,367
2	WATER TREATMENT PLANTS (PHASE 3)	7.0	%	\$800,000,000	\$56,000,000
3	SUBSTATION IMPROVEMENTS (PHASE 2)	1.0	%	\$88,585,017	\$885,850
ANNUAL OPERATION AND MAINTENANCE COST					\$147,393,217

Water Management Strategy Evaluation

Based on the analysis provided above, the Northeast Water Purification Plant Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost		Initial project cost is moderate, with some decrease after completion of debt service.
Location	3	Conveyance required to make water supply available to intended users. This is planned under other projects.
Water Quality		No known issues related to water quality.
Environmental Land and Habitat	4	Expansion to be constructed on existing plant site.
Environmental Flows	3	No direct impact to environmental flows although water diverted for treatment at the NEWPP may reduce flows downstream of Lake Houston.
Local Preference	5	Substantial support for project development.
Institutional Constraints	5	Property acquired and construction in progress.
Development Timeline	5	Project development timeline of less than five years.
Sponsorship	5	Sponsors identified and engaged in project development.
Vulnerability	4	Minor risks from natural and man-made disasters associated with source availability.
Regionalization	4	Serves extensive area and multiple WWPs in Region H, supporting existing regional systems.
Impacts on Other WMS	5	NEWPP expansion is a significant piece of the overall water supply strategy for Harris and Fort Bend Counties as the means of treating water delivered by Luce Bayou before transmission to regional water authority customers.

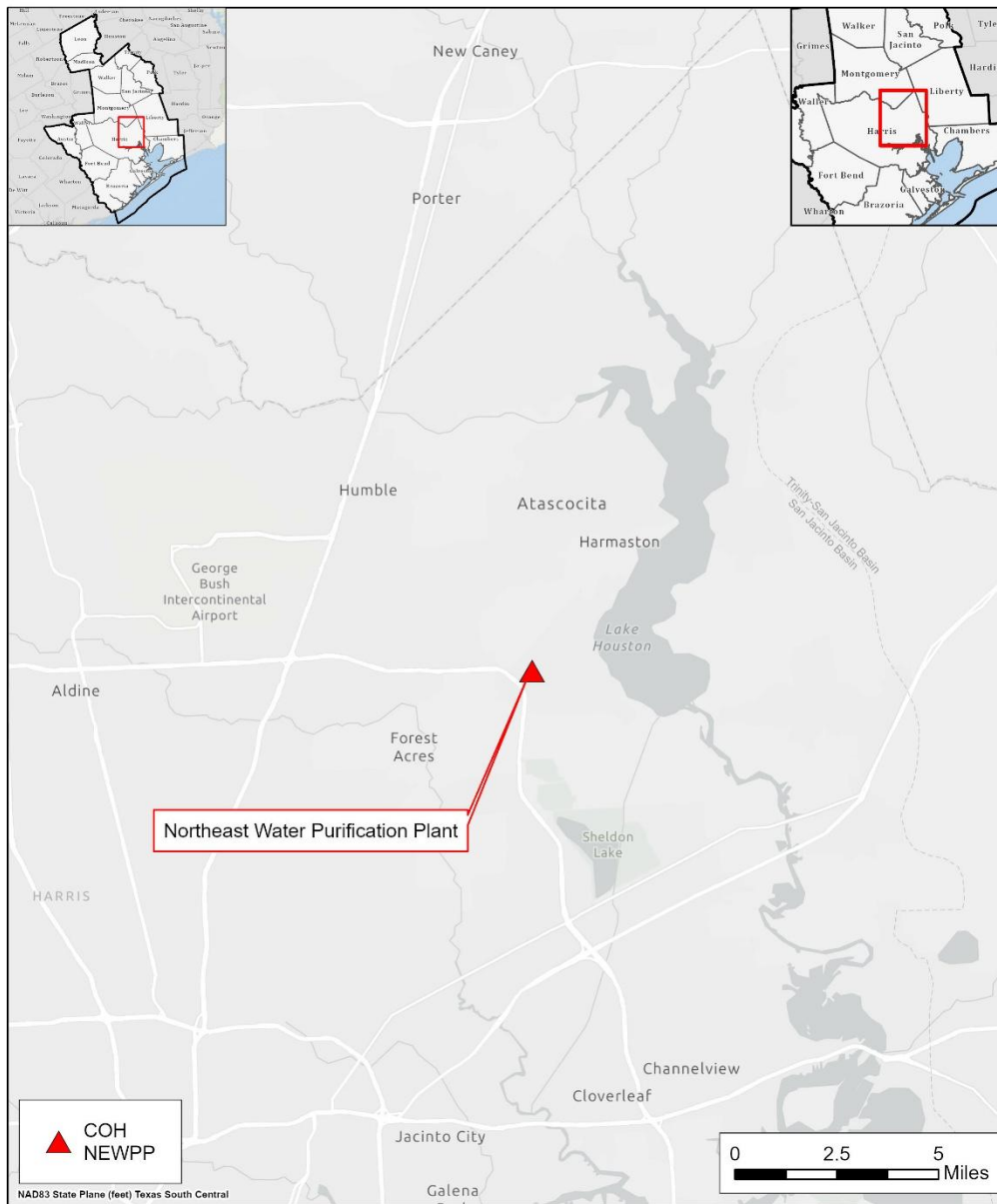
The NEWPP Expansion is not anticipated to affect acreage or vulnerable species. The NEWPP Expansion will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

The Northeast Water Purification Plant Expansion project 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.

CRITERIA	WUG SUITABILITY
Proximity	Treated water from the NEWPP expansion can be made available to meet demands in the immediate vicinity of the plant or conveyed through additional projects to other demand areas.
Size	The expansion provides a sizable amount of treated surface water for use throughout the greater Houston area. The total volume is divided among project participants.
Water Quality	The project provides treated surface water for potable uses such as for meeting municipal demands.
Unit Cost	The unit cost of this project makes it an acceptable project for municipal and other potable water demands.
Other Factors	The participants in this project have been identified and are moving forward with project development.

Location Map



Northeast Water Purification Plant Expansion Location Map



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Pearland Surface Water Treatment Plant
Project ID:	TRET-006
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	22,400 ac-ft/yr (20 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	5 years
Project Capital Cost:	\$261,245,745 (Sept. 2023)
Unit Water Cost (Rounded):	\$1,178 per ac-ft (during loan period) \$358 per ac-ft (after loan period)

Strategy Description

In order to address demand growth and reduce dependence on groundwater, the City of Pearland has contracted with the City of Houston (COH) for treated surface water from the Southeast Water Purification Plant (SEWPP) and with Gulf Coast Water Authority (GCWA) for raw surface water supplies. The City of Pearland is in the process of developing a surface water treatment plant (SWTP) in order to utilize the contracted raw surface water.

Strategy Analyses

The project analyses for Pearland SWTP include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

This project is supplied by contractual agreements for supply from existing water rights. Development of the Pearland SWTP project will require development of a surface water treatment plant and associated infrastructure, including 24-inch and 36-inch transmission lines. The initial 10 mgd (11,200 ac-ft/yr) capacity phase of SWTP development was constructed in 2024 and is entering initial operation. The project also includes an expansion of the SWTP to a total capacity of 20 mgd (22,400 ac-ft/yr) by year 2030.

Environmental Considerations

Implementation of this water management strategy will increase GCWA diversions from the Brazos River, resulting in some minimal decreases in instream flow downstream of the GCWA pump stations. However, these diversions will be made from existing water rights currently owned by GCWA and contracted by the City of Pearland, and no new water rights permits are required for this project.

Otherwise, implementation of this project should produce minimal environmental impacts.

Permitting and Development

Because the supply source for this project is from existing water rights and will be delivered through GCWA’s canal system, permitting of new surface water rights or modification of existing rights to add a diversion point will not be required.

Cost Analysis

Capital costs for the initial 10 mgd surface water treatment plant are summarized in the City of Pearland’s Capital Improvement Plan. Costs associated with environmental studies and mitigation are not identified as separate items, but for purposes of the regional plan it is assumed that these values are included in the estimates for other capital cost components. An estimated capital cost for the year 2030 expansion of the SWTP was provided by Pearland in preparation of prior Regional Water Plans and was scaled to a September 2023 equivalent cost in accordance with TWDB guidance. The costs presented in this memorandum do not include the purchase cost of water. Annual costs presented in *Table 1*, including debt service and costs for operations and maintenance, as well as estimated interest during construction, were calculated using standard cost estimation procedures for Region H.

Table 1 – Pearland Surface Water Treatment Plant Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$175,500,000	\$175,500,000
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$14,307,062	\$14,307,062
3	LAND AND EASEMENTS	1	LS	\$2,265,285	\$2,265,285
4	INTEREST DURING CONSTRUCTION	1	LS	\$12,700,743	\$12,700,743
5	FUTURE 10 MGD EXPANSION	1	LS	\$56,472,655	\$56,472,655
PROJECT CAPITAL COST					\$261,245,745

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$18,381,532	\$18,381,532	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$8,016,219	\$8,016,219	\$8,016,219	\$8,016,219	\$8,016,219	\$8,016,219
TOTAL ANNUAL COST		\$26,397,751	\$26,397,751	\$8,016,219	\$8,016,219	\$8,016,219	\$8,016,219

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$26,397,751	\$26,397,751	\$8,016,219	\$8,016,219	\$8,016,219	\$8,016,219
2	YIELD	22,400	22,400	22,400	22,400	22,400	22,400
3	UNIT COST	\$1,178	\$1,178	\$358	\$358	\$358	\$358
TOTAL UNIT COST		\$631					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PIPELINES	1	LS	\$19,788,298	\$19,788,298
2	WATER TREATMENT PLANTS	1	LS	\$155,711,702	\$155,711,702
PROJECT COST					\$175,500,000

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PIPELINES	1.0	%	\$19,788,298	\$197,883
2	WATER TREATMENT PLANTS	1.0	LS	\$7,818,336	\$7,818,336
ANNUAL OPERATION AND MAINTENANCE COST					\$8,016,219

Water Management Strategy Evaluation

Based on the analysis provided above, the Pearland SWTP project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	2	Costs are somewhat high during debt service but are reduced considerably after completion of debt service.
Location	4	Source located near points of demand with some conveyance infrastructure required to meet additional demands.
Water Quality	3	No known issues regarding water quality.

CRITERIA	RATING	EXPLANATION
Environmental Land and Habitat	4	Minimal impacts anticipated.
Environmental Flows	3	Project does not directly impact flows. Increased diversions are associated with existing water rights.
Local Preference	4	No known opposition.
Institutional Constraints	3	Minimal permitting challenges or opposition expected.
Development Timeline	5	Project development, including permitting, could be accomplished in approximately five years or less.
Sponsorship	4	Sponsor is identified and committed to project.
Vulnerability	5	Minimal risk associated with this project.
Regionalization	2	Serves sponsor entity and a limited number of customers.
Impacts on Other WMS	3	No significant impacts recognized to other projects.

The Pearland SWTP includes a plant site that will be located in the vicinity of existing development. The project will not directly impact environmental flows and is not anticipated to impact agricultural land or production.

Water User Group Application

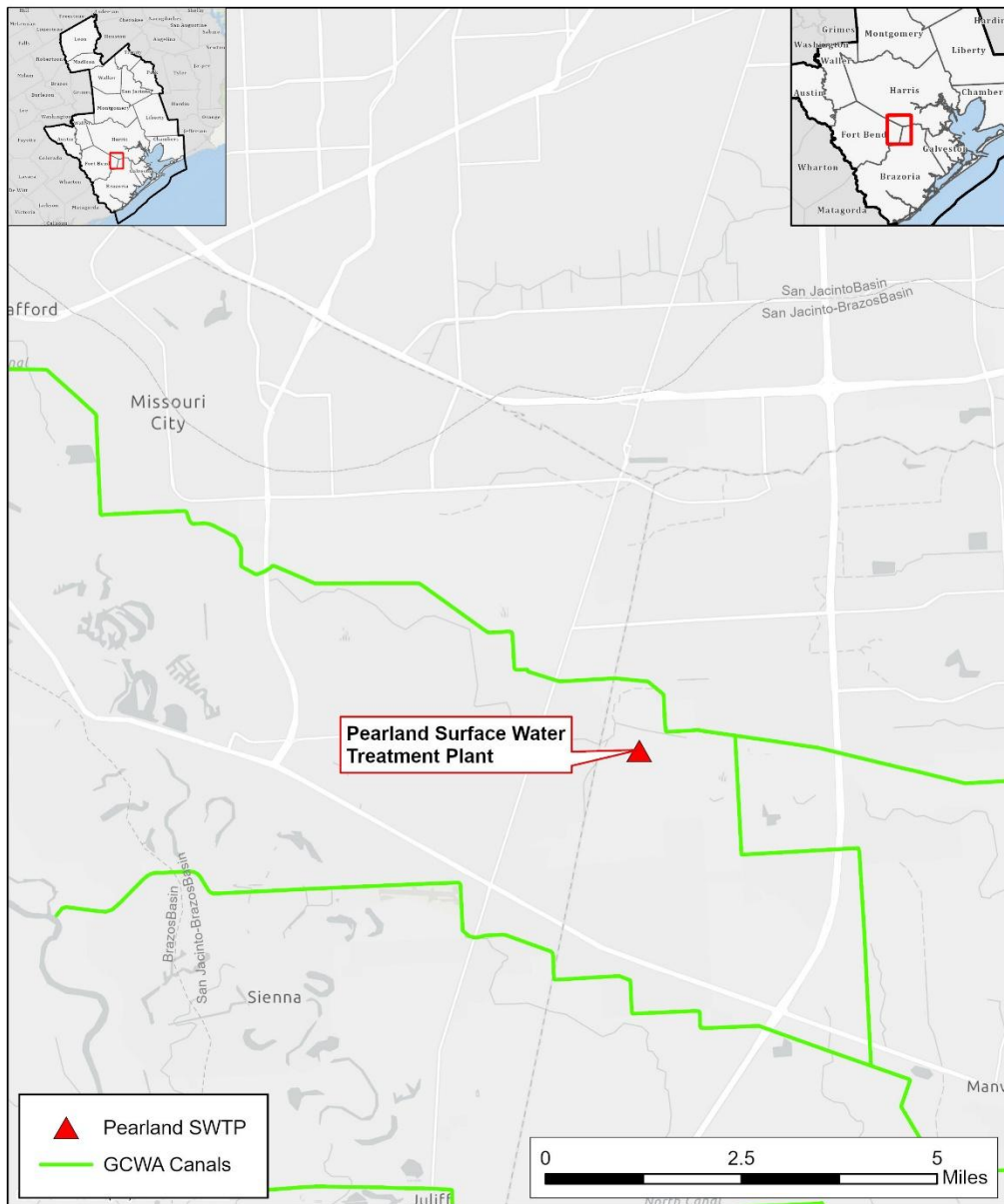
The Pearland SWTP project was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the 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 anticipated that the project will only serve the City of Pearland and any entities that it provides with water supply.

CRITERIA	WUG SUITABILITY
Proximity	Project is located in close proximity to intended points of use.
Size	Project is of appropriate size to utilize the City of Pearland’s surface water contracts.
Water Quality	This project is expected to provide water of acceptable quality.
Unit Cost	The cost of this project is moderately high but decreases substantially after completion of debt service.
Other Factors	This project reduces groundwater dependence.

References

City of Pearland, *2024-2028 City of Pearland Capital Improvement Program*.

City of Pearland. Water Master Plan, August 2019

Location Map

**City of Pearland
Surface Water Treatment Plant
Location Map**



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	SEWPP Expansion
Project ID:	TRET-007
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	134,400 ac-ft/yr (120 mgd)
Implementation Decade:	2030
Development Timeline:	5 years
Project Capital Cost:	\$1,116,248,913 (Sept. 2023)
Unit Water Cost (Rounded):	\$457-\$938 per ac-ft (during loan period) \$353 per ac-ft (after loan period)

Strategy Description

The Southeast Water Purification Plant (SEWPP), which is operated by the City of Houston (COH), provides an important tie between raw water supplies in the Trinity River basin and a number of major demand centers served by the co-participants in the facility. The 200 mgd capacity of the plant is distributed among the COH, the Gulf Coast Water Authority (GCWA), Clear Lake City Water Authority (CLCWA), Clearbrook City Municipal Utility District (MUD), the La Porte Area Water Authority (LPWA), Harris County MUD 55, Pasadena, South Houston, Webster, Friendswood, and Baybrook MUD 1. The treated supply from these facilities enables COH and its customers to meet the groundwater reduction requirements of the Harris-Galveston Subsidence District (HGSD) and Fort Bend Subsidence District (FBSD). As demand increases in both the Houston service area and among wholesale customers of COH, additional treatment capacity will be required.

COH has identified the need for a multi-phase project expanding the capacity of the SEWPP to help meet this demand. In order to satisfy projected future needs due to substantial growth, COH plans an initial 20 to 40 mgd expansion, with a subsequent expansion phase of an additional 100 mgd of treatment capacity. The SEWPP facility currently includes available space dedicated to the development of additional treatment modules, so land purchase will not be necessary. Conveyance of the proposed expanded treated water supply would require improvements to transmission infrastructure from the SEWPP along the Old Galveston Road corridor. Details regarding this transmission expansion project are contained in a separate project memorandum. The project also supports the City's One Water Houston approach to integrated, sustainable management of water resources.

Strategy Analyses

The project analyses for the SEWPP Additional Module include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

COH has identified two anticipated phases of expansion at the SEWPP in order to meet water demands, support groundwater reduction requirements, and address Safe Drinking Water Act requirements. The first phase, anticipated for implementation by 2028, will increase peak treatment capacity of the facility by 20 to 40 mgd (22,400 to 44,800 ac-ft/yr); for purposes of the 2026 RWP, it was assumed that the expansion would be 20 mgd. COH anticipates a subsequent 100 mgd (112,000 ac-ft/yr) expansion by 2035.

Environmental Considerations

The enhanced infrastructure will facilitate an increase in treatment capacity of the COH system and increase overall system reliability. Impacts on instream flows and bay and estuary inflows are expected to be minimal, as the proposed project increases the usable supply from sources associated with existing water rights and conveyance. Infrastructure development may result in some limited surface disturbance from construction; however, this is expected to be minimal as the proposed infrastructure will be developed at the existing SEWPP site.

Permitting and Development

Development of expanded treatment infrastructure will cause some degree of surface disturbance, which may require permitting and mitigation. This is expected to be minimal, as the majority of construction would be expected to occur on the existing plant site.

Cost Analysis

Costs were developed for the project using a preliminary planning-level capital cost estimate provided by the COH in conjunction with standard Regional Planning cost reference data. Costs were scaled to a September 2023 equivalent cost in accordance with TWDB requirements. Costing is shown for two phases, as the initial expansion is implemented in 2028 (2030 decade), with the subsequent larger expansion implemented in 2035 and counted under the 2040 decade. The costs presented in this memorandum do not include the purchase cost of water. Costs and components presented for the project are associated with new infrastructure which will allow increased use of water sources, and do not include any elements for replacement or maintenance of existing capacity. Estimated costs are presented in *Table 1*.

Table 1 – SEWPP Expansion Project Cost

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$677,404,768	\$677,404,768
2	ENGINEERING, FINANCIAL, AND LEGAL SERVICES AND CONTINGENCIES	1	LS	\$237,058,541	\$237,058,541
3	LAND AND EASEMENTS	1	LS	\$3,930,400	\$3,930,400
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$39,205,136	\$39,205,136
5	INTEREST DURING CONSTRUCTION	1	LS	\$158,650,068	\$158,650,068
PROJECT CAPITAL COST					\$1,116,248,913

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE (2028 EXPANSION)	\$6,286,941	\$6,286,941	\$0	\$0	\$0	\$0
2	DEBT SERVICE (2035 EXPANSION)	\$0	\$72,253,535	\$72,253,535	\$0	\$0	\$0
3	OPERATION AND MAINTENANCE (2028 EXPANSION)	\$3,558,964	\$3,558,964	\$3,558,964	\$3,558,964	\$3,558,964	\$3,558,964
4	OPERATION AND MAINTENANCE (2035 EXPANSION)	\$0	\$41,627,865	\$41,627,865	\$41,627,865	\$41,627,865	\$41,627,865
5	PUMPING ENERGY COSTS	\$384,575	\$2,307,523	\$2,307,523	\$2,307,523	\$2,307,523	\$2,307,523
6	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$10,230,480	\$126,034,826	\$119,747,886	\$47,494,351	\$47,494,351	\$47,494,351

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$10,230,480	\$126,034,826	\$119,747,886	\$47,494,351	\$47,494,351	\$47,494,351
2	YIELD	22,400	134,400	134,400	134,400	134,400	134,400
3	UNIT COST	\$457	\$938	\$891	\$353	\$353	\$353
TOTAL UNIT COST		\$574					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS (2028 EXPANSION)	1	LS	\$8,945,484	\$8,945,484
2	PUMP STATIONS (2035 EXPANSION)	1	LS	\$39,760,114	\$39,760,114
3	PIPELINES (2028 EXPANSION)	1	LS	\$196,051	\$196,051
4	PIPELINES (2035 EXPANSION)	1	LS	\$466,511	\$466,511
5	WATER TREATMENT PLANTS (2028 EXPANSION)	1	LS	\$47,619,513	\$47,619,513
6	WATER TREATMENT PLANTS (2035 EXPANSION)	1	LS	\$580,417,095	\$580,417,095
PROJECT COST					\$677,404,768

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS (2028 EXPANSION)	2.5	%	\$8,945,484	\$223,637
2	PUMP STATIONS (2035 EXPANSION)	2.5	%	\$39,760,114	\$994,003
3	PIPELINES (2028 EXPANSION)	1.0	%	\$196,051	\$1,961
4	PIPELINES (2035 EXPANSION)	1.0	%	\$466,511	\$4,665
5	WATER TREATMENT PLANTS (2028 EXPANSION)	1.0	LS	\$47,619,513	\$3,333,366
6	WATER TREATMENT PLANTS (2035 EXPANSION)	1.0	LS	\$580,417,095	\$40,629,197
ANNUAL OPERATION AND MAINTENANCE COST					\$45,186,828

Water Management Strategy Evaluation

Based on the analysis provided above, the SEWPP Expansion project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	2	Cost is relatively high, although it decreases substantially after debt service.
Location	3	Conveyance required to make water supply available to intended users. This is planned under other projects.
Water Quality	3	No known issues related to water quality.
Environmental Land and Habitat	4	Enhancements to be constructed on existing plant site. Minimal impacts anticipated
Environmental Flows	3	Project does not directly impact flows.
Local Preference	3	No known significant opposition.
Institutional Constraints	5	Property and facilities to be enhanced already owned by sponsor.
Development Timeline	5	Project development timeline of less than five years for initial phase
Sponsorship	5	The project sponsor is committed to the project and is actively engaged in planning activities.
Vulnerability	4	Minor risks from natural and man-made disasters associated with source availability.
Regionalization	4	Supports multiple customer systems and expands upon existing regionalized supplies.
Impacts on Other WMS	5	The project enhances the overall treatment capacity and reliability of the City of Houston system, supporting WMS including the City of Houston Groundwater Reduction Plan and contractual supplies to other entities. Later phases are dependent on expansion of raw water capacity.

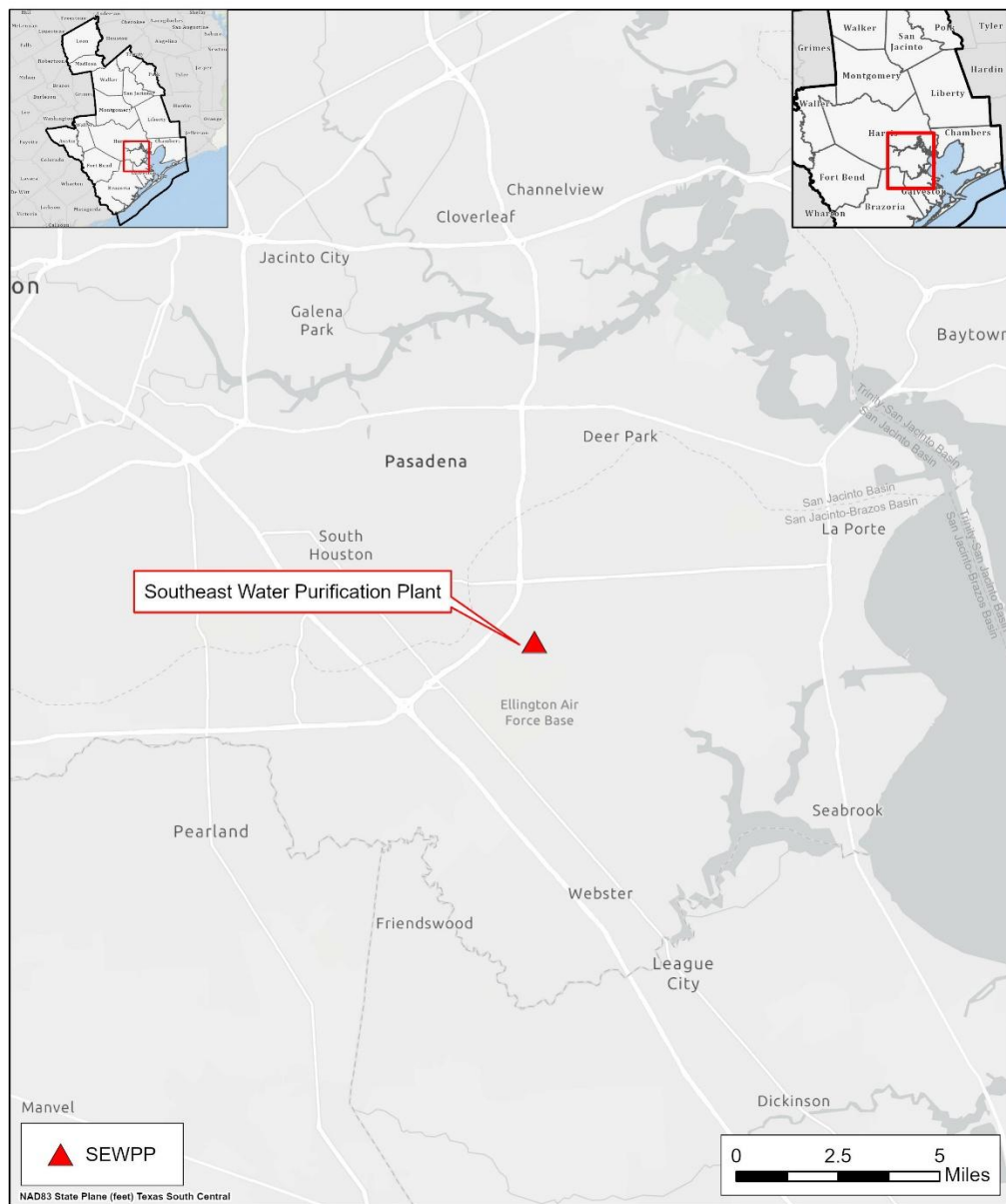
The SEWPP Expansion project is not anticipated to impact acreage or vulnerable species and will not directly impact environmental flows. The project is not anticipated to impact agricultural land or production.

Water User Group Application

The SEWPP Additional Module project 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.

CRITERIA	WUG SUITABILITY
Proximity	The supply could be conveyed through additional projects to meet growing demands in the existing SEWPP service area.
Size	The magnitude of the project was developed based on surface water needs projected for SEWPP participants and customers.
Water Quality	This project provides treated surface water for a variety of uses.
Unit Cost	The unit cost of this project makes it an acceptable project for municipal and other potable water demands.
Other Factors	This project represents additional treated water capacity beyond the level currently implemented or in development.

Location Map



Southeast Water Purification Plant Expansion Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Brazos Saltwater Barrier
Project ID:	OTHR-001
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	10,000 ac-ft/yr (8.9 mgd)
Implementation Decade:	2030
Development Timeline:	10 years
Project Capital Cost:	\$77,571,019 (Sept. 2023)
Unit Water Cost (Rounded):	\$596 per ac-ft (during loan period) \$51 per ac-ft (after loan period)

Strategy Description

The Lower Brazos River is tidally influenced, with the extent of the area of brackish water fluctuating seasonally. Municipal and industrial water users in the Freeport area face water quality concerns as the saltwater wedge moves upstream of the Brazoria Pump Station during periods of low flow in the Brazos River. During these times, a constant and adequate flow of water from higher in the Brazos River Basin is required in order to allow for the diversion of water supplies of sufficient quality. A saltwater barrier has the potential to reduce impacts to water quality in the lower basin and, therefore, to reduce the volume of water required for successful diversion of fresh water from the Brazos River. The proposed project is for the development of a saltwater barrier to protect the Harris Pump Station although alternative concepts to protect the Brazoria Pump Station have also been explored.

Dow Inc. owns water right 12-5328, which authorizes the diversion of 305,656 acre-feet per year from the Brazos River for industrial, municipal, and irrigation uses. Dow provides a portion of this supply to meet the needs of eight surrounding industrial customers in Brazoria County. The Brazosport Water Authority (BWA) owns water right 12-5366, which authorizes the diversion of 45,000 acre-feet per year from the Brazos River for municipal use. The BWA provides treated water to the cities of Angleton, Brazoria, Clute, Freeport, Lake Jackson, Oyster Creek, and Richwood and two TDCJ prison units in Brazoria County, as well as to the city of Rosenberg in Fort Bend County. These are the two most downstream water rights for municipal and industrial demand.

The Texas Commission on Environmental Quality (TCEQ) Water Quality Inventory defines the Brazos River as tidal below river mile 25, which corresponds to the observed situation at the Harris and Brazoria Pump Stations. Measured salinities at the Harris Pump Station range from 50 parts per million (ppm) to 200 ppm, which is typical for river flows. Measured salinities at the Brazoria Pump Station range from 100 parts per million (ppm) to values in excess of 10,000 ppm. (For comparison, typical values in Galveston Bay are approximately 15,000 ppm.) Seawater has a salinity of 3.5%, or 35,000 ppm, causing the tidal reach of the Brazos River to become brackish during lower flows. This

brackish zone decreases in an upstream direction, and also stratifies within the channel, with the denser brackish water below the less dense fresh water. This forms a triangular zone of brackish water, referred to as a salt wedge. TCEQ Rule 30 TAC 290 – Public Drinking Water, defines a secondary standard for Total Dissolved Solids (TDS) of less than 1,000 ppm. Due to the expense and effort required to desalinate brackish water, Dow and BWA divert at their upstream pump station (Harris) when salinities at Brazoria exceed approximately 500 ppm. Note that while seasonal use of the Harris intake is normal and expected, permanent use of this intake would effectively remove the Brazoria Reservoir from the Dow/BWA system, decreasing the yield due to the loss of storage capacity.

Strategy Analyses

The project analyses for Brazos Saltwater Barrier include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

Dow Inc. has engaged in studies to determine the effectiveness of a saltwater barrier project to protect the Harris Pump Station. These studies have demonstrated benefit from the construction of a saltwater barrier for use during low-flow conditions.

Model analyses have been performed using the Texas Commission on Environmental Quality (TCEQ) Water Availability Model (WAM) Run 3 for the Brazos River. Some issues considered in this analysis are the benefits of conservation by Dow and improvements to reservoir storage and pump station performance capturing river flows. In addition, the studies have examined the impacts of infringement on Dow's water rights caused by upstream diverters. These users are attempting to capture water during extreme conditions when Dow requires this supply in order to make diversions from the river. Development of a saltwater barrier will enhance this ability without a priority call being made on the river, thus allowing upstream diverters to continue diverting under dry conditions. The WAM analysis also reflects environmental flow considerations specified by the water right. It should be noted that further reductions in project availability for environmental flows were not applied because the project leverages an existing water right substantially senior to Senate Bill 3 environmental flow requirements.

Environmental Considerations

The construction of the proposed Brazos Saltwater Barrier may have both temporary and permanent impacts on the Brazos estuary and the downstream and immediate upstream reaches of the Brazos River. Temporary construction may include such impacts as increased turbidity, biochemical oxygen demand (BOD), and contaminant loads in the river, depending on the nature of the sediment entering the river due to disturbance of river bottom sediments and adjacent upland areas. These impacts could be expected to occur in the project area and points downstream on the Brazos River to as far south as the Gulf of Mexico and the Brazos River Estuary. Long-term impacts would result from changes to flows in the river as a result of the operation of the barrier. These impacts could include impediments to fish migration, changes (reductions) in the amounts of sediments and nutrients reaching the Gulf of Mexico and Brazos Estuary, localized changes in hydrology of adjacent wetlands downstream of the facility, and increased sedimentation in the river channel immediately upstream of the barrier. It should be noted that the Brazos River Estuary is one of the smallest in the state and in some respects is less studied than other larger or more productive estuaries. Further study of the

impacts on water quantity and quality, ecosystem functions, and species life cycles may be required as part of the project development and detailed design.

The project may also result in permanent impacts to any upstream reservoirs currently used to flush saltwater from the channel during periods of low flow. These could include more stable water levels in such lakes, which in turn would result in higher productivity of the lake fisheries and increased value of the lakes as a recreational resource.

Permitting and Development

Constructing the proposed Brazos Saltwater Barrier would require several state and federal permits. The project would require a Section 404 / Section 10 permit from the U.S. Army Corps of Engineers (USACE), most likely an individual permit as opposed to one of the Nationwide Permits. If a bridge or other obstruction to navigation would result from the project, a Section 9 bridge permit from the U.S. Coast Guard would be required. Additionally, a Section 401 water quality certification would be required from the TCEQ (as part of the Section 404 permit). A Texas Pollution Discharge Elimination System general permit for construction would require submittal of a Notice of Intent and development of a Storm Water Pollution Prevention Plan (with monitoring of the construction site). If substantial materials are excavated from the river, a Sand, Marl and Gravel permit must be obtained from the Texas Parks and Wildlife Department and any structures placed in a tidal water of the State of Texas must be granted an easement from the Texas General Land Office (GLO) unless exempted by law. Many of these permit actions would require secondary reviews, such as archeological and threatened and endangered species investigations of the project site. Dow has already taken steps to provide for a temporary saltwater barrier at the Harris Reservoir site. Permitting for this structure has already been completed through the USACE, GLO, and TCEQ.

Cost Analysis

Preliminary costs have been developed for the construction of the Harris site for the saltwater barrier, based upon information provided by the project sponsor. Capital costs were scaled to a September 2023 equivalent cost using the Construction Cost Index and Producer Price Index in accordance with TWDB guidance. Debt service and annual operations and maintenance costs were also calculated using standard Regional Planning procedures. Estimated costs are presented in *Table 1*.

Table 1 – Brazos Saltwater Barrier Project Costs

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$50,650,000	\$50,650,000
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$20,770,000	\$20,770,000
3	LAND AND EASEMENTS	1	LS	\$1,240,000	\$1,240,000
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$2,480,000	\$2,480,000
5	INTEREST DURING CONSTRUCTION	1	LS	\$2,431,019	\$2,431,019
PROJECT CAPITAL COST					\$77,571,019

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$5,457,980	\$5,457,980	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$506,500	\$506,500	\$506,500	\$506,500	\$506,500	\$506,500
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$5,964,480	\$5,964,480	\$506,500	\$506,500	\$506,500	\$506,500

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$5,964,480	\$5,964,480	\$506,500	\$506,500	\$506,500	\$506,500
2	YIELD	10,000	10,000	10,000	10,000	10,000	10,000
3	UNIT COST	\$596	\$596	\$51	\$51	\$51	\$51
TOTAL UNIT COST		\$233					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	SALTWATER BARRIER	1	LS	\$50,650,000	\$50,650,000
PROJECT COST					\$50,650,000

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	SALTWATER BARRIER	1.0	%	\$50,650,000	\$506,500
ANNUAL OPERATION AND MAINTENANCE COST					\$506,500

Water Management Strategy Evaluation

Based on the analysis provided above, the Brazos Saltwater Barrier project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	4	Project is a reasonable-cost alternative for making more water available in the basin during drought conditions.
Location	5	Project benefit is not location specific as it impacts water rights throughout the basin.

CRITERIA	RATING	EXPLANATION
Water Quality	5	Project significantly reduces water quality issues during low-flow conditions.
Environmental Land and Habitat	2	Environmental issues associated with development in the Brazos River. Project will protect upstream portions of the basin.
Environmental Flows	2	Project will enable the reduction of instream flows in the lower basin in order to add water availability.
Local Preference	4	Local support by industry in Brazoria County.
Institutional Constraints	2	Permits required and property acquisition essential in developing project.
Development Timeline	4	Project can be developed in a relatively short period of time, pending permitting.
Sponsorship	3	One sponsor, Dow Inc., is committed to the project as one of many water supply alternatives.
Vulnerability	3	Moderate risk associated with development of a significant structure in the Brazos River floodplain.
Regionalization	4	Supports multiple participant systems and expands upon existing regionalized supplies.
Impacts on Other WMS	5	Project may enhance yields of existing water rights and future supplies to be permitted in the Brazos River Basin.

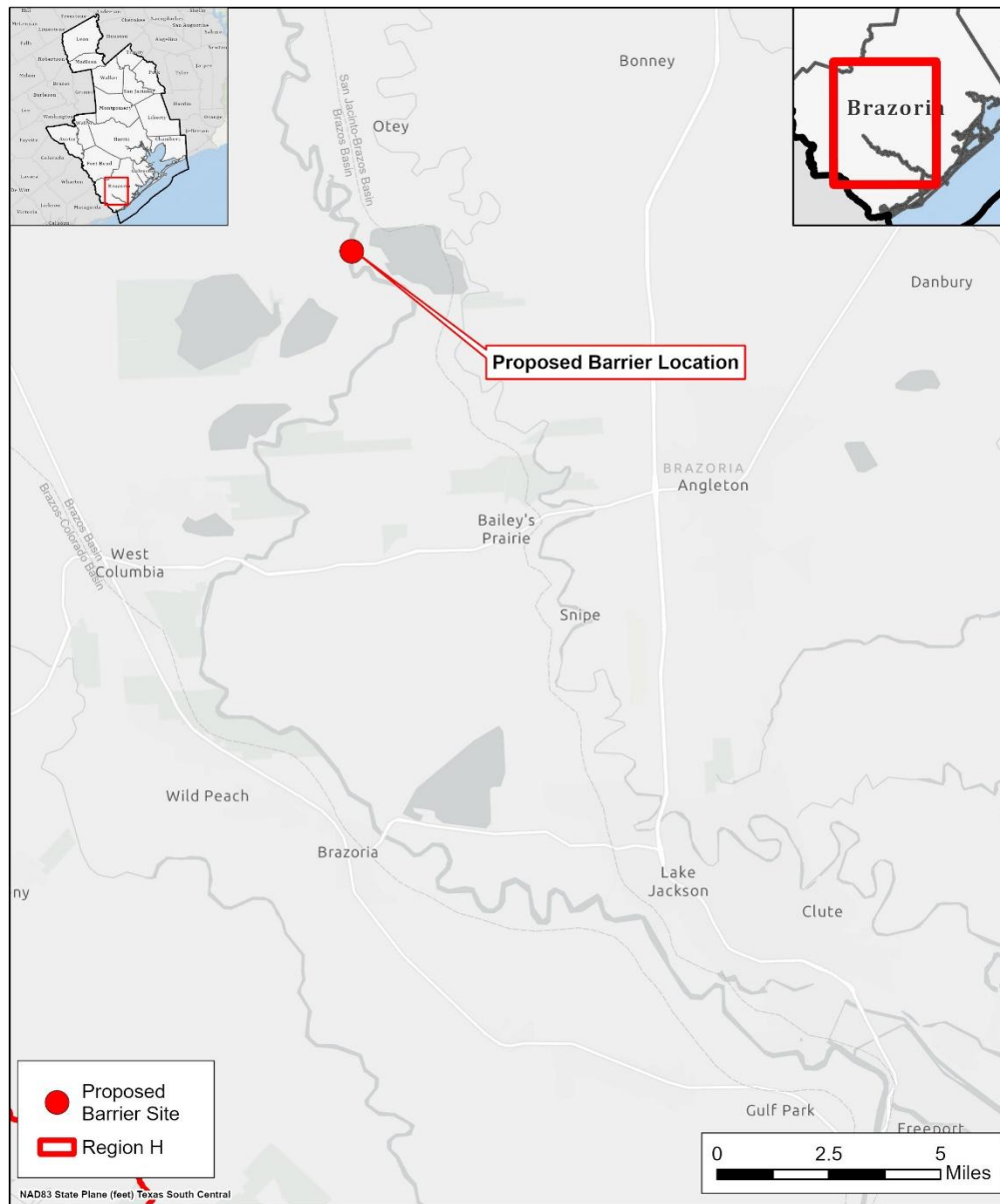
The Brazos Saltwater Barrier will directly impact the Brazos River channel where it is located and may impact the migration of species during its operation. The project operates during periods when flow in the Brazos River will be inadequate to prevent intrusion of highly saline waters. The project is not anticipated to impact agricultural land or production.

Water User Group Application

The Brazos Saltwater Barrier project 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.

CRITERIA	WUG SUITABILITY
Proximity	The benefits of the saltwater barrier are experienced directly in the lower
Size	The magnitude of this project scales according to the magnitude of target diversions.
	The project will make raw water supplies more available in the lower basin.
Unit Cost	The unit cost is moderate and reduces substantially after debt service, while allowing for yield enhancement during drought-of-record conditions.
Other Factors	The primary sponsor of this project is Dow Inc. although there are many more potential benefactors within the Brazos River Basin.

Location Map



Brazos Saltwater Barrier Location Map



THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	GCWA Canal Loss Mitigation
Project ID:	OTHR-002
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	8,960 ac-ft/yr (8.0 mgd)
Implementation Decade:	2030
Development Timeline:	<5 years
Project Capital Cost:	\$21,420,000 (Sept. 2023)
Unit Water Cost (Rounded):	\$192 per ac-ft (during loan period) \$24 per ac-ft (after loan period)

Strategy Description

The Gulf Coast Water Authority (GCWA) supplies a number of municipal, industrial, and agricultural customers in the San Jacinto-Brazos Coastal Basin with surface water from the Brazos River Basin and San Jacinto-Brazos Coastal Basin. The majority of these supplies are diverted at GCWA's three pump stations on the Brazos River and delivered by an extensive canal system including the American, Briscoe, and Juliff canal networks. As part of ongoing efforts to enhance the efficiency and flexibility of its system, GCWA has identified the opportunity to increase delivery capacity through targeted loss mitigation efforts.

Strategy Analyses

The project analyses for GCWA Canal Loss Mitigation include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

GCWA has identified several enhancement activities in order to reduce system losses and increase delivery capacity and flow rates. GCWA is currently engaged in a satellite leak detection survey of its extensive canal conveyance network, reservoirs, and the pipeline conveyance for its treated water system in Galveston County. This survey is intended to help identify target areas for conveyance hardening to reduce leakage losses. These targeted hardening efforts, in conjunction with other loss mitigation activities, are anticipated to increase deliverable capacity by up to 8 mgd (8,960 ac-ft/yr). GCWA has identified additional lining activities in other segments which are aimed primarily at increasing flow rates and delivery capacity, but which may also have some loss reduction benefit as well. The GCWA Canal Loss Mitigation project does not require a new water right appropriation and does not directly increase firm source availability, but does allow for increased overall delivery

capacity and reduces losses of flows diverted from the Brazos River and conveyed through GCWA canals.

Environmental Considerations

The enhanced infrastructure will facilitate increased delivery capacity from sources diverted from the Brazos River. These diversions will be made primarily from existing water rights or from sources developed under other future projects, and the GCWA Canal Loss Mitigation project does not directly increase diversions. The project will decrease conveyance losses within the canal system, offsetting a portion of the need for river diversions.

Infrastructure development may result in some construction disturbance which could require mitigation. This construction impact would occur primarily on the existing conveyance facility sites and would cause little disturbance to undeveloped habitat.

Permitting and Development

Loss mitigation activities will cause some degree of surface disturbance, which may require permitting and mitigation. This is expected to be minimal, as the majority of construction would be expected to occur within or adjacent to existing canal sites. Because the project increases deliverable supply from existing water rights and through GCWA's canal system, permitting of new surface water rights or modification of existing rights will not be required.

Cost Analysis

Planning level cost estimates were developed for the Region H Plan based on available sponsor information. Sponsor estimates were assumed to be inclusive of all capital cost components. The annual cost was estimated assuming a debt service of 3.5% for 20 years, in accordance with TWDB regional water planning cost assumptions. Costs are presented in September 2023 equivalent costs in *Table 1*.

Table 1 – GCWA Canal Loss Mitigation Project Costs

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	LEAK DETECTION AND MITIGATION	1	LS	\$4,800,000	\$4,800,000
2	CANAL LINING	1	LS	\$16,620,000	\$16,620,000
PROJECT CAPITAL COST					\$21,420,000

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$1,507,134	\$1,507,134	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$214,200	\$214,200	\$214,200	\$214,200	\$214,200	\$214,200
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$1,721,334	\$1,721,334	\$214,200	\$214,200	\$214,200	\$214,200

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$1,721,334	\$1,721,334	\$214,200	\$214,200	\$214,200	\$214,200
2	YIELD	8,960	8,960	8,960	8,960	8,960	8,960
3	UNIT COST	\$192	\$192	\$24	\$24	\$24	\$24
TOTAL UNIT COST		\$80					

Water Management Strategy Evaluation

Based on the analysis provided above, the GCWA Canal Loss Mitigation project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	Project is a very low-cost alternative for making more water available in the GCWA system.
Location	5	Project is associated with existing conveyance infrastructure serving a large area.
Water Quality	3	No known issues related to water quality.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	3	Project will allow more efficient delivery of existing diversions.
Local Preference	3	No known significant opposition.
Institutional Constraints	5	Property and facilities to be improved already owned by sponsor.
Development Timeline	5	Project can be developed in a relatively short period of time.

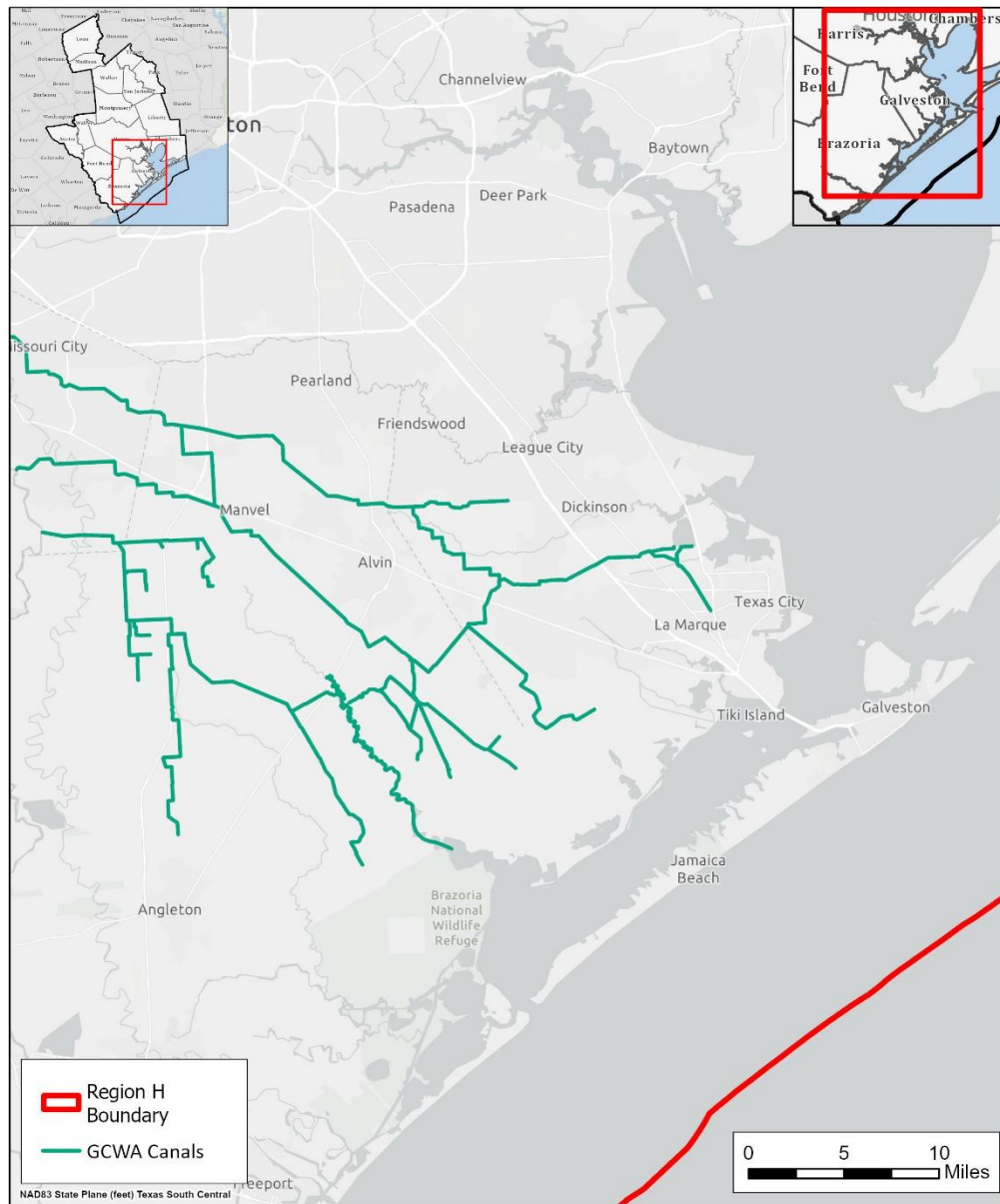
Vulnerability	5	Minimal risk from natural and manmade disaster to enhancements of the conveyance system.
Impacts on Other WMS	4	Project will increase overall GCWA system flexibility and reliability, positively impacting customer WMS.

Water User Group Application

The GCWA Canal Loss Mitigation project 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.

CRITERIA	WUG SUITABILITY
Proximity	The benefits of improved delivery efficiency and capacity are experienced by an extensive area of the GCWA system.
Size	The project is sized in accordance with preliminary facility assessment results.
Water Quality	The project will increase efficiency in the delivery of raw water for multiple uses. Water quality issues are considered by other related projects.
Unit Cost	The unit cost, which is low, is appropriate to the municipal, industrial, and irrigation uses in the GCWA system.
Other Factors	Allows more flexible and reliable utilization of existing sources.

Location Map



GCWA Canal Loss Mitigation Location Map



Texas

THIS PAGE INTENTIONALLY LEFT BLANK

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	GCWA Shannon Pump Station Expansion
Project ID:	OTHR-003
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	201,600 ac-ft/yr (180 mgd)
Implementation Decade:	2030
Development Timeline:	1 year
Project Capital Cost:	\$81,410,301 (Sept. 2023)
Unit Water Cost (Rounded):	\$120 per ac-ft (during loan period) \$27 per ac-ft (after loan period)

Strategy Description

The Gulf Coast Water Authority (GCWA) supplies a number of municipal, industrial, and agricultural customers in the San Jacinto-Brazos Coastal Basin with surface water from the Brazos River Basin and San Jacinto-Brazos Coastal Basin. GCWA holds several water rights in these basins and supplies its customers with surface water from these rights as well as contractual supplies purchased from the Brazos River Authority (BRA). The majority of these supplies are diverted at GCWA's three pump stations on the Brazos River and delivered by an extensive canal system. The most upstream of these points, the Shannon pump station, provides flow directly to the American Canal as well as supplying other portions of the GCWA system through interconnections. As part of ongoing efforts to enhance the flexibility of its system, GCWA has identified the need to develop expanded facilities at the Shannon pump station. This project does not require a new water right appropriation because it is intended to increase infrastructure capacity related to use of existing rights and existing and future contractual sources.

Strategy Analyses

The project analyses for GCWA Shannon Pump Station Expansion include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The GCWA Shannon Pump Station Expansion project is intended to take advantage of supplies from existing and potential future sources. While the project will not require a new water right appropriation and does not directly increase firm source availability, it would allow a larger portion of owned or contracted surface water supply to be diverted at the Shannon Pump Station site. New facilities would be integrated into GCWA's existing distribution network for delivery to customers.

The improved pump station is a key component of GCWA’s overall system and would operate synergistically with other projects. In addition to addressing growing water demands for customers along the American Canal, the expanded diversion capacity would allow the Shannon Pump Station to serve a substantial portion of the GCWA service area, increasing system supply security and facilitating maintenance downtime for other intake and pump station sites.

Major project components include development of a new intake structure, high-capacity pump station, and temporary bypass pumping facilities to meet water demand during project development. The current pump station facility is capable of diverting up to approximately 55 mgd. The proposed project would replace existing intake and pump station facilities, creating a capacity of approximately 110 mgd and allowing 55 mgd (61,600 ac-ft/yr) of additional supply to be captured from the Shannon diversion point. The expanded pumping facilities are designed to accommodate potential expansion to 180 mgd (201,600 ac-ft/yr).

Environmental Considerations

The enhanced infrastructure will facilitate an increase in diversions from the GCWA Shannon Pump Station, resulting in some decreases in instream flow downstream of the diversion point. However, these diversions will be made primarily from existing water rights or from sources developed under other future projects. Further, during periods when the Shannon Pump Station is used to allow downtime at other GCWA diversion points, a portion of the increased diversion at the Shannon site will be offset by reduced GCWA diversions downstream.

Infrastructure development may result in some construction disturbance which could require mitigation. This construction impact would occur on the existing facility site and would cause little disturbance to undeveloped habitat.

Permitting and Development

Development of expanded treatment infrastructure will cause some degree of surface disturbance, which may require permitting and mitigation. This is expected to be minimal, as the majority of construction would be expected to occur on the existing pump station site. Because the supply source for this project is from existing water rights and will be delivered through GCWA’s canal system, permitting of new surface water rights or modification of existing rights to add a diversion point will not be required.

Cost Analysis

Planning level cost estimates were developed for the Region H Plan based on available sponsor information. Capital costs were scaled to a September 2023 equivalent cost in accordance with TWDB guidance. Additional cost components, such as interest during construction, annualized debt service, and annualized operations and maintenance costs, were assumed using standard Regional Planning costing assumptions. Estimated costs are presented in *Table 1*.

Table 1 – GCWA Shannon Pump Station Expansion Project Costs

OPINION OF PROBABLE CONSTRUCTION COST					September 2023	
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL	
PROJECT CAPITAL COST SUMMARY						
1	CONSTRUCTION COST	1	LS	\$67,593,394	\$67,593,394	
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$11,265,568	\$11,265,568	
3	LAND AND EASEMENTS	1	LS	\$0	\$0	
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$0	\$0	
5	INTEREST DURING CONSTRUCTION	1	LS	\$2,551,339	\$2,551,339	
PROJECT CAPITAL COST					\$81,410,301	

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$5,728,116	\$5,728,116	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$1,689,835	\$1,689,835	\$1,689,835	\$1,689,835	\$1,689,835	\$1,689,835
3	PUMPING ENERGY COSTS	\$0	\$0	\$0	\$0	\$0	\$0
4	PURCHASE COST OF WATER	\$0	\$0	\$0	\$0	\$0	\$0
TOTAL ANNUAL COST		\$7,417,951	\$7,417,951	\$1,689,835	\$1,689,835	\$1,689,835	\$1,689,835

ITEM DESCRIPTION		ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$7,417,951	\$7,417,951	\$1,689,835	\$1,689,835	\$1,689,835	\$1,689,835
2	YIELD	61,600	61,600	61,600	61,600	61,600	61,600
3	UNIT COST	\$120	\$120	\$27	\$27	\$27	\$27
TOTAL UNIT COST		\$58					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$67,593,394	\$67,593,394
PROJECT COST					\$67,593,394

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$67,593,394	\$1,689,835
ANNUAL OPERATION AND MAINTENANCE COST					\$1,689,835

Water Management Strategy Evaluation

Based on the analysis provided above, the GCWA Shannon Pump Station Expansion project was evaluated across twelve different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	Project is a very low-cost alternative for making more water available in the GCWA system.
Location	5	Project is associated with existing diversion site and conveyance infrastructure serving a large area.
Water Quality	3	No known issues related to water quality.

CRITERIA	RATING	EXPLANATION
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	2	
Local Preference	3	No known significant opposition.
Institutional Constraints		Property and facilities to be improved already owned by sponsor.
Development Timeline	5	Project can be developed in a relatively short period of time.
Sponsorship		The project sponsor, GCWA, is committed to the project and is actively evaluating preliminary design.
Vulnerability	3	Moderate risk associated with development of a structure in a coastal basin.
		Serves multiple customers and supports multiple regionalized water systems.
Impacts on Other WMS	5	Project will increase overall GCWA system flexibility and reliability, positively impacting customer WMS.

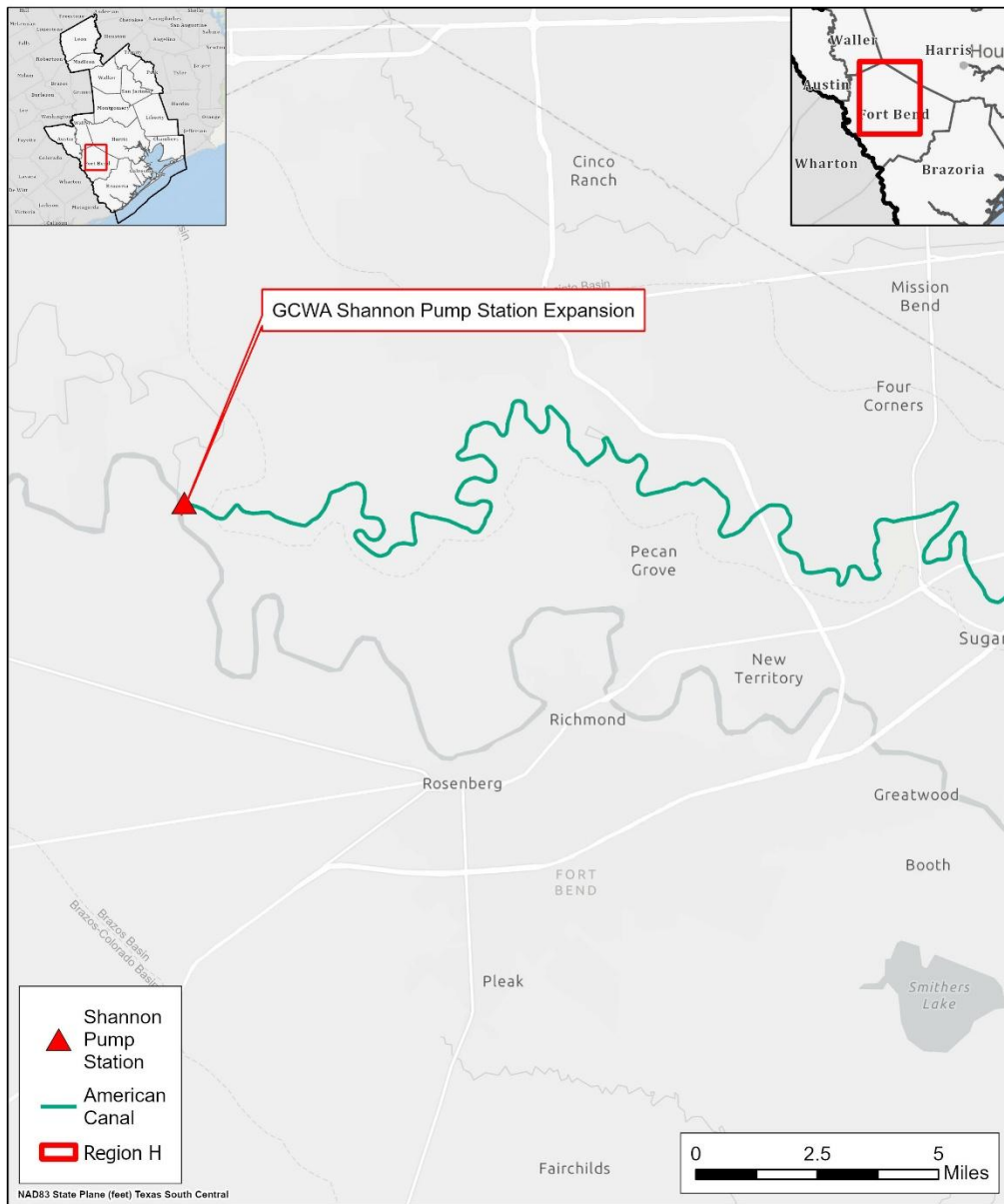
The GCWA Shannon Pump Station Expansion will facilitate increased diversions made primarily from existing water rights or from sources developed under other future projects. The project is not anticipated to impact agricultural land or production or to affect vulnerable species.

Water User Group Application

The GCWA Shannon Pump Station Expansion project 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.

CRITERIA	WUG SUITABILITY
Proximity	The benefits of the pump station expansion are experienced by an extensive area of the GCWA system, with points of demand serviced through existing canal infrastructure.
Size	The project is sized in accordance with the available source, anticipated future demands, and provision for system infrastructure redundancy.

CRITERIA	WUG SUITABILITY
Water Quality	The project will increase flexibility in the diversion of raw water for multiple uses. Water quality issues are considered by other related projects.
Unit Cost	The unit cost, which is relatively low, is appropriate to the municipal, industrial, and irrigation uses in the GCWA system.
Other Factors	Allows more flexible and reliable utilization of existing sources.

Location Map

**GCWA Shannon
Pump Station Expansion
Location Map**



REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	LNVA Devers Pump Station Relocation
Project ID:	OTHR-004
Project Type:	Existing Surface Water Source
Potential Supply Quantity (Rounded):	88,704 ac-ft/yr (79 mgd)
Implementation Decade:	2030 (2025)
Development Timeline:	1 year
Project Capital Cost:	\$21,337,986 (Sept. 2023)
Unit Water Cost (Rounded):	\$21 per ac-ft (during loan period) \$4 per ac-ft (after load period)

Strategy Description

The Lower Neches Valley Authority (LNVA) is a major water supplier to irrigators in the eastern portion of Region H, including rice production in Chambers and Liberty County. A substantial portion of this supply is provided through LNVA's Devers Canal System, which diverts water from the Trinity River at the Devers 1st Pump Station near Moss Bluff, TX for conveyance through a canal network to points of use. In order to meet the needs of current and future customers and increase deliverable supply, LNVA has identified the need to develop a new Devers 1st Pump Station. The new pump station will be located adjacent to the current pump station, limiting the required permitting and the need for development of additional conveyance to connect to existing canal infrastructure. This project does not require a new water right appropriation because it is associated with infrastructure capacity related to the use of existing rights.

Strategy Analyses

The project analyses for the LNVA Devers Pump Station Relocation project include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

The LNVA Devers Pump Station Relocation project will increase deliverable supplies from existing sources and will not require a new water right appropriation. The proposed infrastructure will increase pumping capacity to allow existing LNVA owned or contracted surface water supply to be diverted from the Trinity River and delivered to LNVA's customers. Major project components include development of a new intake structure, high-capacity pump station, and discharge structures to connect the pump station to the Devers Canal System. The new facility has a planned capacity of 200,000 gpm, resulting in an additional 55,000 gpm (88,704 ac-ft/yr) of reliable pumping capacity.

While LNVA is authorized to divert the full volume permitted under their existing water rights, their current infrastructure limits the actual amount that can be physically diverted and delivered to customers along the Devers Canal system. This additional pumping capacity will enable LNVA to divert up to 88,704 ac-ft/year more than is currently possible with their existing infrastructure, enabling more efficient utilization of additional supplies from established water rights. The enhanced infrastructure from this project could also potentially support other future strategies and supplies. The project therefore translates to an increase in the volume of supplies that can be reliably delivered to LNVA's customers, especially during peak demand periods. The supply volume allocated for this strategy in the Plan reflects modeled source availability for currently-utilized sources and annualized use.

Environmental Considerations

The enhanced infrastructure will facilitate an increase in diversion capacity for the LNVA Devers Canal system. Impacts on instream flows and bay and estuary flows are anticipated to be minimal, as the proposed project increases supply from existing water rights to levels observed in prior historical conditions; the project does not develop new surface water sources. Diversions will be made from existing water rights and at the existing diversion location. Infrastructure development may result in some surface disturbance from construction that could require mitigation; however, this is expected to be minimal as the proposed infrastructure has a limited footprint and will be developed on LNVA's existing pump station site adjacent to existing facilities.

Permitting and Development

The development of this strategy may require some permitting due to surface disturbance from the construction of pump station infrastructure. This is expected to be minimal, as construction is anticipated to occur on the sponsor's existing property and in close proximity to the existing pump station site. Because the supply source is provided by existing water rights and will be delivered through LNVA's Devers system, permitting of new water rights to add a diversion point will not be required.

Cost Analysis

Planning level cost estimates for this strategy are included in the table below. Capital costs include planning, design, real estate, environmental and permitting, and construction of pump station infrastructure. The annual cost was estimated assuming a debt service of 3.5% for 20 years, in accordance with TWDB regional water planning cost assumptions. Costs are presented in September 2023 equivalent costs in *Table 1*.

Table 1 – LNVA Devers Pump Station Relocation Cost Estimate

OPINION OF PROBABLE CONSTRUCTION COST					September 2023
ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
PROJECT CAPITAL COST SUMMARY					
1	CONSTRUCTION COST	1	LS	\$15,262,337	\$15,262,337
2	ENGINEERING, FINANCIAL, LEGAL SERVICES, AND CONTINGENCIES	1	LS	\$5,341,818	\$5,341,818
3	LAND AND EASEMENTS	1	LS	\$5,920	\$5,920
4	ENVIRONMENTAL - STUDIES AND MITIGATION	1	LS	\$59,195	\$59,195
5	INTEREST DURING CONSTRUCTION	1	LS	\$668,717	\$668,717
PROJECT CAPITAL COST					\$21,337,986

ITEM	DESCRIPTION	ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	DEBT SERVICE	\$1,501,364	\$1,501,364	\$0	\$0	\$0	\$0
2	OPERATION AND MAINTENANCE (O&M)	\$381,558	\$381,558	\$381,558	\$381,558	\$381,558	\$381,558
TOTAL ANNUAL COST		\$1,882,922	\$1,882,922	\$381,558	\$381,558	\$381,558	\$381,558

ITEM DESCRIPTION		ANNUAL TOTAL					
ANNUAL COST SUMMARY		2030	2040	2050	2060	2070	2080
1	ANNUAL COST	\$1,882,922	\$1,882,922	\$381,558	\$381,558	\$381,558	\$381,558
2	YIELD	88,704	88,704	88,704	88,704	88,704	88,704
3	UNIT COST	\$21	\$21	\$4	\$4	\$4	\$4
TOTAL UNIT COST		\$10					

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
CONSTRUCTION COST SUMMARY					
1	PUMP STATIONS	1	LS	\$15,262,337	\$15,262,337
PROJECT COST					\$15,262,337

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
OPERATION AND MAINTENANCE (O&M) COST SUMMARY					
1	PUMP STATIONS	2.5	%	\$15,262,337	\$381,558
ANNUAL OPERATION AND MAINTENANCE COST					\$381,558

Water Management Strategy Evaluation

Based on the analysis provided above, the LNVA Devers Pump Station Relocation project was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	Project is a very low-cost alternative for making more water available in the LNVA Devers System.
Location	5	Project is associated with an existing diversion site and conveyance infrastructure serving a large area.

CRITERIA	RATING	EXPLANATION
Water Quality		No known issues related to water quality.
Environmental Land and Habitat	3	Environmental impacts can be mitigated. Limited concerns.
Environmental Flows	3	Project will increase diversion capacity from existing sources to levels observed in prior conditions and is anticipated to have minimal impacts on environmental flows.
Local Preference	3	No known significant opposition.
Institutional Constraints	5	Property and facilities to be improved already owned by sponsor.
Development Timeline	5	Project can be developed in a relatively short period of time.
Sponsorship	5	The project sponsor, LNVA, is committed to the project and is actively evaluating final design.
Vulnerability	3	Moderate risk associated with development of a structure in a coastal area.
Regionalization	3	Supports service to multiple customer entities.
Impacts on Other WMS	5	Project will increase overall LNVA system reliability, positively impacting customer supply. Potential synergy with other project(s). No negative impacts on other WMS or projects.

The LNVA Devers Pump Station Relocation will facilitate diversions made from existing water rights. The project is anticipated to positively impact agricultural land and production through increased supply reliability. The project is not anticipated to impact vulnerable species.

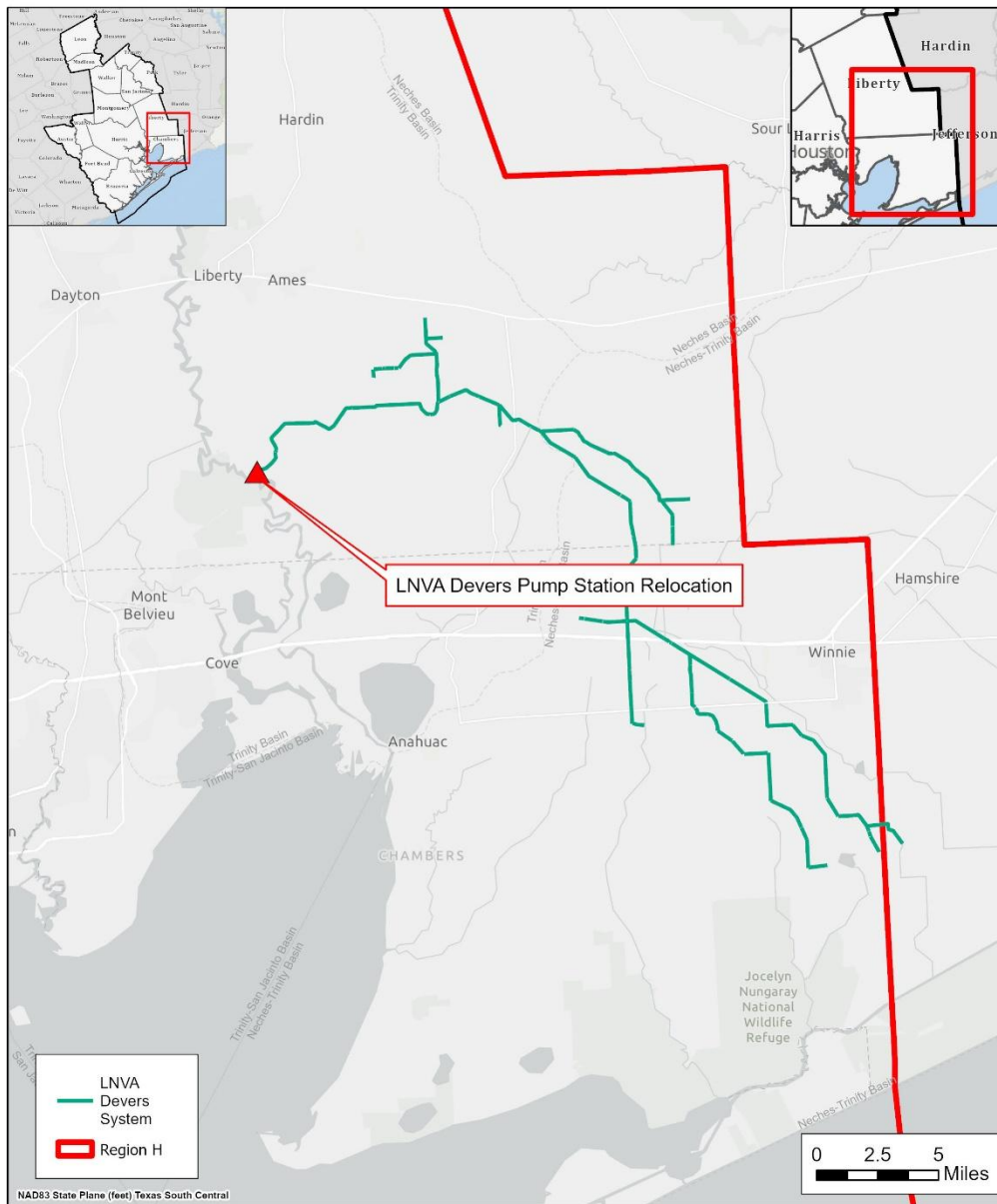
Water User Group Application

The LNVA Devers Pump Station Relocation project 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.

CRITERIA	WUG SUITABILITY
Proximity	The benefits of the pump station relocation would be experienced by LNVA customers supplied by the LNVA Devers System, with points of demand serviced through existing canal infrastructure.
Size	The project is sized in accordance with the available source, anticipated future demands, and provision for system infrastructure redundancy.

CRITERIA	WUG SUITABILITY
Water Quality	The project is not anticipated to impact water quality. This project will convey raw water, which is suitable for irrigation use.
Unit Cost	The unit cost, which is relatively low, is appropriate to the irrigation use within the LNVA Devers System.
Other Factors	This project is identified primarily for irrigation customers in Chamber and Liberty Counties but could also potentially supply other customers with future needs.

Location Map



LNVA Devers Pump Station Relocation Location Map



Texas

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	Municipal Drought Management
Project ID:	OTHR-005
Project Type:	Drought Management
Potential Supply Quantity (Rounded):	2,759 ac-ft/yr (2.5 mgd)
Implementation Decade:	2030
Development Timeline:	0 years
Project Capital Cost:	N/A
Unit Water Cost (Rounded):	\$52 to 57 per ac-ft

Strategy Description

The Texas Commission on Environmental Quality (TCEQ), in accordance with the Texas Administrative Code (TAC), requires all wholesale public water suppliers, retail public water suppliers, and irrigation districts to prepare drought contingency plans (DCPs) meeting the requirements of 30 TAC §288(b) and to update these plans at least every five years. TCEQ administrative rules in 30 TAC §288.1 define a drought contingency plan as “a strategy or combination of strategies for temporary supply management and demand management responses to temporary and potentially recurring water supply shortages and other water supply emergencies”. Most DCPs aim to curtail demands through temporary reductions in certain categories of water use, often in response to hydrologic drought conditions but also in cases of other water supply emergencies (for example, equipment failures caused by excessively high peak water demands). Common elements of DCPs are successive stages of drought response, criteria for initiating each stage (triggers), objectives such as a percent reduction in demand (targets), and voluntary and/or mandatory actions to achieve those objectives (response measures).

It is important to note that drought management differs from typical water management strategies in that it benefits an enacting utility only temporarily at the time of implementation. Because drought management is only active and beneficial during certain periods of time, its reliable yield is essentially zero when considered in an analogous manner to surface water, groundwater, reuse, or conservation. However, it does represent savings of supply volume through demand reduction during drought conditions, such as those that form much of the basis for Regional Water Plan (RWP) development.

The Municipal Drought Management strategy considers the potential temporary benefit of demand reductions produced by implementation of the short-term measures outlined in entities’ DCPs. As the TCEQ does not require private industrial water users or individual agricultural users to develop DCPs, this analysis was limited to the assessment of potential demand reductions among municipal water user groups (WUGs). It should be noted that the Region H 2026 RWP does not seek to dictate a specific, narrow DCP implementation and instead recognizes that DCP activation and response relies

on many different factors and compliance enforcement will be on an individual WUG basis. Currently, the yield from this WMS is a minimum expectation of demand savings. It is anticipated that in future planning cycles this number will be refined, and that the DCP savings potential for the region under aggressive implementation conditions exceeds the number shown in the RWP.

Strategy Analyses

The project analyses for Municipal Drought Management include evaluations of the potential supply to be created, environmental factors involved in the project, permitting and development considerations, and an analysis of project cost.

Supply Development

For each municipal WUG in Region H, potential savings were estimated based on the most recent available version of the WUG's own DCP. For entities which have not submitted DCPs to the Region H Water Planning Group (RHWPG), DCP stages and target reductions were applied based on the DCP of the wholesale provider serving the entity, when available. In total, target demand reductions were determined for 210 of the 383 municipal WUGs in Region H. WUGs that have not submitted DCPs to the RHWPG and which are not served by a wholesale provider were assumed to have zero potential benefit from the Municipal Drought Management strategy. County-Other WUGs were also not evaluated, as they are made up of multiple individual utilities.

In addition to the assessment of DCPs submitted by entities across Region H, the RHWPG also reviewed recent occurrences of entities implementing measures from their DCPs. Although within Region H the year 2011 represents the most severe drought in recent years, drought responses from 2023 have been used to estimate the potential level of DCP implementation by entities in Region H under another drought of record. This is due to a greater number of public water systems implementing drought restrictions in 2023 compared to 2011. The RHWPG performed an analysis of TCEQ records of entities implementing mandatory landscape watering restrictions to estimate the percent of time in a one-year period (based on 2023) during which each entity would likely be enforcing mandatory outdoor watering restrictions.

Demand reductions were assessed for multiple scenarios. Demand reduction targets were applied to municipal WUGs' projected decadal demands only for the percent of time during which any entity was assumed to be in a drought stage with mandatory curtailments. Targets were based on either the first stage in which a DCP prescribed mandatory restrictions, the next highest stage with mandatory restrictions, or multiple stages based on which stages were implemented in 2023. The multiple-stage scenario was considered to most closely reflect 2023 conditions; however, as most reporting entities in Region H did not trigger a more restrictive stage than their first mandatory stage, the outcomes of this scenario are similar to those in the first mandatory stage option. (For most entities, the first stage with mandatory restrictions is Stage 2, with only voluntary responses prescribed in Stage 1 of the DCP.) Voluntary drought response stages were assumed to have no impact on demands.

Targeted demand reductions were applied to each WUG's post-conservation demand, which is the projected demand after reductions were applied from the Advanced Municipal Conservation and Water Loss Reduction water management strategies. Furthermore, as many of the measures defined in DCPs focus on demand curtailment through the reduction of outdoor watering, this analysis assumed that any substantial benefits from Municipal Drought Management would be attributable to mandatory restrictions on outdoor watering. Because Region H has included twice-per-week watering

restrictions in its Advanced Municipal Conservation strategy, savings already accounted for as part of Advanced Municipal Conservation were excluded from potential drought management savings.

Additionally, a factor was applied to account for the potential impacts of less than 100% compliance among retail water customers and less than 100% efficacy of DCP response measures in achieving the targeted demand reductions. Scenarios were assessed for compliance and efficacy factors of 50% and 100%. Finally, as Municipal Drought Management may reduce demand but does not, by nature, provide a surplus supply, estimated potential savings were capped at a WUG's post-conservation needs (unmet demand after application of other demand reduction strategies).

Table 1 summarizes the potential savings estimated for each scenario in each of the planning decades. At 50% efficacy, savings under approximate 2023 conditions range from 2,194 ac-ft/yr in 2030 to 2,759 ac-ft/yr in 2080.

Table 1 – Total Demand Reduction from Municipal Drought Management Strategy

Reduction Scenario	Compliance / Efficacy Factor	Potential Savings from DCP Implementation					
		2030	2040	2050	2060	2070	2080
First Mandatory Stage ¹	50%	2,085	2,566	2,640	2,660	2,731	2,649
Next Mandatory Stage ²		7,040	7,997	8,104	8,027	8,074	7,903
Multiple Stages ³		2,194	2,671	2,745	2,766	2,839	2,759
First Mandatory Stage¹	100%	4,063	5,096	5,273	5,317	5,347	5,297
Next Mandatory Stage²		13,947	15,404	16,162	15,993	16,014	15,750
Multiple Stages³		4,280	5,304	5,484	5,529	5,563	5,516

1) First Stage – Reduction targets based on least restrictive stage with any mandatory curtailment in each entity's DCP (or wholesale provider's DCP).

2) Next Stage – Reduction targets based on second least restrictive stage with any mandatory curtailment.

3) Multiple Stages – Reduction targets based on multiple stages with mandatory curtailments, distributed based on each entity's projected percent of year in that stage.

Because Municipal Drought Management reduces need through a percentage reduction in demand, municipal WUGs with large population and high demands are most impacted by the implementation of this strategy.

Environmental Considerations

Generally, no significant negative environmental impacts are associated with Municipal Drought Management, as typical drought management measures do not involve the construction of any facilities. Municipal effluent is a critical and substantial component to baseflows in the Houston area. However, drought response measures typically focus on reducing outdoor water use, which would likely impact return flows less than indoor water use reduction. Furthermore, any reduction in return flows to receiving basins would, theoretically, be more than offset by reduced diversions of water from the source basins.

Permitting and Development

A drought management strategy is very local in nature and would be implemented by individual utilities, typically through municipal ordinances and enforcement. Drought response measures can be implemented immediately upon utility determination that a drought trigger has been reached, and implementation timelines and requirements are usually outlined in a utility's DCP.

Cost Analysis

Implementation of demand reduction measures in response to a drought would likely impose minimal direct costs to a water provider, limited primarily to the costs of notifying customers and enforcement. However, because the Municipal Drought Management strategy reduces demand on a short-term basis rather than providing additional supply, costs are borne by end-users in the form of economic impacts. Estimates of adverse monetary impacts due to residential water use restrictions were analyzed using the Texas Water Development Board (TWDB) Drought Management Costing Tool, which estimates the foregone consumer surplus cost of reduced residential water use. In other words, the estimated impacts represent the value consumers would be willing to pay to not have implemented residential watering use restrictions.

The analysis of cost assumes that residential outdoor water use will be reduced by the same percentage as the reduction assumed for the entire WUG, which is the DCP Target Reduction multiplied by the assumed Efficacy and compliance factor. For purposes of a consumer surplus (lost) cost estimate, this reduction is applied to the average household water use, which is for many WUGs less than the overall WUG's dry-year per-capita demand estimate, which may include non-residential use and increases due to dry conditions. The volume of water savings represented in the cost is thus less than the total savings estimated for the Demand Management WMS. Costs were estimated based on the assumption that all savings represented by the Municipal Drought Management strategy occur within residential water use. Furthermore, this cost estimate is limited to an estimate of foregone consumer surplus (i.e., the cost to residents) and does not include additional costs that may be borne by a utility during enactment and enforcement of demand management measures. The unit cost is specifically based on the Consumer surplus cost of reduced outdoor residential watering, which are estimates of the consumers' willingness to pay to be restored back to their normal levels of water usage. Impacts of drought response measures applied to non-residential consumers were not evaluated as part of this strategy analysis. *Table 2* summarizes the potential adverse monetary impacts of the Municipal Drought Management strategy for the multiple stages scenario at an efficacy factor of 50%. The relationship between price and demand differs greatly between WUGs, so the economic impact per acre-foot of demand reduction changes from decade to decade depending on which entities contribute greater portions of total savings due to varying demands.

Table 2 – Adverse Monetary Impacts of Residential Water Use Restrictions

Annual Cost Summary	2030	2040	2050	2060	2070	2080
Annual Cost	\$115,000	\$153,000	\$152,000	\$147,000	\$150,000	\$146,000
Demand Reduction (ac-ft/yr)	2,194	2,671	2,745	2,766	2,839	2,759
Unit Cost	\$52	\$57	\$55	\$53	\$53	\$53
Average Unit Cost						\$54

Non-residential economic impacts were not analyzed as part of this strategy. Commercial and industrial impacts may include reducing operations or even temporary business closures, particularly for businesses with high water use. Reductions in agricultural irrigation may directly reduce crop yields and subsequent revenues.

Water Management Strategy Evaluation

Based on the analysis provided above, the Municipal Drought Management strategy was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may

be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	1	Estimated economic impacts to residential water users are relatively low, but additional potential costs associated with industrial, commercial, and agricultural water use are unknown. True costs encompass greater socioeconomic impacts of unmet needs on job and income losses and reduced tax revenue.
Location	5	Drought management measures generally benefit the WUGs in which they are implemented, but demand reduction in one WUG may also allow for water to be used by other customers after the demand level is reduced.
Water Quality	3	No known issues related to water quality.
Environmental Land and Habitat	5	No impacts to landform associated with drought management.
Environmental Flows	3	No impacts to instream flows. Typically, reductions in return flows are also associated with reduced diversions. Although drought management may reduce diversions during extreme droughts, they are typically not enacted and, therefore, do not have any routine impact.
Local Preference	2	Local support varies from utility to utility. Some opposition expected.
Institutional Constraints	5	No permits required for implementation of drought response measures.
Development Timeline	5	Drought management measures can be implemented in a relatively short period of time.
Sponsorship	3	Although sponsors are identified, commitment to implementation varies considerably.
Vulnerability	5	Drought management has no identifiable risk from natural or man-made disasters.
Regionalization	1	Typically implemented at the individual water system level or for a small number of interconnected systems.
Impacts on Other WMS	2	Drought management measures may negatively impact the availability of return flows for downstream use.

Water User Group Application

The Municipal Drought Management strategy was evaluated on a basis of several criteria to

determine the 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.

CRITERIA	WUG SUITABILITY
Proximity	Drought management measures do not produce water and only reduce total demand. Therefore, proximity of source and demand is not an issue for implementation.
Size	Targeted demand reductions of drought management measures are proportional to WUG demands.
Water Quality	Measures produce no water and only reduce demand.
Unit Cost	Estimated economic impacts to residential water users are relatively low. Additional potential costs associated with industrial, commercial, and agricultural water use are unknown.
Other Factors	Total reduction in demand due to drought management measures is highly dependent on localized supply conditions and levels of customer compliance.

References

Texas Water Development Board. *Drought Management Costing Tool*. Available at <http://www.twdb.texas.gov/waterplanning/rwp/planningdocu/2021/current_docs.asp>. October 2019.

REGION H PROJECT ANALYSIS TECHNICAL MEMORANDUM

Project Name:	New and Expanded Contracts
Project ID:	OTHR-006
Project Type:	N/A
Potential Supply Quantity:	Varies
Implementation Decade:	Varies
Development Timeline:	0 years
Project Capital Cost:	N/A
Unit Water Cost:	N/A

Strategy Description

The Region H Water Planning Group supports the voluntary transfer of water between entities to effectively meet the needs of some Water User Groups (WUGs) with water surpluses available from other entities. Several water management strategies have been recommended through which WUGs would pursue new contracts for purchasing water or would expand the contracted amounts of existing agreements from Major Water Providers (MWP) in the region.

Strategy Analyses

The strategy analyses for New and Expanded Contracts include evaluations of the potential supply to be created. Because most of the recommended contracts are for WUGs and MWPs between which infrastructure already exists to transfer water, the strategy is limited to execution of a contract for purchase of water. Where additional infrastructure may be required, environmental factors, permitting and development considerations, and an analysis of cost were performed as part of a separate project analysis.

Supply Development

Transferred supply volumes transferred through New and Expanded Contracts are intended to meet needs of WUGs. However, transferred volumes are limited to the surplus available to a MWP for sale and thus depend on the MWP's surface water rights, groundwater pumping permits, and treatment capacity. Surplus available to a MWP may consist of existing unused water supplies or new supply sources developed through other water management strategies and contracts. Contracts are also recommended based on the feasibility of transferring water from a MWP to a WUG and often make use of existing infrastructure.

Environmental Considerations

The execution of new water supply contracts or expansion of existing contracts do not directly require any development which could present environmental concerns. While the use of purchased water

may reduce instream flows, the volumes transferred for supply are permitted under existing surface water rights.

Permitting and Development

The contractual transfers recommended as part of New and Expanded Contracts strategies are limited to transfers of waters already owned by the seller, either through a water rights permit or purchase from another wholesale water provider. No additional permitting is required. Interbasin transfers, which do require additional permitting, were each considered as separate water management strategies.

Cost Analysis

The cost of purchasing water under new or expanded contracts was not evaluated, as these costs are highly variable and many of the recommended contracts would begin in later decades of the planning period. Costs of developing infrastructure for water transfers, where necessary, were considered under separate projects.

Water Management Strategy Evaluation

Based on the analysis provided above, the New and Expanded Contracts water management strategy was evaluated across 12 different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

CRITERIA	RATING	EXPLANATION
Cost	5	No direct infrastructure costs are associated with this strategy.
Location	4	Contracts are typically recommended between WUGs and MWP in close proximity to one another.
Water Quality	3	No known water quality issues.
Environmental Land and Habitat	5	Limited impacts are associated with this strategy.
Environmental Flows	2	Transfer of purchased water may result in reduced instream flows.
Local Preference	3	No known opposition.
Institutional Constraints	5	No permitting or land acquisition required.
Development Timeline	5	Contracts can typically be executed in less than one year.
Sponsorship	3	Sponsors have been identified.

Vulnerability	5	Minimal risk from natural and man-made disasters.
Impacts on Other WMS	5	New and Expanded Contracts utilize supplies developed through other WMS to meet needs.

Water User Group Application

The New and Expanded Contracts 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.

CRITERIA	WUG SUITABILITY
Proximity	New and Expanded Contracts would directly supply WUGs with existing water needs.
Size	Contract allocations are sized to meet WUG needs.
Water Quality	Purchased supplies may be raw or treated, depending on the seller. Purchased raw water supplies will require treatment by the WUG.
Unit Cost	Costs associated with this strategy will depend on negotiated contract prices. No costs have been evaluated as part of the 2026 RWP.

THIS PAGE INTENTIONALLY LEFT BLANK