

Freeport Seawater Desalination Project

Brazos River authority

Summary Report¹

SR.1 Introduction

The State of Texas, recognizing a growing water need and the limited availability of fresh surface water and groundwater, funded analyses of three seawater desalination projects located along the Gulf Coast. The projects include this proposed facility at Freeport, Texas.

Extensive analyses, detailed in this report, conclude that the Freeport Seawater Desalination Project is an integral component to meeting future water demands in Brazoria and Fort Bend counties. Major observations include:

- Population in the service area is projected to grow from 450,000 in 2000 to 1.2 million in 2060.
- Groundwater supplies in the service area are limited. Existing groundwater withdrawals in Brazoria County are approaching the available yield, meaning additional groundwater supplies cannot be developed in the county. In addition, the Fort Bend Subsidence District has adopted rules requiring phased reductions in the use of groundwater. For the study area in Fort Bend County, groundwater can meet only 70 percent of total water demand starting in 2013 and only 40 percent in 2025.
- Existing surface water supplies will not meet all of the long-term water needs.
- As population continues to grow in the service area and groundwater use restrictions take effect, water deficits will occur. The total unmet municipal average day water demand in 2060 is more than 35 MGD.²
- Desalination technology is becoming more cost effective at the same time that the cost of treating surface water is becoming more complex and expensive due to more stringent drinking water rules. As these trends continue, desalination will become more cost competitive.
- There are significant public benefits to using desalinated water as a primary drinking water supply in the lower Brazos basin, including diversifying water resources in an area with limited traditional water supply alternatives, providing a high quality, drought-proof supply, mitigating growing subsidence problems due to groundwater withdrawals, and enhancing Brazos River flows in an area with increasing needs for surface water for manufacturing and irrigation uses.
- The public-private partnership between the Brazos River Authority (BRA) and Poseidon Resources provides added value to the State by leveraging private-sector capital for a public good, allowing flexibility to adapt to rapidly changing technology of the project, and shift part of the performance risk to the private sector.

¹ Prepared by CDM (Professional Engineer seal of Allen D. Woelke) for the Brazos River Authority under a grant from the Texas Water Development Board, TWDB contract number 2004-483-514.

² An additional 15 MGD is need for seasonal peaking.

- Recognizing the public benefit of seawater desalination, both Florida and California have provided subsidies to enable seawater desalination projects to move forward. Also, the federal government is considering bipartisan legislation that would provide subsidies for desalination facilities up to \$0.62/1000 gallons to partially offset the cost of electrical energy required to operate such facilities.

The Freeport Seawater Desalination Project is the right project for Texas to pursue as a demonstration project. In addition to proactively meeting long-term needs, the project has several unique advantages:

- Experienced Partners – A public-private partnership between the BRA and Poseidon Resources will leverage local and state resources with \$76 million in private investments. Poseidon has substantial experience in large-scale desalination projects in Florida and California.
- Suitable Location – Co-locating the project at The Dow Freeport facilities brings numerous advantages:
 - ✓ existing infrastructure, including on-site power and established site security;
 - ✓ convenient access to seawater, river water supply, and discharge;
 - ✓ existing permits will speed the project implementation schedule²; and
 - ✓ no bay means reduced environmental issues related to brine disposal.

Furthermore, because this project will use existing infrastructure, project implementation can occur rapidly.

- Basinwide Benefits – The project will provide a new, drought-proof source of water resulting in a diversity of supply and enhanced reliability for the region. It also will provide efficiency and future benefits to the entire Brazos River basin by allowing limited surface water to be used in areas for which seawater is too distant to be a practical option. Finally, using high quality, reliable desalinated water for municipal supplies could make raw surface water available for irrigation and for manufacturing needs that do not require highly treated water.

SR.2 Evaluation Process

The evaluation of the proposed Freeport Seawater Desalination Project entailed identifying water demands for the service area, calculating the cost of providing desalinated water, and identifying the economic feasibility of a seawater desalination plant. Specific tasks completed during the study included:

- Task 1 – defining the study area by gathering data on population, water demand, water quality, and water supplies.
- Task 2 – projecting population and water demands in the study area.

² In February 2004, the Texas Commission on Environmental Quality (TCEQ) modified Dow's existing seawater withdrawal permits to include industrial and potable municipal uses.

- Task 3 – identifying available water supplies and their quantities, assessing the quality of existing and future water supplies, and then pinpointing water shortages, or deficits, for water suppliers based on water demand projections and identified supplies and infrastructure capacity.
- Task 4 – evaluating options for using desalinated seawater to meet the projected water deficits.
- Task 5 – comparing the cost of desalinated water to other future water supply alternatives, including continued use of groundwater or development of new surface water supplies. Both Tasks 4 and 5 also involved sizing treatment and conveyance facilities to support planning level cost estimates for all options.
- Task 6 – conducting economic analyses of desalination options and non-desalination options to assess cost differences on a net present value basis, and computing the unit cost of water for each option.
- Task 7 – analyzing the impact that desalinated water options and the alternative to using desalinated water would have on water rates for potential customers.
- Task 8 – developing an implementation plan encompassing the final facility plan, financing options, and the need for potential subsidies.

Throughout the project, stakeholders played important roles in providing information and feedback. In addition to individual meetings with water suppliers and water users, the study team held several public meetings to keep communities informed on the progress of the project and results of the analyses.

SR.3 Service Area

The proposed service area for the Freeport Seawater Desalination Project includes Brazoria County and the southeastern portion of Fort Bend County, as shown in Figure SR-1. The planning area was defined with the help of local community participation at three public meetings.

SR.4 Population and Water Demand Projections

Population projections for the service area were based on extensive analyses of data from state, regional, and local sources. The total population in the service area was determined based on population data from the Texas Water Development Board (TWDB), then geospatially distributed based on these data and data from individual cities and from regional analysis zones (RAZ) prepared by the Houston-Galveston Area Council of Government (HGAC). The method used to distribute population placed primary emphasis on local planning data and allowed distribution of the TWDB’s population for “County-Other” into cities or, at a minimum, into a RAZ.

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As shown in Figure SR-2, population in the service area is projected to grow from 450,000 in 2000 to 1.2 million in 2060. The majority of the population growth occurs in the northern Brazoria County and Fort Bend County portions of the service area.

Water demand projections were prepared using TWDB data on population and per capita water use. TWDB per capita water use data, which incorporate future conservation, were confirmed using individual utility data reported to the Texas Commission on Environmental Quality (TCEQ). The seasonal variance in water use, typified by the ratio of maximum day to average day use, was obtained from TCEQ records.

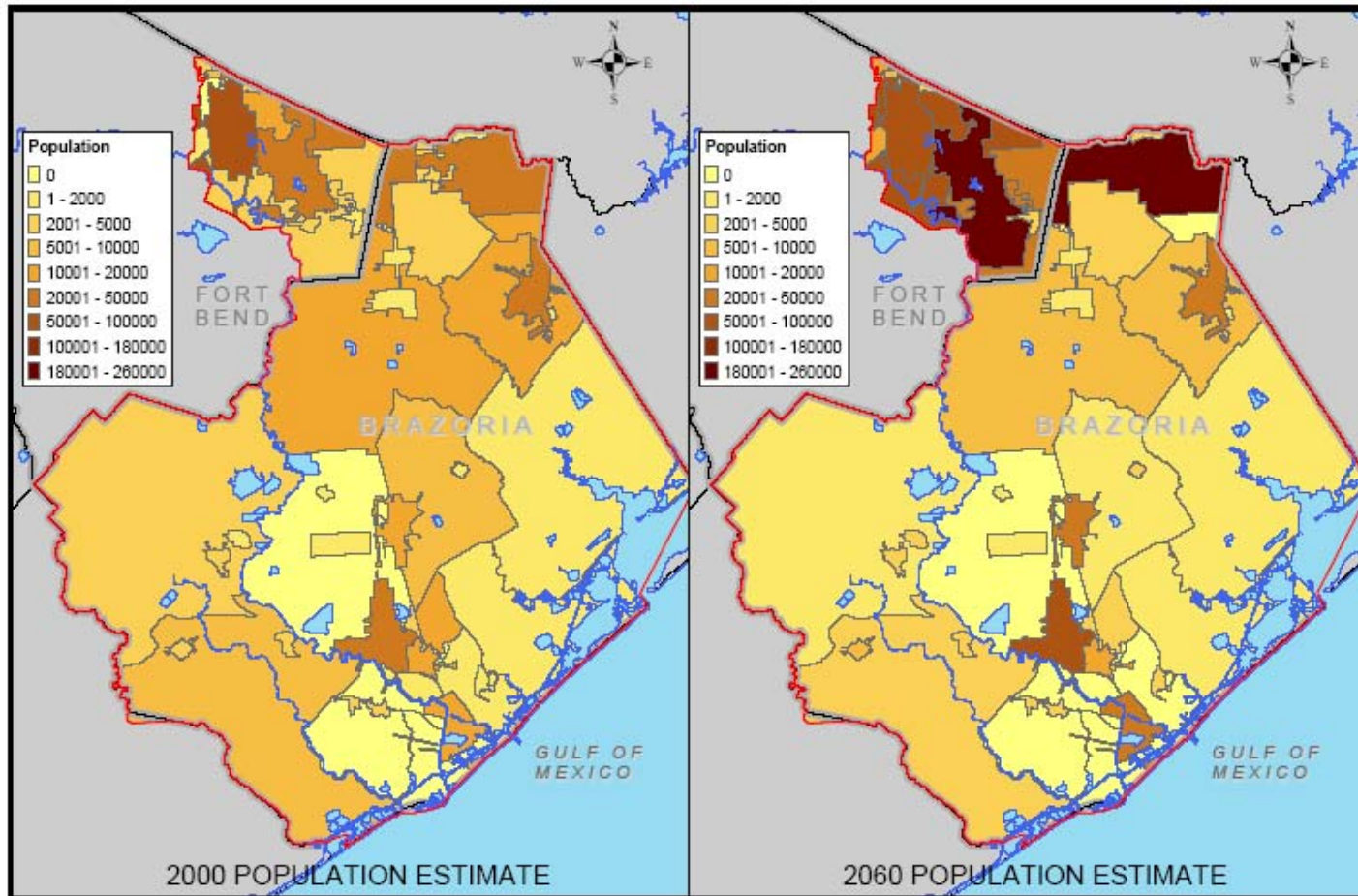
SR.5 Existing Water Supplies

Groundwater currently is the only supply source for the majority of water suppliers in the service area. Exceptions are the cities that meet a portion of their demand with treated surface water from the Brazosport Water Authority (BWA) and cities that have surface water connections with the City of Houston.

The groundwater availability model for Brazoria County was not available for use in completing this planning effort. However, discussions with TWDB staff and data from the Region H Water Planning Group indicate that existing groundwater withdrawals in Brazoria County are approaching the available yield. This means that development of additional groundwater supplies for Brazoria County is not feasible. In Fort Bend County, the Fort Bend Subsidence District has adopted rules requiring phased reductions in the use of groundwater. For the service area in Fort Bend County, groundwater can meet only 70 percent of total water use starting in 2013, decreasing to only 40 percent in 2025. With groundwater supplies either diminishing or remaining stagnant, alternative water supplies will be required in the service area to meet expected water demand.

The cities of Pearland, Missouri City, Sugar Land, and Stafford/WCID No. 2 have option contracts with the Gulf Coast Water Authority (GCWA). These option contracts are not currently used, but are likely to be used in the future. The contracts are for a given quantity of water per day, without specification of a maximum rate. Based on other water supply studies in the region, the GCWA contracts are assumed to be base loaded, with the contract amount used as both an average day and maximum day value. The cities are expected to meet their maximum day demands by using existing or new wells, as required, as long as total groundwater usage does not exceed the regulatory limit in any calendar year.

The quality of existing water supplies was evaluated relative to existing and proposed drinking water standards. Isolated violations of existing primary drinking water standards were found, along with several potential violations of new drinking water rules. Most common were violations of secondary standards, established to protect the aesthetics of the drinking water.



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POPULATION DATA

While violations of secondary standards do not affect health, they do have an effect on taste, odor, and appearance. Many of the groundwater supplies in the service area exceed the secondary drinking water standards for iron and manganese. In addition, standards for aluminum and total dissolved solids are being violated at some locations. The report discusses the impact of these water quality issues on water supply availability.

Water deficits for each utility were computed as the difference between demand and available supply. Deficits were determined for both average day supplies and maximum day capacities. Currently, there are no unmet water demands. As shown in Figure SR-3, unmet water demands occur as early as 2010, before the Subsidence District rules take effect. As population continues to grow in the service area and groundwater use restrictions take effect, water deficits steadily rise. The total unmet municipal average day water demand in 2060 is greater than 35 MGD.³

This study focuses on unmet municipal demand, as opposed to manufacturing and irrigation demands, because the desalination facility is expected to produce a high quality potable water. However, in addition to the municipal deficit, the Region H Water Plan also predicts year 2050 water deficits of over 90,000 acre-feet/year for manufacturing and over 30,000 acre-feet/year for irrigation in Brazoria County. The Region H Water Plan indicates that these manufacturing and irrigation deficits are projected to begin occurring as early as 2010. The Region H Water Plan recommends that most of these deficits be met with water supplies delivered via the Brazos River by the Brazos River Authority.

SR.6 Alternatives to Desalinated Seawater

If desalinated seawater is not used to meet projected water deficits in the service area, additional water supplies must be developed. The following three water supply alternatives to desalinated seawater were identified and evaluated:

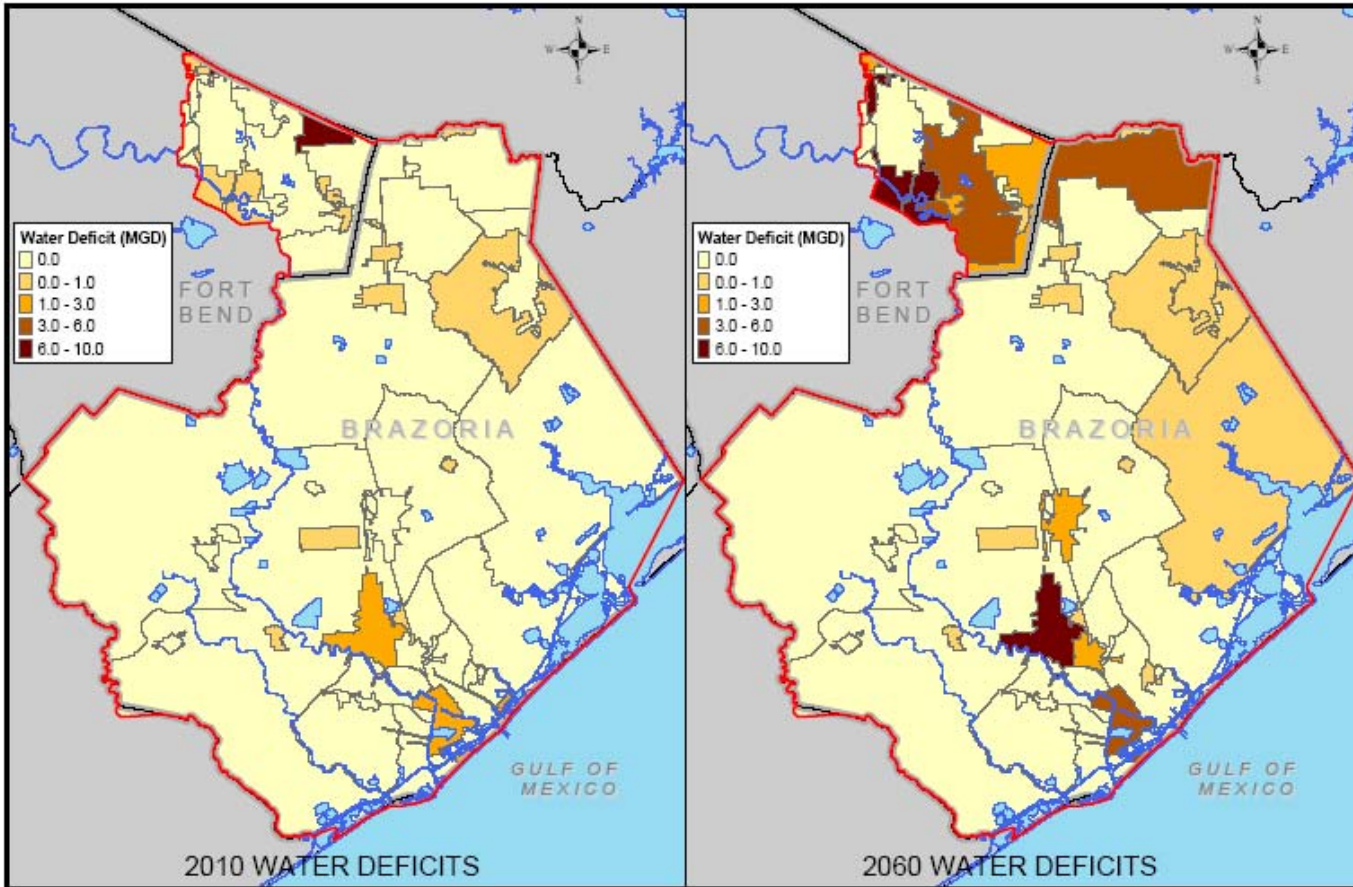
Groundwater

As discussed above, additional groundwater is not available to meet the long-term supply needs in the service area.

Supplies from the City of Houston

The City of Pearland already has entered into a contract to buy wholesale treated water from the City of Houston and is negotiating to increase that contract amount. Pearland also is negotiating to buy additional water supplies from Houston's Southeast Water Purification Plant (SEWPP). Based on discussions with City of Houston officials, service to utilities in the Fort Bend County portion of the service area would not be feasible at this time.

³ An additional 15 MGD is need for seasonal peaking.



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WATER DEFICIT DATA

FIGURE SR-3

Surface water from the Brazos River

Communities located in southeast Fort Bend County and northwest Brazoria County could augment their water supplies from a possible southwest water plant that would deliver treated Brazos River surface water to the water plant customers. The cities of Missouri City, Sugar Land, Stafford/WCID No. 2, and Pearland have surface water contracts with the GCWA. The GCWA's surface water supply is based on its own water rights in the Brazos River and contracts with the BRA. For these cities and the utilities in this area, the alternative to seawater desalination is using the GCWA surface water and constructing facilities to treat that water. Surface water for the Fort Bend County cities could be treated at a regional water plant located near Stafford, as indicated by previous regional water supply studies. Surface water for the Pearland area could be treated at a nearby water plant. While the GCWA surface water supplies could meet the next increment of demand in east Fort Bend and northwest Brazoria counties, projected long-term water deficits for Pearland and Missouri City exceed their respective GCWA water supplies.

In southern Brazoria County, BWA cities could augment their water supplies by contracting for additional surface water and expanding the existing surface water treatment plant; however, surface water in the lower Brazos remains vulnerable to low flow conditions during drought.

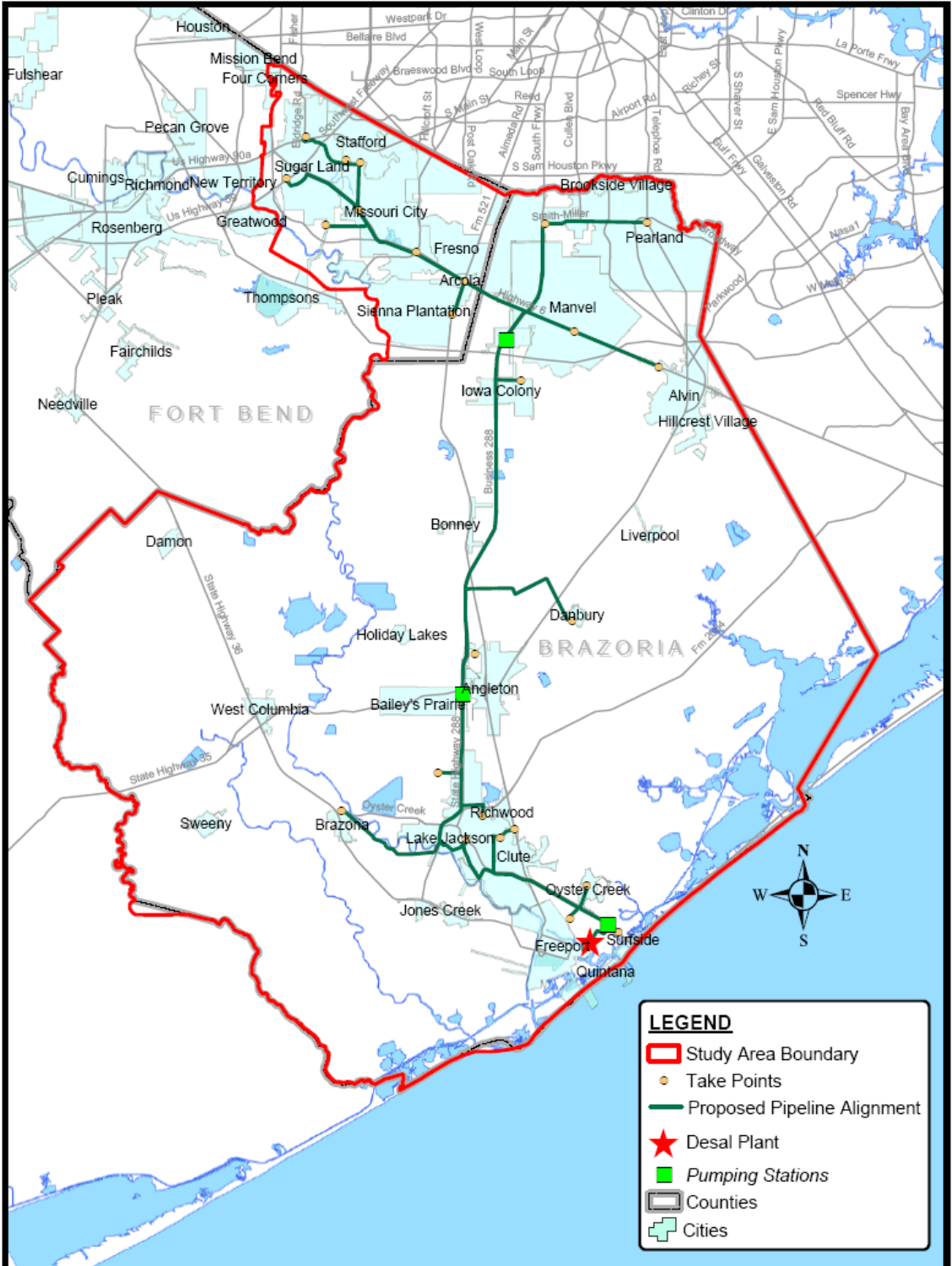
SR.7 Desalinated Seawater Options

In the public-private partnership proposed between the BRA and Poseidon, Poseidon will design, permit, build, operate, and finance the seawater desalination facility. The BRA will purchase water from Poseidon through a wholesale contract and will be responsible for conveying the water from the gate of the desalination facility to water utilities. The proposed conveyance facilities for the ultimate delivery system are shown in Figure SR-4.

The proposed facility will be capable of running in either a full seawater or full river water mode to take advantage of the economics of the lower salinity source water in the Brazos River. This concept of "scalping" river water is a form of natural economic subsidy when river water is available to the Dow canal system, while still providing a drought proof water supply. The proposed plant site location near the river's discharge to the Gulf makes scalping excess flow an attractive option.

A blending analysis indicates that the desalinated seawater is compatible with the existing groundwater and surface water supplies. The desalinated seawater will be conditioned as it leaves the desalination facility such that the treated water has a balanced pH and is non-aggressive in piping systems.

This study assumed desalination infrastructure would be implemented in two phases throughout the project planning horizon. Initial infrastructure would be implemented by 2010 to meet short-term demands, followed by additional infrastructure in 2020 to meet long-term demands.



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PROPOSED CONVEYANCE FACILITIES
FIGURE SR-4

Five options using desalinated seawater were developed for evaluation. These are shown in tabular format below and graphically depicted in Figure SR-5. The net present values for each option, shown in Figure SR-6, are computed based on the cost to deliver water to the entire service area. It should be noted that only a portion of the net present value is related to desalination related costs, as indicated in Figure SR-6. These net present values also include surface water costs, depending on the option. The details of the net present value analysis are included in Section 8.

		BRAZOSPORT WATER AUTHORITY (BWA)	
		Use BWA Surface Water to Max Capacity	Provide Desalinated Water to BWA for Wholesale Distribution to Customers
GULF COAST WATER AUTHORITY (GCWA)	Use GCWA Raw Surface Water to Max Capacity	<p><u>Option 1</u> Desalinated water used to meet deficits only.</p>	<p>BWA discontinues using its Brazos River surface water supply.</p> <p><u>Option 2</u> Desalinated water is supplied to BWA in lieu of using existing surface water.</p> <p><u>Option 5</u> Same as Option 2, except infrastructure to convey water to northern part of study area is not constructed in 2025.</p>
	Provide Desal Water In Lieu of Raw GCWA Surface Water	<p><u>Option 3</u> WCID 2 and cities of Missouri City, Pearland, and Sugar Land allow their GWCA option contracts for raw surface water to expire, replacing this supply with desalinated water.</p>	<p><u>Option 4</u> Desalinated water replaces both BWA and GCWA surface water supplies.</p>

A comparison of desalination alternatives yields the following results:

- Option 1 is the simplest to implement but initially yields the smallest amount of desalinated seawater. Additionally, significant transmission infrastructure expenses are incurred for delivering the relatively small amount of desalinated water.
- While Option 2 has the advantage of providing an immediate demand for desalinated water within close proximity to the proposed desalinated water treatment plant location, it requires a large initial capital investment to deliver desalinated water to the northern limits of the study area by 2010. Consequently, it would be difficult to acquire immediate funding for Option 2.
- Option 3 has a relatively low projected unit cost of water. However, it would be difficult to implement because it requires utilities in the northern portion of the study area to forgo implementation of existing surface water supply contracts. This option was evaluated to compare with the other options for determining potential economies of scale. Under Option 3, most of the short-term demand for desalinated water is located in the northern extents of the study area, relatively far from the proposed desalination water treatment plant location. Consequently, a relatively high initial capital investment would be required to implement Option 3.

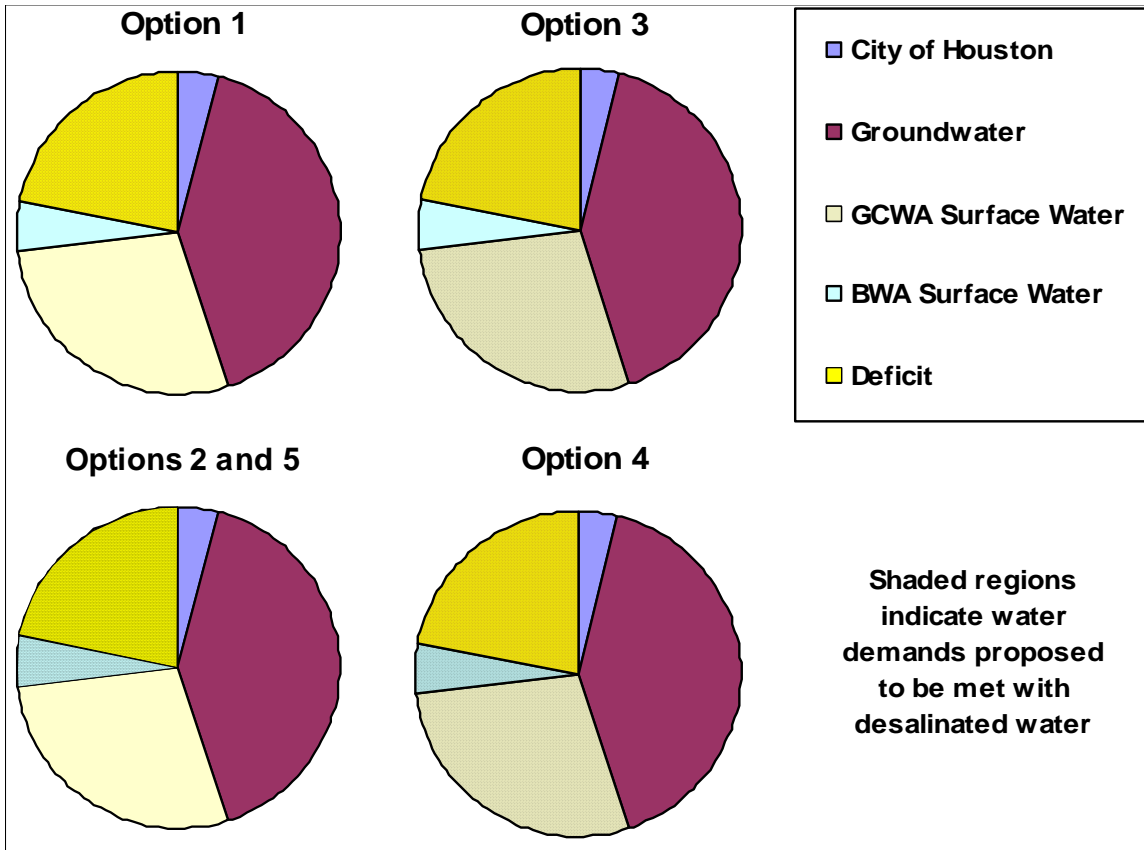


Figure SR-5 Percent of 2060 Water Demand by Water Supply for Desalination Options

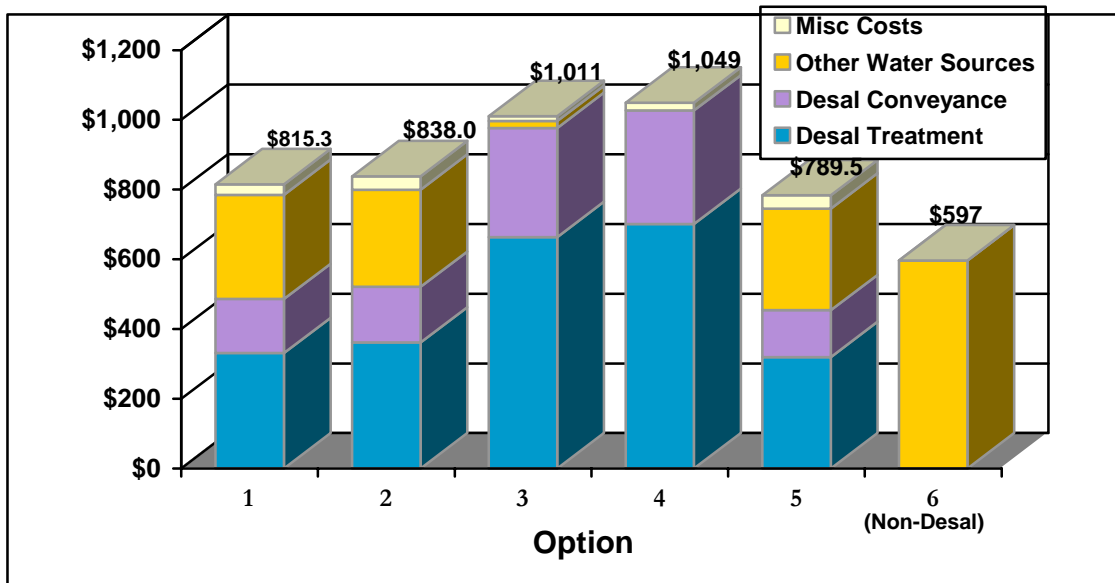


Figure SR-6 Net Present Value of Water Supply Options

- Option 4 has the lowest unit cost for desalinated seawater because it maximizes the use of desalinated seawater, but it may be the most difficult to implement because it requires utilities to forgo implementation of their existing surface water supply contracts.
- Option 5 provides for a constant demand initially to support a seawater desalination facility, then phases in the capital required to extend desalinated seawater service north to meet growing water demand in northern Brazoria and southeastern Fort Bend counties after 2025.

Also shown in Figure SR-6 is the net present value of a water supply alternative for the study area that does not include seawater desalination, which is referred to as Option 6.

Option 5 has the lowest net present value of the desalination options considered. In addition, Option 5 has cash flow advantages. Listed below are the capital requirements for Option 1 and Option 5 over the first years of implementation. Capital costs for Option 1 include construction of 102 miles of pipeline improvements from the desalination facility near Freeport to customers in Fort Bend County. Capital costs for Option 5 include constructing a 15-mile pipeline from the desalination facility to Lake Jackson and compensating BWA and its customer cities for stranded investment.

Capital Cost Comparisons Between Option 1 and Option 5 (Year 2010)		
Option	Capital Cost	Average Day Water Use
1	\$59,455,514	2.0 MGD
5	\$27,832,860	6.5 MGD

Option 1 has a lower demand in the early years as this option considers only meeting projected water deficits. Option 5 has a constant demand earlier by producing desalinated seawater that the BWA can provide to its customers in lieu of treated surface water. **Appropriate arrangements that are agreeable to the BWA will be necessary in order to implement Option 5.** The BWA will need a solution that does not increase existing costs to its customer cities.

SR.8 Desalination Recommendation

The most economical seawater desalination option is more costly than the alternative to seawater desalination in terms of net present value. For a demonstration desalination project to succeed, the unit cost for potable desalinated water to potential customers should not be significantly more than the available alternatives. The Freeport project will require some form of financial assistance to achieve this end.

As expected, Option 5 will result in treated water that is more expensive than that of the surface water alternative. The primary reason for this is two-fold. First, desalination treatment technology is currently still more expensive than conventional surface water treatment costs. Second, new transmission infrastructure would be required to deliver desalinated water because the proposed desalination solution is regional as opposed to local. However, desalination technology is becoming more cost effective at the same time that the cost of treating surface water is becoming more complex and expensive due to more stringent drinking water rules. As these trends continue, desalination will become more cost competitive. In addition, there are significant benefits to using desalinated water that should be taken into account. These include a more diversified water source, a high quality, drought-proof supply, and increased river flows.

We recommend proceeding with implementation of Option 5. The location of the desalination facility and the initial conveyance facilities for this option are shown in Figure SR-7. This option offers several advantages over the other desalinated water options:

- The State can implement a modestly sized 10 MGD demonstration seawater desalination project without having to provide capital for long-term needs.
- The BWA's existing surface water treatment plant could serve as a "back-up" in the event unforeseen problems were encountered during initial operations of the desalination plant, an ideal situation for a demonstration project.
- The utilities in northern Brazoria and eastern Fort Bend Counties will use their surface and ground- water until 2025, when a pipeline will be built to convey desalinated seawater to these utilities and the seawater desalination facility is expanded to meet their growing demands.

In addition, we recommend proceeding as soon as possible with piloting studies. Notwithstanding activities associated with a full-scale demonstration plant, the State can learn much from piloting the proposed treatment process, and the piloting studies may be partially funded by a federal grant that has already been approved for the Freeport Seawater Desalination Project. Piloting will also demonstrate viability of the project to the local area, an important consideration for implementing the 10 MGD demonstration facility.

SR.9 Financial

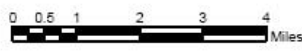
The BWA currently charges its customers \$1.58/1000 gallons. This fee covers the liquidation of the capital cost of the surface water plant, water distribution piping and appurtenant storage and pumping facilities, and operating costs. It is anticipated that improvements to the BWA surface water treatment plant may be required that would increase the unit cost of water to BWA customers to \$1.62/1000 gallons by 2010. The BWA's operations costs are estimated at approximately \$0.41/1000 gallons. Consequently, for the demonstration desalination project to have no financial impact on the BWA, a subsidy would be required to hold the cost of water from the desalination project to approximately \$1.21/1000 gallons. Included in this cost would be the capacity and commodity charges for the desalination plant, liquidation of the capital cost of the pipeline from the desalination plant to Lake Jackson, pumping, storage, and the cost of compensating BWA and its customer cities for stranded investment. The remaining \$0.41/1000 gallons would be required by the BWA to liquidate the capital costs of the existing water distribution piping and appurtenant storage and pumping facilities, and for operation and maintenance costs.

The BWA currently has contracts to deliver 7.83 MGD to its customers on a take-or-pay basis. The average demand for water from these customers is 6.5 MGD. There have been discussions with



LEGEND

○ Take Points	BWA pipes (in)	Initial New Pipes (in)
■ Pumping Stations	8	4
□ Cities	10	16
□ Counties	12	20
	14	24
	16	
	18	
	20	



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INITIAL CONVEYANCE FACILITIES - OPTION 5

FIGURE SR-7

industries in the area to purchase additional water from BWA. We believe for 2010 planning that a contract quantity of 9.2 MGD is reasonable.

At a unit cost of \$1.21/1000 gallons and at an estimated water delivery quantity of 9.2 MGD, the annual cost to the BWA cannot exceed \$4,063,200. The annual charges for the seawater desalination project would be \$12,025,300. In order to proceed, the demonstration project will need an annual operating subsidy of \$7,962,100, or about \$2.37/1000 gallons. The subsidy would be required as long as the cost of desalinated water is more than the cost for non-desalination alternatives. The need for and the amount of a subsidy should be evaluated biennially. As desalination technology improves, the unit cost of desalinated water should decrease.

Ongoing discussions with local stakeholders revealed an interest in a seawater desalination facility that would provide 3 MGD to 4 MGD. Because of the timing of this expression of interest, an option for a facility of this size was not included in this report. However, the BRA will continue to pursue this option and will keep the TWDB informed regarding its progress.

Recognizing the benefits of seawater desalination, the federal government and several states have proposed operating subsidies for desalination plants. For the Tampa Bay facility, the State of Florida set aside an amount equal to 90 percent of the capital cost of the 25 MGD facility, up to a maximum amount of \$85 million. For the projected \$2.08/1000 gallons cost of desalinated water, an initial subsidy of \$0.50 to \$0.60/1000 gallons was proposed to yield a net price of \$1.50/1000 gallons for wholesale desalinated water. California has entered into agreements for annual subsidies of up to \$250/acre-foot. The federal government is considering bipartisan legislation that would provide subsidies for desalination facilities up to \$0.62/1000 gallons to partially offset the cost of electrical energy required to operate such facilities. These subsidies are being considered because of the benefits that the general public enjoys from the use of desalinated water.

SR.10 Implementation

Implementation of Option 5 will include several discrete tasks, as summarized below.

- Initiate pilot treatment process to validate pretreatment and component costs, provide treatment information to TCEQ, and demonstrate feasibility to stakeholders. Because EPA funding is available for this project, this step can proceed before a State subsidy is secured, providing both the project and the State of Texas with significant benefits.
- Secure necessary financial assistance so final cost of water can be determined.
- Pursue cooperative opportunities with the BWA for use of water from the desalination project.
- Negotiate a pay-for-performance contract between Poseidon and the BRA.
- Conduct required environmental and archaeological studies and obtain required permits.
- Develop water agreements between the BRA and proposed customers.
- Complete project financing for desalination project and conveyance facilities.

- Release turnkey engineering, procurement, and construction RFPs on desalination facility and conveyance facilities.