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Final Report on Five Potential Seawater Demineralization Project Sites – Task C.5

For the Seawater Demineralization Feasibility Investigation

January 23, 2004

Final Report on Five Potential Seawater Demineralization Project Sites – Task C.5

For the

Seawater Demineralization Feasibility Investigation
Contract SE459AA

by

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FINAL

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Executive Summary

As part of the St. Johns River Water Management District (SJRWMD) Water Resource Development Program, seawater demineralization is being examined as a potential means to provide future water supply within SJRWMD. SJRWMD has retained R. W. Beck to perform a feasibility analysis of seawater demineralization.

The following documents have been previously issued with respect to this study:

- Seawater Demineralization Annotated Bibliography – Task B.1
- Applicable Rules and Regulations for Seawater Demineralization - Task B.6
- Demineralization Treatment Technologies – Task B.7
- Criteria for Preliminary Screening of Areas for Potential Seawater Demineralization Facilities - Task C.1
- Ranking Matrix for Potential Seawater Demineralization Sites - Task C.2
- Identification of Favorable Sites for Feasible Seawater Demineralization – Task C.4

R. W. Beck, Inc. performed this study in conjunction with Parson Brinkerhoff Quade and Douglas, Inc. and PBSJ, Inc.

Five sites have been identified for development of conceptual designs and costs within SJRWMD for seawater demineralization. R. W. Beck and SJRWMD have identified these sites based upon the analysis described in the report titled “Identification of Favorable Sites for Feasible Seawater Demineralization – Task C.4,” dated September 11, 2003 and other preferred features and water needs.

The five sites include:

1. Indian River Power Plant (Owner: Reliant Energy Indian River, LLC)
2. Cape Canaveral Power Plant (Owner: Florida Power & Light - FPL)
3. Daytona Beach/Bethune Point Wastewater Treatment Plant (Owner: City of Daytona Beach)
4. W. E. Swoope Generating Station Power Plant (Owner: City of New Smyrna Beach)
5. Northside Power Plant (Owner: Jacksonville Electric Authority - JEA)

One of the screening and scoring factors that affects a site ranking is the location of the site within ten miles of a SJRWMD priority water resource caution area. Following completion of the Task C.4 report dated September 11, 2003, which did not include the Northside Power Plant site, the proposed priority water resource caution areas were being redefined by SJRWMD in portions of Duval and St. Johns counties. Because of the potential for the Northside Power Plant site to be within ten miles of a SJRWMD priority water resource caution area, it became a candidate for consideration as a favorable site for collocating a desalination facility. Additionally, and of greater significance, the Northside Power Plant has similar preferred site characteristics as the highly ranked Cape Canaveral Power Plant site and the Indian River Power Plant site. For these reasons, SJRWMD requested that the Northside Power Plant in Duval County be included in the five sites for conceptual design and costing. At the present time, based on subsequent evaluations, SJRWMD does not propose to identify the Duval County area as a priority water resource caution area in its 2003 water supply assessment.

This report summarizes the findings of Task C.5 of the SJRWMD contract with R. W. Beck, Inc., for the Seawater Demineralization Feasibility Investigation (Contract SE459AA) which involved the development of comparative-level cost estimates and concept designs for the five preferred sites for seawater demineralization.

Each design incorporates the following features:

- Influent pumping
- Pretreatment consisting of sand filtration and cartridge filtration
- Pretreatment chemical addition
- Demineralization consisting of reverse osmosis membranes
- Post treatment
- Concentrate management by a various methods appropriate to the specific site
- Ground storage
- Product water conveyance

The comparative project cost estimate elements include:

1. Construction
2. Land
3. Non-construction capital cost
4. Total Capital Cost (inclusive of items 1+2+3)
5. Annual O&M Cost at design capacity in $/year
6. Equivalent annual cost ($/year)
7. Unit production cost ($/kgal)

A summary of the project costs is as follows:

Table 1. Summary of Project Costs

Summary of Costs			
Indian River Power Plant			
Treatment Capacity (mgd)	10	20	30
Cost/ 1,000 Gallons	$3.06	$2.80	$2.69
Cape Canaveral Power Plant			
Treatment Capacity (mgd)	10	20	30
Cost/ 1,000 Gallons	$3.06	$2.77	$2.63
Daytona Beach/Bethune Point Wastewater Treatment Plant			
Treatment Capacity (mgd)	5	10	15
Cost/ 1,000 Gallons	$3.93	$3.32	$3.11
W. E. Swoope Generating Station			
Treatment Capacity (mgd)	5	10	15
Cost/ 1,000 Gallons	$4.93	$3.90	$3.53
Northside Power Plant			
Treatment Capacity (mgd)	10	20	30
Cost/ 1,000 Gallons	$3.12	$2.76	$2.57

The estimated unit costs of water produced in terms of $/1,000 gallon were much lower for the three sites rated for 10, 20 and 30 mgd capacity (Cape Canaveral, Indian River Power Plant and Northside Power Plants) than those for the two sites rated for 5, 10 and 15 mgd capacity (W. E. Swoope Generating Station and Daytona Beach/Bethune Point Wastewater Treatment Plant). The Northside Power Plant site yielded the lowest at 20 and 30 mgd. The Indian River Power Plant and Cape Canaveral Power Plant sites yielded the lowest estimated costs for water produced at a 10 mgd capacity. The unit costs ranged from $3.12/1000gal to $2.57/1000gal for the Northside Power Plant site. The unit costs ranged from $3.06/1000gal to $2.69/1000gal for the Indian River Power Plant site. The unit costs ranged from $3.06/1000gal to $2.63/1000gal for the Cape Canaveral Power Plant site.

The W. E. Swoope Generating Station site yielded the highest estimated unit costs for water produced at lower capacities. The W. E. Swoope Generating Station unit costs ranged from $4.93/1000gal to $3.53/1000gal. Higher costs are expected on a delivered water cost ($/1000 gallon) basis for a smaller capacity facility. However, other factors contributing to the higher costs for this facility are related to the separate concentrate discharge pipeline outfall to the ocean. This re-affirms the cost savings associated with blending the concentrate with available power plant cooling water discharges where feasible.

Additionally, conceptual level costs are expected to be higher and are not comparable to actual bid dollars or estimates based on detailed design.

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Introduction

Purpose and Scope

As part of its water supply planning efforts, the St. Johns River Water Management District (SJRWMD) retained R. W. Beck, Inc., to perform a feasibility investigation for potential siting of seawater demineralization facilities (Contract SE459AA). The objectives of the project are to examine various potential sites within SJRWMD, screen the sites based on selected criteria, narrow the potential sites to the top five preferred sites and develop conceptual designs and comparative-level cost estimates for possible development of a seawater demineralization facility. Task C.5 includes the development of comparative-level cost estimates and concept designs for five preferred sites for seawater demineralization.

SJRWMD retained R. W. Beck to examine the viability of seawater demineralization with an emphasis on finding sites that offer distinct advantages through collocation with other facilities. The study, a multi-step process, includes:

- Development of site selection criteria to use in developing a preliminary list of up to 20 candidate sites for seawater demineralization facilities. Sites considered included those that offered opportunities for collocation with existing facilities, such as power or wastewater treatment plants. The study also considered undeveloped sites when there were apparent economic, environmental or social advantages to these locations
- Development of a ranking matrix to prepare a final site list for up to five seawater demineralization facilities deemed most feasible
- Preparation of concept level design and a comparative project cost estimate for each of the top five sites

The up-to-20 candidate sites were previously identified in the report titled "Identification of Favorable Sites for Feasible Seawater Demineralization – Task C.4," dated September 11, 2003. Subsequently, the list of sites to be considered for concept design and comparative cost estimating was modified to reflect SJRWMD's recently modified Priority Water Resource Caution Areas and other siting preferences relating to once-through cooling power plants.

Concept designs and conceptual costs were developed for the following potential seawater demineralization sites:

1. Cape Canaveral Power Plant (Owner: FPL)
2. Indian River Power Plant (Owner: Reliant Energy Indian River, LLC)
3. W. E. Swoope Generating Station Power Plant (Owner: City of New Smyrna Beach)
4. Northside Power Plant (Owner: JEA)

5. Daytona Beach/Bethune Point Wastewater Treatment Plant (Owner: City of Daytona Beach)

Figure 1 shows these sites.

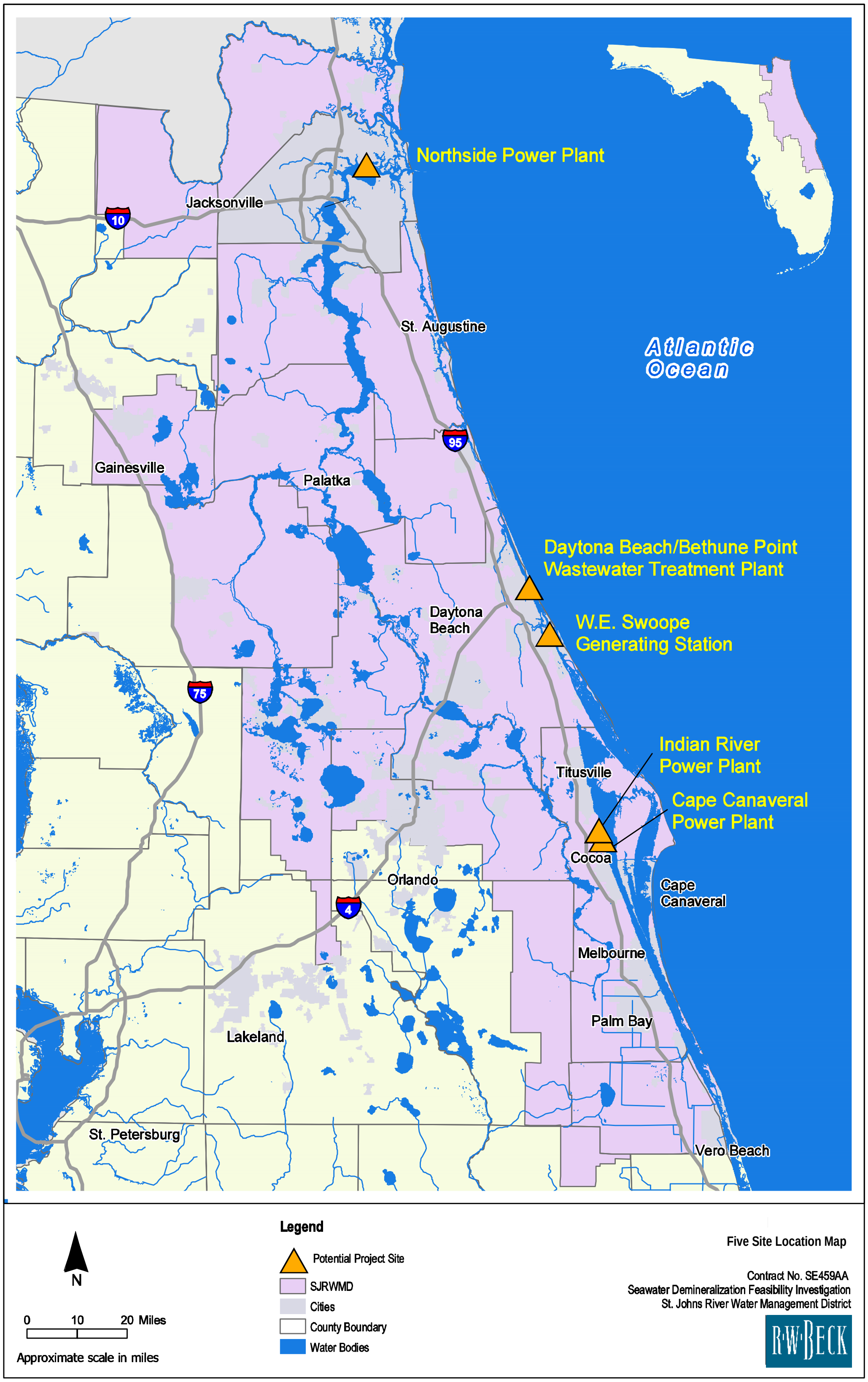


Figure 1. Five-site Location Map

Background

As part of the SJRWMD Water Resource Development Program, SJRWMD is exploring various alternative water supply options that could increase the quantity of water resources available to help satisfy the future water needs of SJRWMD.

With the recent cost performance of large scale seawater demineralization processes around the world, SJRWMD has identified seawater demineralization as a potentially significant source of water supply to meet projected 2020 demands and beyond. Recent applications of seawater demineralization have demonstrated the benefits of collocating these facilities with other facilities such as power plants.

This report presents the evaluation of the five preferred sites, including:

- Process elements and site layout
- Estimated construction costs for various capacities
- Estimated operation and maintenance costs at various capacities

Summary of Methodology for Selection of Sites

Identification of the top sites for seawater demineralization involved a multi-step process including data collection, followed by initial screening, macro screening of sites and creation of a ranking matrix.

A description of the screening process is included in the report titled “Identification of Favorable Sites for Feasible Seawater Demineralization – Task C.4,” dated September 11, 2003.

Initial screening consisted of determining demineralization project boundaries within SJRWMD’s physical boundaries and the development of an initial site list. Acceptable areas for siting a demineralization project meet the following criteria:

- Source waters located within SJRWMD and
- Source waters with a salinity greater than 20 parts per thousand (ppt)

The prospective sites the study considered for application of macro-screening criteria included wastewater plants, power plants, and undeveloped sites. Fifty-six prospective sites were candidates for evaluation using the macro screening criteria.

Preliminary or macro level screening of sites was accomplished using preliminary (macro-level) screening measures for siting seawater demineralization facilities within the coastal areas of the SJRWMD.

Ranking of the sites represented the second step in the screening process. The evaluation applied the macro-screened sites to a ranking matrix to establish a list of five preferred sites for seawater demineralization facilities.

The criteria developed for the ranking matrix represents an expansion of the initial criteria developed for the macro-level screening, plus additional secondary site-specific criteria and a criteria-weighting system. Scoring of the various criteria, when combined with the weighting system established an overall ranked score for each site. The top six sites as ranked in C.4 included:

1. Indian River Power Plant (Owner: Reliant Energy Indian River, LLC)
2. Cape Canaveral Power Plant (Owner: FPL)
3. Daytona Beach/Bethune Point Wastewater Treatment Plant (Owner: City of Daytona Beach)
4. BCUD/South Beaches Waste Water Treatment Plant (Owner: Brevard County)
5. W. E. Swoope Generating Station Power Plant (Owner: City of New Smyrna Beach)
6. BCUD/Sykes Creek Regional Waste Water Treatment Facility (Owner: Brevard County

The Task C.4 report describes in detail the application of the criteria and the ranking of sites.

Selection of Five Sites for Conceptual Design and Costing

One of the screening and scoring factors that affect a site ranking is the location of the site within ten miles of a SJRWMD priority water caution area. At the time of the completion of the Task C.4 report, the SJRWMD priority water caution area designation was in draft form. Following completion of the recent report dated September 11, 2003, the proposed priority water resource caution areas were redefined by SJRWMD to include additional areas, including portions of Duval and St. Johns counties.

One of the screening and scoring factors that affects a site ranking is the location of the site within ten miles of a SJRWMD priority water resource caution area. Following completion of the Task C.4 report dated September 11, 2003, which did not include the Northside Power Plant site, the proposed priority water resource caution areas were being redefined by SJRWMD in portions of Duval and St. Johns counties. Because of the potential for the Northside Power Plant site to be within ten miles of a SJRWMD priority water resource caution area, it became a candidate for consideration as a favorable site for collocating a desalination facility. Additionally, and of greater significance, the Northside Power Plant has similar preferred site characteristics as the highly ranked Cape Canaveral Power Plant site and the Indian River Power Plant site. For these reasons, SJRWMD requested that the Northside Power Plant in Duval County be included in the five sites for conceptual design and costing. At the present time, based on subsequent evaluations, SJRWMD does not propose to identify the Duval County area as a priority water resource caution area in its 2003 water supply assessment.

The W. E. Swoope Generating Station site has generated some local interest as a potential seawater demineralization site. Taking this and the site’s high ranking score into account, SJRWMD requested that this site be included in the five sites for conceptual design and costing. The remaining sites to be included in the five sites for conceptual design and costing include the top three ranked sites as identified in C.4.

Conceptual Designs

Conceptual designs have been prepared for the following five potential seawater demineralization projects:

1. Indian River Power Plant (Owner: Reliant Energy Indian River, LLC)
2. Cape Canaveral Power Plant (Owner: FPL)
3. Daytona Beach/Bethune Point Wastewater Treatment Plant (Owner: City of Daytona Beach)
4. W. E. Swoope Generating Station Power Plant (Owner: City of New Smyrna Beach)
5. Northside Power Plant (Owner: JEA)

Each concept design incorporates the following features:

- Influent pumping
- Pretreatment consisting of sand filtration and cartridge filtration
- Pretreatment chemical addition
- Demineralization consisting of reverse osmosis membranes
- Post treatment
- Concentrate management by a various methods appropriate to the specific site
- Ground storage
- Product water conveyance

General Assumptions

The study applied the following general assumptions universally to all sites in generating conceptual costs of a seawater demineralization facility:

- Product storage tanks are included at the demineralization facility site. Tank capacity is equal to one-half days production
- The demineralization plants will be developed in phases corresponding to the three capacities requested by SJRWMD
- Intake and discharge pipelines will be installed in phases corresponding with demineralization facility expansions (per 5 or 10 mgd increments)
- The transmission pipeline for product water delivery will extend to the nearest large capacity water treatment plant with a 5 mgd average daily flow minimum in an area with projected water supply deficits

- Product water quality will meet State of Florida Primary and Secondary Drinking water standards, with further reduction of chloride concentration to 125 parts per million (ppm)
- The plant will be designed with 15% peaking factor for a total capacity of 115% of Average Daily Flow (ADF)
- The design will also provide redundancy for all plant pumping systems excluding the membrane and pretreatment process trains
- If a site has a once through cooling water power plant, the design assumes collocation and blending with cooling water discharge is feasible
- Non-interruptible industrial power rates in effect at the time of the C.5 report are used
- Demineralization plant operation is 365 days/year, 24 hours/day
- Pretreatment uses sand filters
- Demineralization uses reverse osmosis membranes
- Life of the reverse osmosis membranes is 5 years
- High-service product-water pump station is included in costs to deliver water to closest water transmission system or water treatment plant where the study identified a deficit in Task C.4 at water treatment plants greater than 5 mgd
- The design provides no back-up power generation. Battery back-up for the SCADA computer system will be included
- Feed pump efficiency will be 87%
- Second pass feed pump (where required) efficiency will be 80%
- Energy-recovery turbine efficiency will be 86%
- Motor efficiency will be 93%
- User will finance capital costs at 5% annual percentage rate (APR) over 20 years and amortize equipment at 5% APR over 20 years

Cape Canaveral Power Plant Site

Site Description

The Cape Canaveral Power Plant is a once-through cooled power plant located in northern Brevard County, Florida. The facility is owned by Florida Power and Light Company. The existing capacity of the facility is 804 megawatts. This facility presents collocation opportunities including use of the existing cooling water for source water and discharge of concentrate.

Existing Conditions

The Cape Canaveral Power Plant site is on the western shoreline of the Indian River Lagoon between the cities of Cocoa and Titusville. This portion of the Indian River Lagoon is referred to as Segment 1C pursuant to the segmentation scheme developed by the Indian River Lagoon National Estuary Program.

Water depths in the vicinity of the site generally range from 1-2 ft mean low water (MLW) near the shoreline to 8-9 ft MLW in the natural channel running north-south in this segment of the Indian River Lagoon. The dredged Intracoastal Waterway (ICW) channel runs down the approximate middle of the natural channel. The control depth of the ICW is 12 ft MLW. The ICW is located approximately 3,000 ft east of the site. There is an existing navigation channel extending westward from the ICW to the site. The control depth of this channel was not determined but is assumed to be at least 12 ft MLW similar to the ICW. Figure 2 shows bathymetry in the site vicinity.

This segment of the Indian River Lagoon is relatively far removed from coastal passes that allow for tidal exchange and flushing with the Atlantic Ocean. The closest coastal pass is Port Canaveral Inlet, a hydraulic flow distance of over 18 miles. There are no major freshwater inflows to this segment of the Lagoon; however, freshwater is delivered seasonally via numerous minor tributaries and drainage ditches. Consequently, the ambient salinity in this segment is relatively high despite the long hydraulic flow distance to the closest ocean pass. Water quality data collected by SJRWMD over a period of record of January 1987 through May 2002 indicate that salinity in this vicinity of the Indian River Lagoon ranged from a low of 13 ppt to a high of 37 ppt, with a mean annual salinity of 24.8 ppt. The frequency distribution of the data indicates that salinity exceeded 33 ppt less than 5 percent of the time.

The shoreline on the site is hardened (e.g., concrete rubble), however, dense mangrove growth occurs along nearby shoreline areas and spoil islands. Shallow tidal flats occur immediately adjacent to the site. Sparse sea grass growth (predominantly Halodule wrightii) is reported to exist in the north and central portions of the Indian River Lagoon (IRL SWIM Plan Update, SFWMD 2003).

Environmental Opportunities and Constraints

The Cape Canaveral Power Plant site is an existing developed industrial site with an NPDES permit to withdraw once-through cooling water and to discharge a slightly heated effluent. These features offer significant engineering, economic, and regulatory opportunities for seawater demineralization plant development. The most significant environmental constraints at this site are the shallow natural depths in the immediate vicinity of the site, as well as potentially poor tidal flushing due to the relatively long hydraulic flow distance to the closest ocean pass. As part of the permitting process or a next phase of work, the dilution and flushing of the concentrate discharge would likely need to be modeled under worst-case conditions to ensure adequate design for optimal dispersion and to verify minimal salinity changes at the discharge point.

Due to the shallow natural depths in the area, regulatory agencies could require the extension of a submerged concentrate disposal pipeline eastward to the ICW to better facilitate efficient dilution and flushing of the concentrate discharge. If this is the case, the pipeline would likely need to be buried within the deepest portion of the existing east-west navigation channel leading to the site to minimize potential navigational hazards. Dredge and fill activities associated with the construction of such a pipeline could also potentially result in adverse impacts to shallow benthic habitats, and such impacts would be scrutinized and balanced in the permitting process. With these potential regulatory constraints, other means of concentrate management such as deep well injection or open ocean disposal should be explored in future planning efforts.

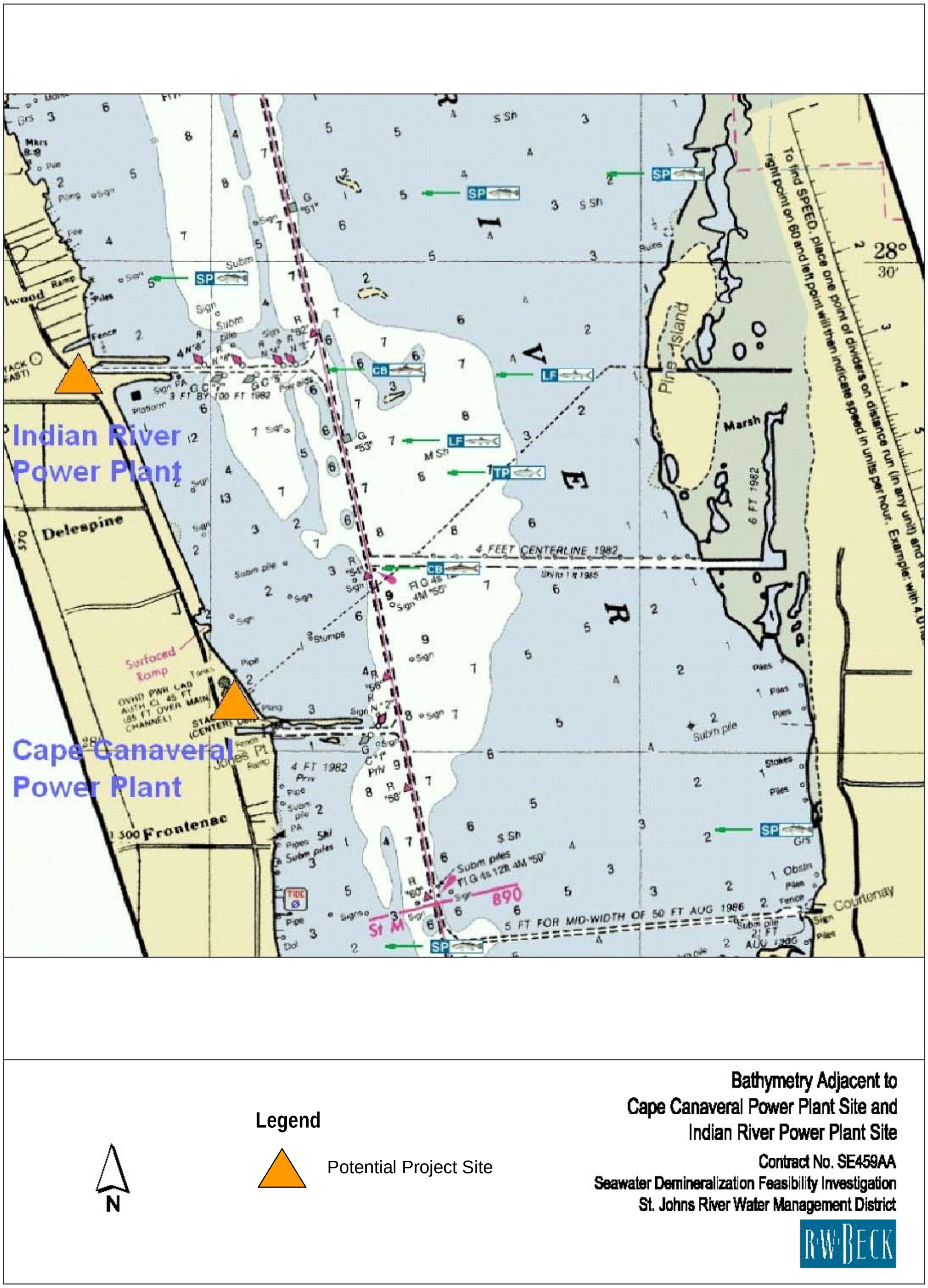


Figure 2. Bathymetry Adjacent to the Cape Canaveral Plant Site and Indian River Power Plant Site

Design Approach

A conceptual design for 10, 20 and 30 mgd capacities for a seawater demineralization plant was developed for the Cape Canaveral Power Plant site. Proposed plant capacities are based upon a range of potential water needs of local communities as defined by SJRWMD. See Figure 4 for a site location map. The concept design approach is based on an initial plant capacity of 10 mgd, followed by subsequent expansions to 20 mgd and then 30 mgd.

SJRWMD provided water quality data for several existing sampling locations in the Indian River Lagoon, near the power plant sites. Researchers compiled the data over a 15-year period and this is considered representative of seasonal variations in water quality. The station labeled IRL110 is closest to this power plant site, and it showed salinities ranging from a low of 13 ppt to a high of 37 ppt. The frequency distribution of the data indicates that salinity exceeded 33 ppt less than 5 percent of the time. Therefore, the projections used standard seawater at 34.4 ppt as the design source for water salinity.

Review of photos and aerial maps of the sites indicated that there is an area of about 8 acres available for the seawater demineralization plant at this location. The seawater demineralization plant conceptual design includes a 15% peaking capacity, which results in a reverse osmosis membrane plant capable of producing 11.5 mgd initially, and then 23 mgd and 34.5 mgd after the expansions. Splitting the capacity into trains of 3.833 mgd capacity and providing standby pumps where practical provides redundancy. This includes the source water intake pumping system, high service product water pumping system, and feed water transfer pumping station.

For pretreatment, the conceptual design incorporates conventional gravity sand filtration, which has been used successfully at seawater demineralization plants around the world. Recently, gravity sand filtration has been used successfully at the 28 mgd Trinidad desalination plant. The Tampa Bay Seawater desalination project utilizes a proprietary non-gravity (up-flow) sand filtration process.

An alternative to sand filtration for pretreatment is membrane micro-filtration, which has not been demonstrated on any large seawater seawater demineralization plants to date. The capital costs for membrane pretreatment are projected to typically be more expensive than gravity sand filtration pretreatment. Currently there is limited available and verifiable full-scale performance and cost data on membrane micro-filtration operation. In the absence of membrane micro-filtration specific pilot testing operational performance data, an estimate for the delivered water cost ($/1,000 gallons), inclusive of both capital and O&M costs, cannot be reliably estimated.

In any project that moves forward, careful consideration and design of pilot studies will be necessary to select the optimum pretreatment technology for a specific source water. The pilot study will be the key to determining if sufficient life cycle cost benefits may be realized with membrane micro-filtration pretreatment on specific source waters from the

extension of the useful life of the reverse osmosis membranes and reduced pretreatment chemical usage.

For product water delivery, routing was considered to be to the largest water demand centers in proximity to the site, where water supply deficits are projected. For the Cape Canaveral Power Plant site, routing was chosen to go to the Titusville Morning Dove Water Treatment Plant (WTP). Routing of the product water line was assumed to run along major thoroughfares and existing easements. The use of existing mains and intermediate water delivery points should be explored as part of facility planning for these communities. Figure 3 shows an approximate routing of the product water main for the Cape Canaveral Power Plant site.

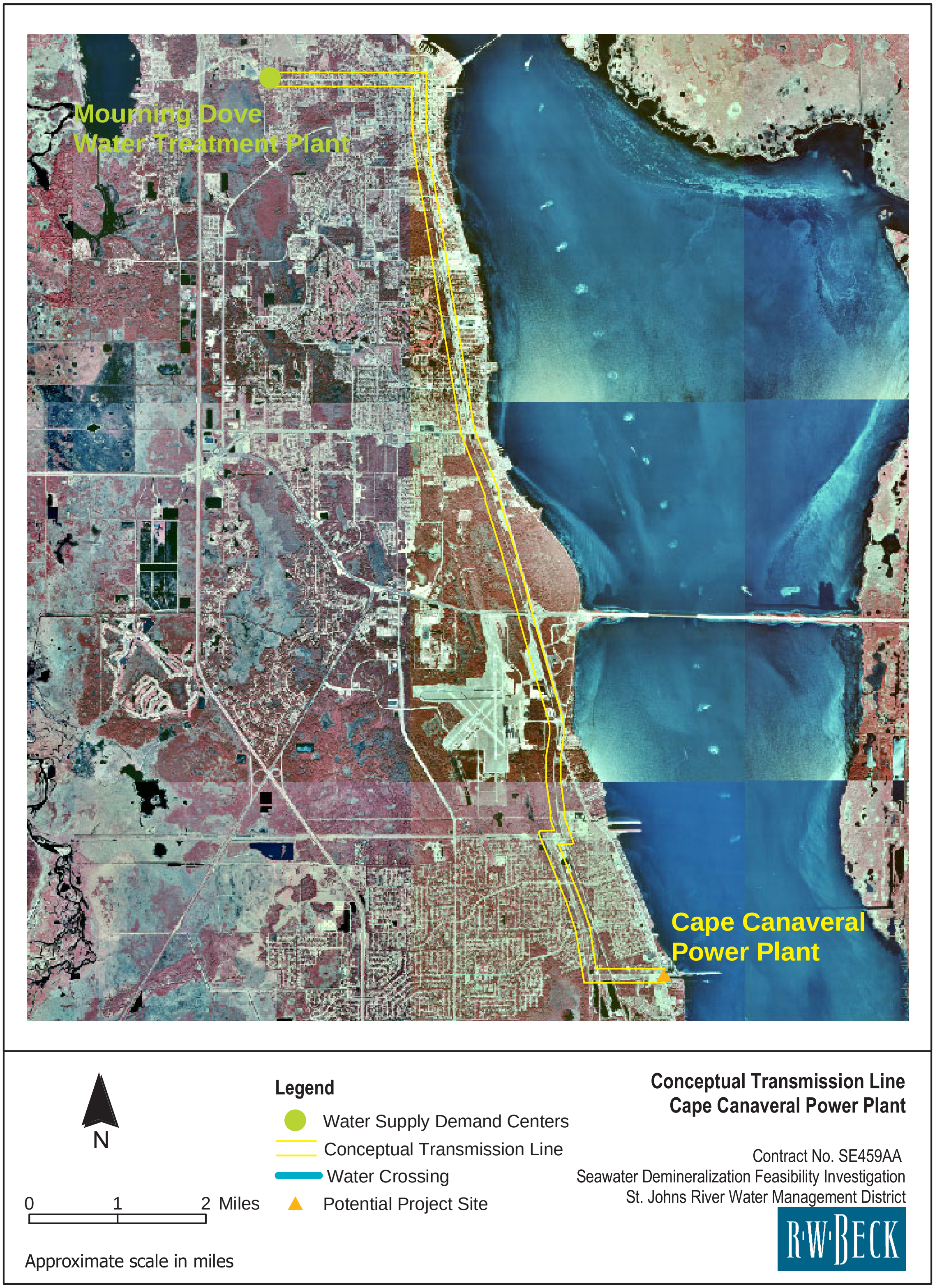


Figure 3. Conceptual Transmission Line - Cape Canaveral Power Plant

Specific Assumptions

The study applies specific assumptions for individual sites in order to develop the concept designs and comparison-level costs. These specific assumptions for this site are:

- Power rate of $0.0532/kWHr (published GSLDT-3 rate from FPL for estimated load)
- Power plant downtime of 5% (estimated) The seawater demineralization plant is intended to be run continuously using power from the grid and operation of the power plant's cooling water intake pumps for feed and dilution water
- Plant to be constructed on open land identified as available
- The design will use power plant cooling water discharge for demineralization source water
- Concentrate discharge will be blended with power plant cooling water discharge
- Cooling water temperature range of 15ºC (59ºF) to 40ºC (104ºF) will cover 95% of the expected variations in feed water temperature. Hotter temperatures are not likely, but cooler temperatures may occur occasionally, which would reduce production capacity

Flow Rates and Recoveries

The concept design for the Cape Canaveral Power Plant site consists of three trains for the 10 mgd plant, six trains for the 20 mgd plant and nine trains for 30 mgd plant. Each first pass train will require 139 pressure vessels of seven seawater reverse osmosis elements each. Each second pass train will require 31 pressure vessels of seven brackish water reverse osmosis elements each.

See Figures 5 and 6 for conceptual design layout and process flow schematics for each site.

When the feed water from the power plant is the warmest and tempered by mixing with cooling water to the maximum design temperature, at 100ºF, it is necessary to use a 2-pass reverse osmosis plant to reduce the chloride concentration to 125 ppm.

The feed water temperature will normally range from 59 to 104ºF. This temperature range will cover at least 90% of the time based on historical data. Cooling water will only be used when the temperature exceeds 100ºF. If the feed water temperature is 104ºF and the cooling water temperature is 89ºF (15 degree rise) then each 3.833 mgd train will use 7.36 mgd (5,108 gpm) of feed water and 2.68 mgd (1,857 gpm) of cooling water. If the raw water temperature is 98ºF and the discharged power plant cooling water is 120ºF (worst case reported for month of August 2002), then each train will use 9.12 mgd (6,331 gpm) of feed water and only 0.91 mgd (634 gpm) of cooling water. RO plants can actually operate at temperatures as high as 113ºF; however, membrane based micro-filtration pretreatment systems are limited to 104ºF. Operating the first pass at a 40% recovery yields a product with a chloride concentration of 151 ppm. Approximately one-fifth of the first pass product runs through the second pass at an 85% conversion yielding permeate with a chloride concentration of about 5.9 ppm. The remaining first pass product blends with the second pass product to obtain a blended product with a chloride concentration of about 125 ppm. To obtain 11.5 mgd in three trains requires a feed to each train of 6,879 gpm. The high pressure feed pumps must handle 6,879 gpm at 789 psig. The second pass pumps must handle 599 gpm at 136 psig. The overall recovery is approximately 38.7%. The typical power consumption at the elevated temperature is approximately 14.57 kWh/kgal.

When the feed water is the coldest, 59ºF, a single pass seawater reverse osmosis plant can produce a chloride concentration of 79 ppm at 44% conversion. To produce 11.5 mgd in three trains requires a feed to each train of 6,050 gpm. The high pressure feed pumps must be capable of delivering this flow at 998 psig. The overall recovery is 44%. The power consumption at the low temperature is approximately 16.6 kWh/kgal.

The energy costs for the seawater demineralization plant are based on annual average energy usage. The average estimated energy usage is based on an assumed average operating temperature of 100ºF the majority of the time (95% of the time for the Canaveral site). The remaining 5% of the time, the temperature is assumed to be at 77ºF. Further analysis of years of actual operating data from this power plant before preliminary design of a seawater demineralization plant at this location should be performed.

Concentrate Management

Concentrate would be disposed of through the existing cooling water discharge from the power plant. Based on data provided by the power plant, the Cape Canaveral Power Plant cooling water flows typically range from 513 to 751 mgd on a monthly average basis. For the concept design operating case of 38.85% overall conversion of the RO system and a 30 mgd product water capacity, using the 513 mgd cooling water rate at a TDS concentration of 34,400 ppm, the concentrate flow rate would be 47.22 mgd at a TDS concentration of 56,200 ppm. The feed water flow required would be 77.22 mgd, leaving the available cooling water for dilution at 435.78 mgd. The blended concentrate discharge flow would be approximately 483 mgd at a TDS concentration of 36,531 ppm, which is a 6.2% increase in TDS, which proportionally corresponds with chloride levels. This would be the worst-case scenario combining the maximum plant capacity with the minimum cooling water flow rate. This is less than the 10% increase in chlorides regulated under Chapter 63-302 of the Florida Administrative Code which is administered by the Florida Department of Environmental Protection.

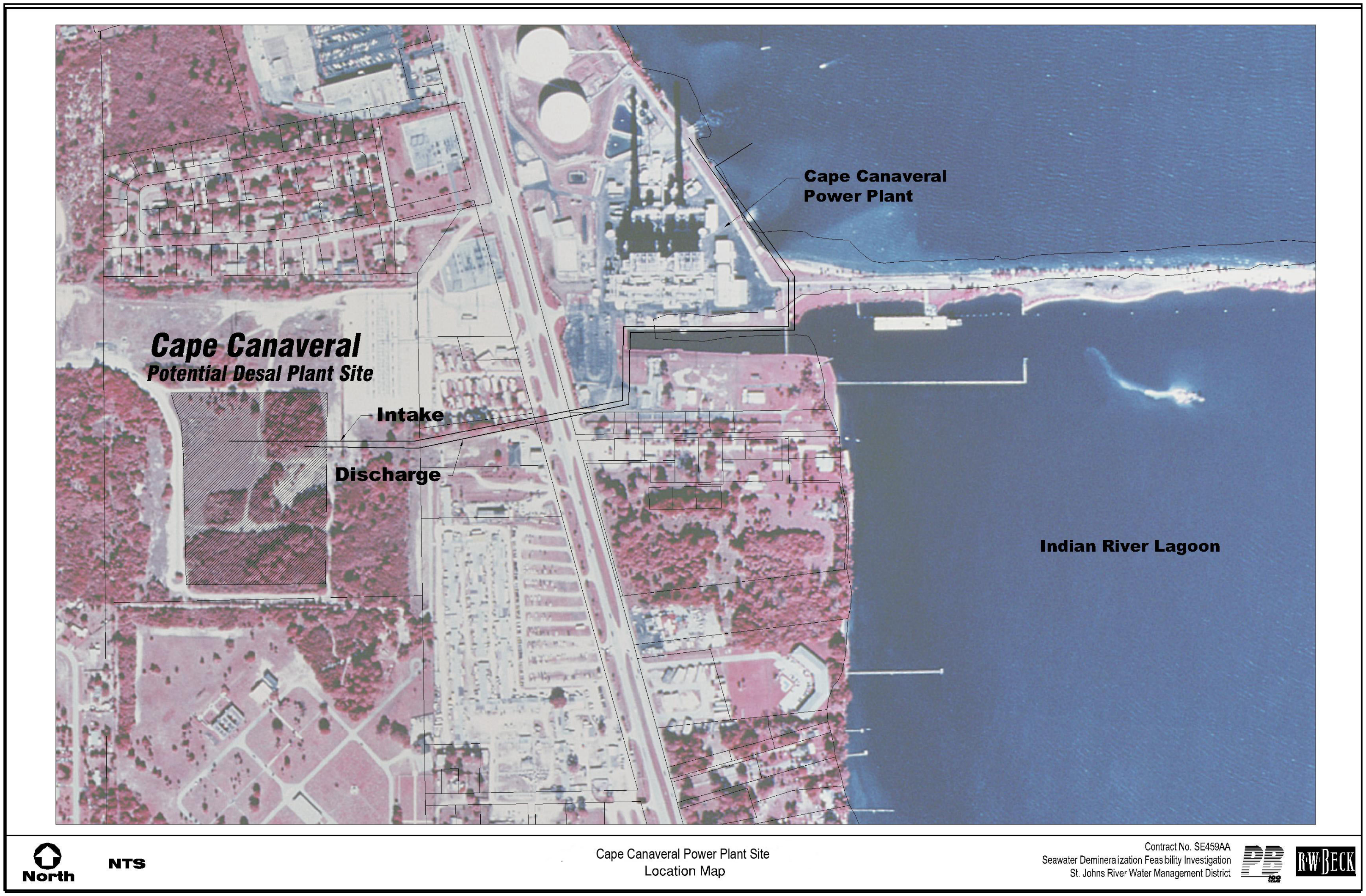
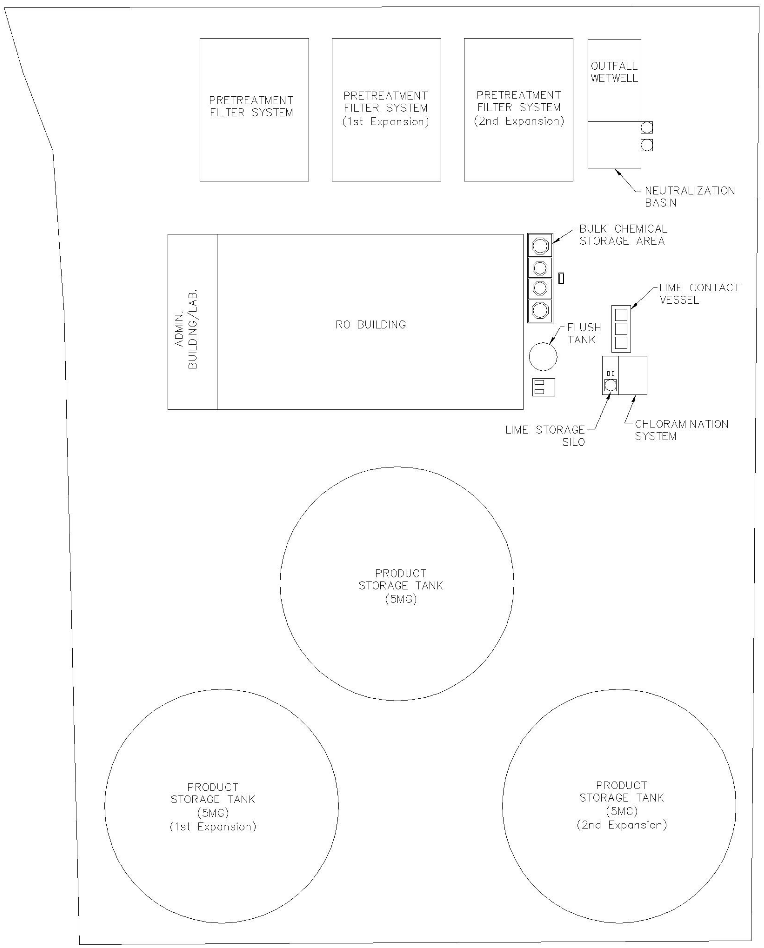


Figure 4. Cape Canaveral Power Plant Site Location Map



Equipment	Initial	1st Expansion	2nd Expansion
Feed intake Pump Units	3	5	7
Pretreatment Train Units	3	6	9
Cartridge Filter Housing Units	3	5	7
1st Pass RO Train Units	3	6	9
2nd Pass RO Train Units	3	6	9
Product Booster Pump Units	3	5	7

North

Cape Canaveral Power Plant Conceptual Site Plan
(10/20/30 MGD)

Contract No. SE459AA
Seawater Demineralization Feasibility Investigation
St. Johns River Water Management District

Figure 5. Cape Canaveral Power Plant Conceptual Site Plan

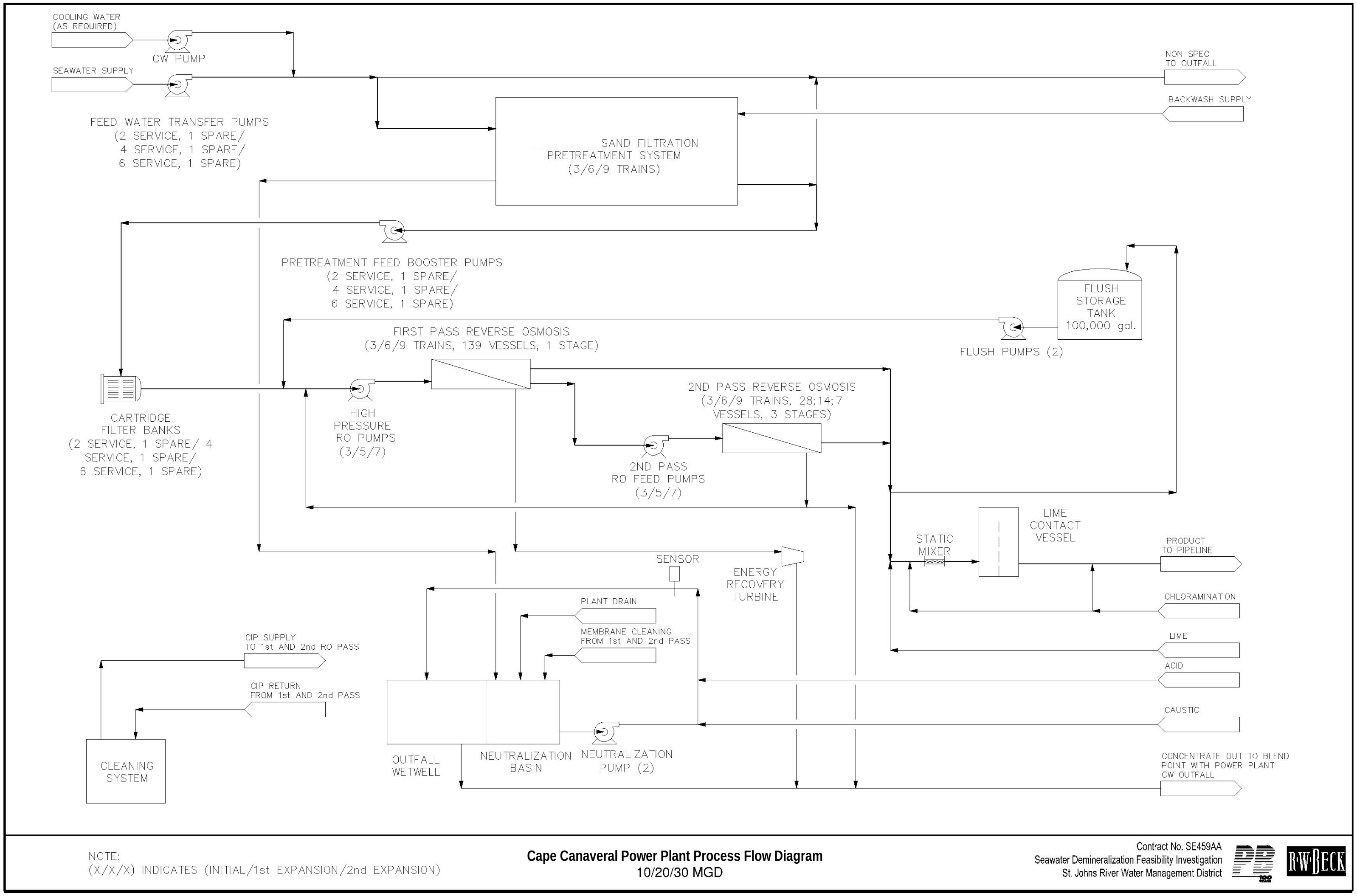


Figure 6. Cape Canaveral Power Plant Process Flow Diagram

Alternative Configurations

While many configurations are available, the close proximity of the Indian River Power Plant to the Cape Canaveral Power Plant may provide additional options. The siting of a seawater demineralization facility between the two plants, or at one or the other site, with use of both plants' intakes and discharges may provide unique advantages including additional reliability or operating time when one facility is offline. However, this type of configuration may also be a disadvantage due to additional permitting, confusion of responsibility in the case of violations, and reduction of power selling incentives.

Indian River Power Plant Site

Site Description

The Indian River Power Plant is a once-through cooled power plant located in northern Brevard County. The facility is owned by Reliant Energy Indian River, LLC. The existing capacity of the facility is 981 megawatts. This facility presents collocation opportunities including use of the existing cooling water for source water and discharge of concentrate. Figures 7, 8, 9 and 10 show various views of the project site.

Existing Conditions

The Indian River Power Plant site is located on the western shoreline of the Indian River Lagoon between the cities of Cocoa and Titusville. This site is located approximately one nautical mile north of the Cape Canaveral Power Plant site, therefore, virtually all of the opportunities and constraints discussed for the latter site apply to the Indian River Power Plant site. This portion of the Indian River Lagoon is referred to as Segment 1C pursuant to the segmentation scheme developed by the Indian River Lagoon National Estuary Program.

Water depths in the vicinity of the site generally range from 1-2 ft mean low water (MLW) near the shoreline to 8-9 ft MLW in the natural channel running north-south in this segment of the Indian River Lagoon. The dredged Intracoastal Waterway (ICW) channel runs down the approximate middle of the natural channel. The control depth of the ICW is 12 ft MLW. The ICW is located approximately 4,000 ft east of the site. There is an existing navigation channel extending westward from the ICW to the site. The control depth of this channel was not determined but is assumed to be at least 12 ft MLW, similar to the ICW.

This segment of the Indian River Lagoon is relatively far removed from coastal passes that allow for tidal exchange and flushing with the Atlantic Ocean. The closest coastal pass is Port Canaveral Inlet, which is a hydraulic flow distance of approximately 17 nautical miles. There are no major freshwater inflows to this segment of the lagoon; however, freshwater is delivered seasonally via numerous minor tributaries and drainage ditches. Consequently, the ambient salinity in this segment is relatively high despite the long hydraulic flow distance to the closest ocean pass. Water quality data collected by SJRWMD over a period of record of January 1987 through May 2002 indicate that salinity in this vicinity of the Indian River Lagoon ranged from a low of 13 ppt to a high of 37 ppt, with a mean annual salinity of 24.8 ppt. The frequency distribution of the data indicates that salinity exceeded 33 ppt less than 5 percent of the time.

The shoreline on the site is hardened (e.g., concrete rubble, rip-rap), however, dense mangrove growth occurs along nearby shoreline areas and spoil islands. Shallow tidal flats occur immediately adjacent to the site. Sparse sea grass growth (predominantly

Halodule wrightii) is reported to exist in the north and central portions of the Indian River Lagoon (IRL SWIM Plan Update, SFWMD, 2003).

Environmental Opportunities and Constraints

The Indian River Power Plant site is an existing developed industrial site with an NPDES permit to withdraw once-through cooling water and to discharge a slightly heated effluent. These features offer significant engineering, economic, and regulatory opportunities for seawater demineralization plant development. The most significant environmental constraints at this site are the shallow natural depths in the immediate vicinity of the site, as well as potentially poor tidal flushing due to the relatively long hydraulic flow distance to the closest ocean pass. As part of the permitting process or a next phase of work, the dilution and flushing of the concentrate discharge would likely need to be modeled under worst-case conditions to ensure adequate design for optimal dispersion and to verify minimal salinity changes at the discharge point.

Due to the shallow natural depths in the area, regulatory agencies could require the extension of a submerged concentrate disposal pipeline eastward to the ICW to better facilitate efficient dilution and flushing of the concentrate discharge. If this is the case the pipeline would likely need to be buried within the deepest portion of the existing east-west navigation channel leading to the site to minimize potential navigational hazards. Dredge and fill activities associated with the construction of such a pipeline could also potentially result in adverse impacts to shallow benthic habitats, and such impacts would be scrutinized and balanced in the permitting process. With these potential regulatory constraints, other means of concentrate management such as deep well injection or open ocean disposal should be explored in future planning efforts.

Figure 7. Indian River Power Plant Open Space looking West - View #1

Figure 8. Indian River Power Plant Open Space looking West - View #2

Figure 9. Indian River Power Plant Open Space Looking East

Figure 10. Indian River Power Plant Intake and Discharge Configuration

Design Approach

As requested by SJRWMD, the study developed a conceptual design for 10, 20 and 30 mgd capacities for a potential seawater demineralization plant to be located on the Indian River Power Station site. Proposed plant capacities are based upon a range of potential water needs of local communities as defined by SJRWMD. See Figure 12 for a site location map. The concept design approach used an initial plant capacity of 10 mgd, followed by subsequent expansions to 20 mgd and then 30 mgd.

SJRWMD provided water quality data for several existing sampling locations in the Indian River Lagoon, near the respective power plant sites. Researchers compiled the data over a 15-year period and the study considers it representative of seasonal variations in water quality. The station labeled IRL110 is closest to this power plant site, and it showed salinities ranging from a low of 13 ppt to a high of 37 ppt. The frequency distribution of the data indicates that the salinity only exceeded 33 ppt for 4% of the samples. Therefore, the projections used standard seawater at 34.4 ppt as the design source for water salinity.

Review of photos and aerial maps of the sites indicated that there is an area of about 8 acres available for the seawater demineralization plant at this location. The seawater demineralization plant conceptual design includes a 15% peaking capacity, which results in a reverse osmosis membrane plant capable of producing 11.5 mgd initially, and then 23 mgd and 34.5 mgd after the expansions. Splitting the capacity into trains of 3.833 mgd capacity and providing standby pumps where practical provides redundancy. This includes the source water intake pumping system, high service product water pumping system, and feed water transfer pumping station.

For pretreatment, the conceptual design incorporates conventional gravity sand filtration, which has been used successfully at seawater demineralization plants around the world. Recently, gravity sand filtration has been used successfully at the 28 mgd Trinidad desalination plant. The Tampa Bay Seawater desalination project utilizes a proprietary non-gravity (up-flow) sand filtration process.

An alternative to sand filtration for pretreatment is membrane micro-filtration, which has not been demonstrated on any large seawater desalination plants to date. The capital costs for membrane pretreatment are projected to typically be more expensive than gravity sand filtration pretreatment. Currently there is limited available and verifiable full-scale performance and cost data on membrane micro-filtration operation. In the absence of membrane micro-filtration specific pilot testing operational performance data, an estimate for the delivered water cost ($/1,000 gallons), inclusive of both capital and O&M costs, cannot be reliably estimated.

In any project that moves forward, careful consideration and design of pilot studies will be necessary to select the optimum pretreatment technology for a specific source water. The pilot study will be the key to determining if sufficient life cycle cost benefits may be realized with membrane micro-filtration pretreatment on specific source waters from the

extension of the useful life of the reverse osmosis membranes and reduced pretreatment chemical usage.

For product water delivery, routing was considered to be to the largest water demand center in proximity to the site. For Indian River Power Plant site, routing was chosen to go to the Titusville Morning Dove WTP. Routing of the product water line was assumed to run along major thoroughfares and existing easements. The use of existing mains and intermediate water delivery points should be explored as part of facility planning for these communities. Figure 11 shows an approximate routing.

Figure 11. Conceptual Transmission Line Indian River Power Plant

Specific Assumptions

The study applies specific assumptions for individual sites in order to develop the concept designs and comparison-level costs. The specific assumptions for this site are:

- Power rate of $0.0532/kWHr (published GSLDT-3 rate from FPL for estimated load)
- Power plant downtime of 10% (This is based on historical data and considering the power demand of the seawater demineralization plant since this is a peaking facility. The seawater demineralization plant is intended to be operated continuously using power from the grid and operating the power plant's cooling water pumps for feed and dilution water as needed.)
- The design will use power plant cooling water discharge for demineralization source water
- Concentrate discharge blended with power plant cooling water discharge

Flow Rates and Recoveries

The concept design for the Indian River Power Plant site consists of three trains for the 10 mgd plant, six trains for the 20 mgd plant and nine trains for 30 mgd plant. Each first pass train will require 139 pressure vessels of seven seawater reverse osmosis elements each. Each second pass train will require 31 pressure vessels of seven brackish water reverse osmosis elements each.

When the feed water from the power plant is the warmest and tempered by mixing with cooling water to the maximum design temperature, at 100ºF, it is necessary to use a 2-pass reverse osmosis plant to reduce the chlorides concentration to 125 ppm. Operating the first pass at a 40% recovery yields a product of a chloride concentration of 151 ppm. Approximately one fifth of the first pass product runs through the second pass at an 85% conversion yielding permeate with a chloride concentration of about 5.9 ppm. The remaining first pass product blends with the second pass product to obtain a blended product with a chloride concentration of about 125 ppm. To obtain 11.5 mgd in three trains requires a feed to each train of 6,879 gpm. The high pressure feed pumps must handle 6,879 gpm at 789 psig. The second pass pumps must handle 599 gpm at 136 psig. The overall recovery is approximately 38.7%. The typical power consumption at the elevated temperature is approximately 14.57 kWh/kgal.

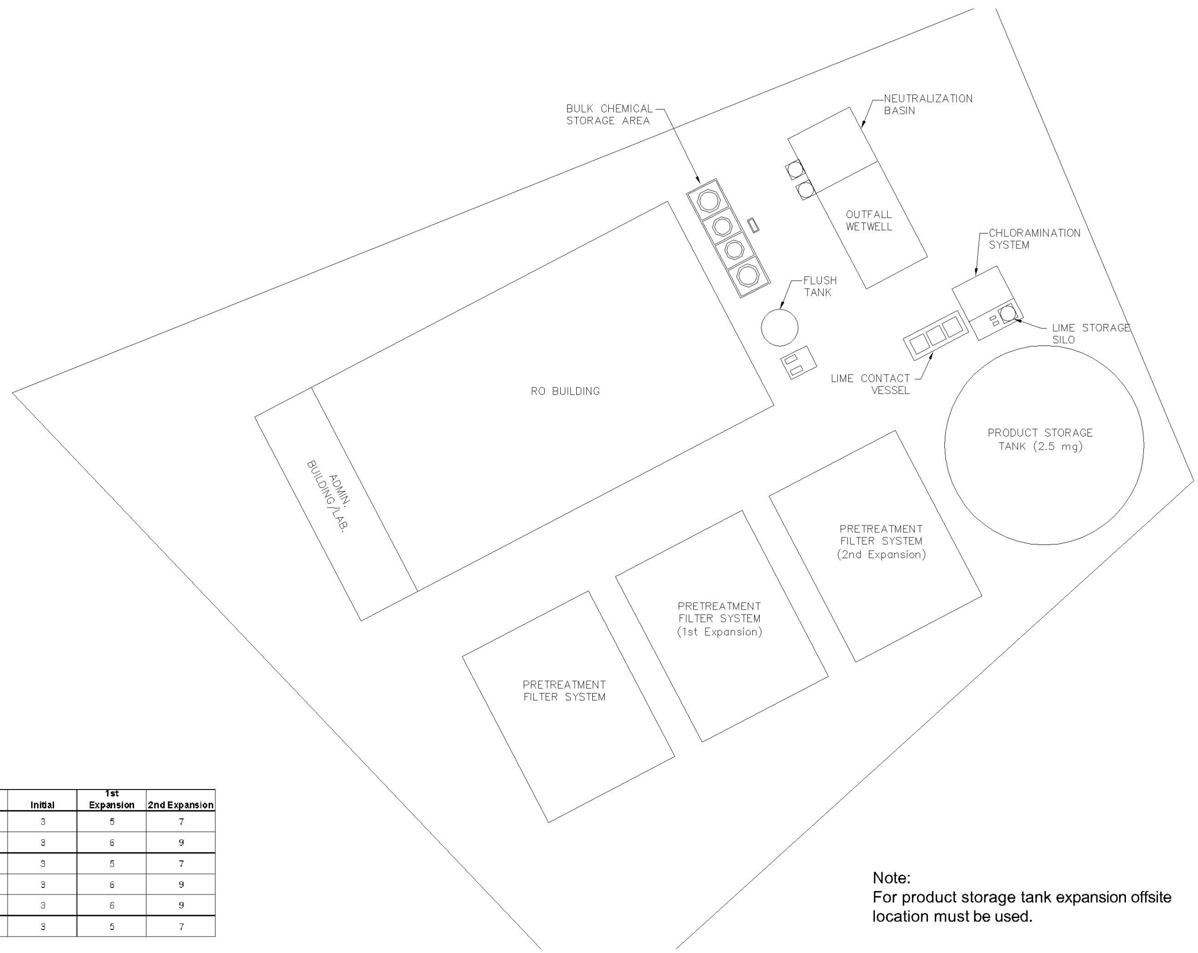
When the feed water is the coldest, 59ºF, a single pass seawater reverse osmosis plant can produce a chloride concentration of 79 ppm at 44% conversion. To produce 11.5 mgd in three trains requires a feed to each train of 6,050 gpm. The high pressure feed pumps must be capable of delivering this flow at 998 psig. The overall recovery is 44%. The power consumption at the low temperature is approximately 16.6 kWh/kgal.

The design calculated energy costs for the seawater demineralization plant are based on annual average energy usage. The average estimated energy usage is based on an assumed average operating temperature of 100ºF the majority of the time (90% of the time at the Indian River Power Plant site). The remaining 10% of the time, the design assumed the temperature to be at 77ºF. The study recommends further analysis of years of actual operating data from this power plant before preliminary design of the seawater demineralization plant. A conceptual site plan for a seawater demineralization plant located at the Indian River Power Plant is shown in Figure 13. A process flow diagram for the concept design is presented in Figure 14.

Concentrate Management

Concentrate would be disposed of through the existing cooling water discharge from the power plant. According to available data, the Indian River Power Plant uses 194 to 259 mgd of cooling water flow per day on a monthly average. For the RO plant concept design of 38.85% overall conversion and a 30 mgd product water capacity, using the minimum flow of 194 mgd cooling water rate, at 34,400 ppm TDS, the concentrate flow rate would be 47.22 mgd at 56,200 ppm TDS. The feedwater flow required would be 77.22 mgd and the cooling water available for dilution would be 116.78 mgd. The blended concentrate discharge flow would be approximately 164 mgd at 40,677 ppm TDS, which is an 18.25 % increase in TDS. This would be the worst-case scenario at the maximum RO plant capacity of 30 mgd discharging resulting concentrate with the minimum cooling water flow rate of 194 mgd. Supplemental dilution water of approximately 135 mgd (for a total of 329 mgd) from the power plant would be required by the Florida Department of Environmental Protection (FDEP) to get the change of chlorides at or below a 10% increase as required by Rule 62-302.530 during the low cooling water flow conditions at the power plant. During power plant operation on the high end, at 259 mgd of cooling water discharge, an additional 70-mgd of dilution water would be needed. If the power plant does not have this additional cooling water pumping capacity, then additional dilution pumps (either existing at the power plant or new pumps) should be considered. Alternatively, the seawater demineralization plant may have to be limited to a plant capacity of 10 mgd. At the lowest cooling water flows, the blended concentrate would yield a 5.5% increase, which is well below the 10 percent increase.

Figure 12. Indian River Power Plant Site Location Map



Equipment	Initial	1st Expansion	2nd Expansion
Feed intake Pump Units	3	5	7
Pretreatment Train Units	3	6	9
Cartridge Filter Housing Units	3	5	7
1st Pass RO Train Units	3	6	9
2nd Pass RO Train Units	3	6	9
Product Booster Pump Units	3	5	7

Note:
For product storage tank expansion offsite location must be used.

North

Indian River Power Plant Conceptual
Site Plan
(10/20/30 MGD)

Contract No. SE459AA
Seawater Demineralization Feasibility Investigation
St. Johns River Water Management District

Figure 13. Indian River Power Plant Conceptual Site Plan

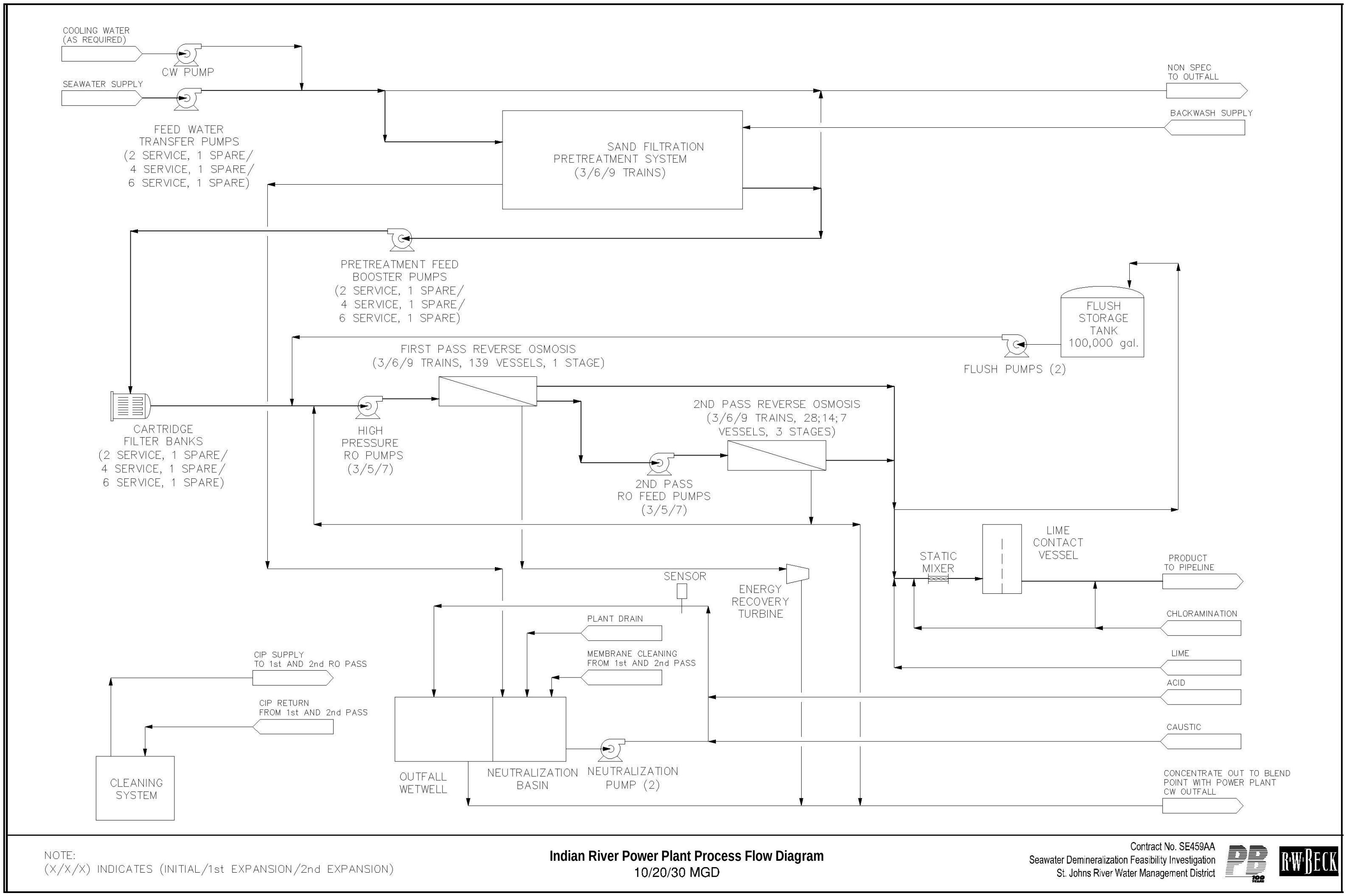


Figure 14. Indian River Power Plant Process Flow Diagram

W. E. Swoope Generating Station

Site Description

The W.E. Swoop Generating Station is an infrequently used power plant located in New Smyrna Beach, Florida, in Volusia County. The facility is owned by the City of New Smyrna Beach. Figures 16 and 17 show various views of the project site.

Existing Conditions

The W. E. Swoope Generating Station site is located on a segment of the Halifax River and Intracoastal Waterway (ICW) referred to as Ponce de Leon Cut, immediately west of Ponce Inlet. Water depths in the vicinity of the site generally range from 1-2 ft mean low water (MLW) along the immediate shoreline to approximately 12 ft in the ICW. The site is located at a hydraulic flow distance of approximately two nautical miles from the mouth of Ponce Inlet. Consequently, tidal circulation and flushing in Ponce de Leon Cut is very efficient.

There are no major freshwater inflows to this segment of the Halifax River; however, freshwater is delivered seasonally via numerous minor drainage ditches and urban storm water discharge structures. Consequently, the ambient salinity in this segment is expected to be consistently high. No applicable water quality data from this area were available in public databases, so ambient data were collected in the vicinity of the site by PBS&J environmental scientists on May 16, 2003. During this sampling period, salinity measurements at numerous locations in the area ranged between 31.2 and 34.9 ppt. It should be noted that these measurements were collected during the dry season, and that lower values may occur during wetter periods of the year.

The shoreline in the immediate vicinity of the site is a mixture of filled land and natural shoreline. The undeveloped shoreline consists primarily of mangroves and scattered Brazilian peppers. The island immediately west of the site is undeveloped and consists of several small upland areas apparently created by spoil material discharges and covered by a mix of Brazilian pepper, pines, oaks, and cabbage palms. The majority of this island is an extensive tidal marsh consisting primarily of Juncus roemerianus, Spartina alterniflora and scattered mangroves. In addition, scattered oyster bars were observed in the area. West of the island is an extensive sand flat. During the May 16, 2003, site inspection, numerous wading and shorebirds were observed utilizing the tidal marsh and sand flats.

Environmental Opportunities and Constraints

The W. E. Swoope Generating Station site is an existing developed industrial site, currently being utilized for peaking power generation only. No facilities exist on site for the intake and discharge of once-through cooling water, nor does the facility have an

NPDES permit to withdraw cooling water and discharge thermal effluent. In addition, no significant source of fresh or brackish surface water exists nearby as a source of raw water (e.g., tidal river), or for the dilution of a concentrate discharge (e.g., wastewater discharge). Despite these disadvantages, the hydraulic characteristics of this segment of the Halifax River would allow for very efficient dilution and flushing of a concentrate discharge due to the close proximity to Ponce Inlet. The most significant environmental constraints at this site are the environmentally sensitive marsh and benthic habitats in the immediate vicinity of the site. If it is determined to be necessary to construct an intake/discharge pipeline, dredge/fill and salinity impacts to these resources may be an issue in the permitting process. These impacts could be minimized if the intake/discharge pipeline was buried within the ICW and extended to the south and then to the east through Rockhouse Creek and through the mouth of Ponce Inlet. This alignment would avoid dredge and fill impacts to the tidal marsh and sensitive benthic habitats, and salinity impacts would be negligible due to the high ambient salinity and very efficient tidal flushing.

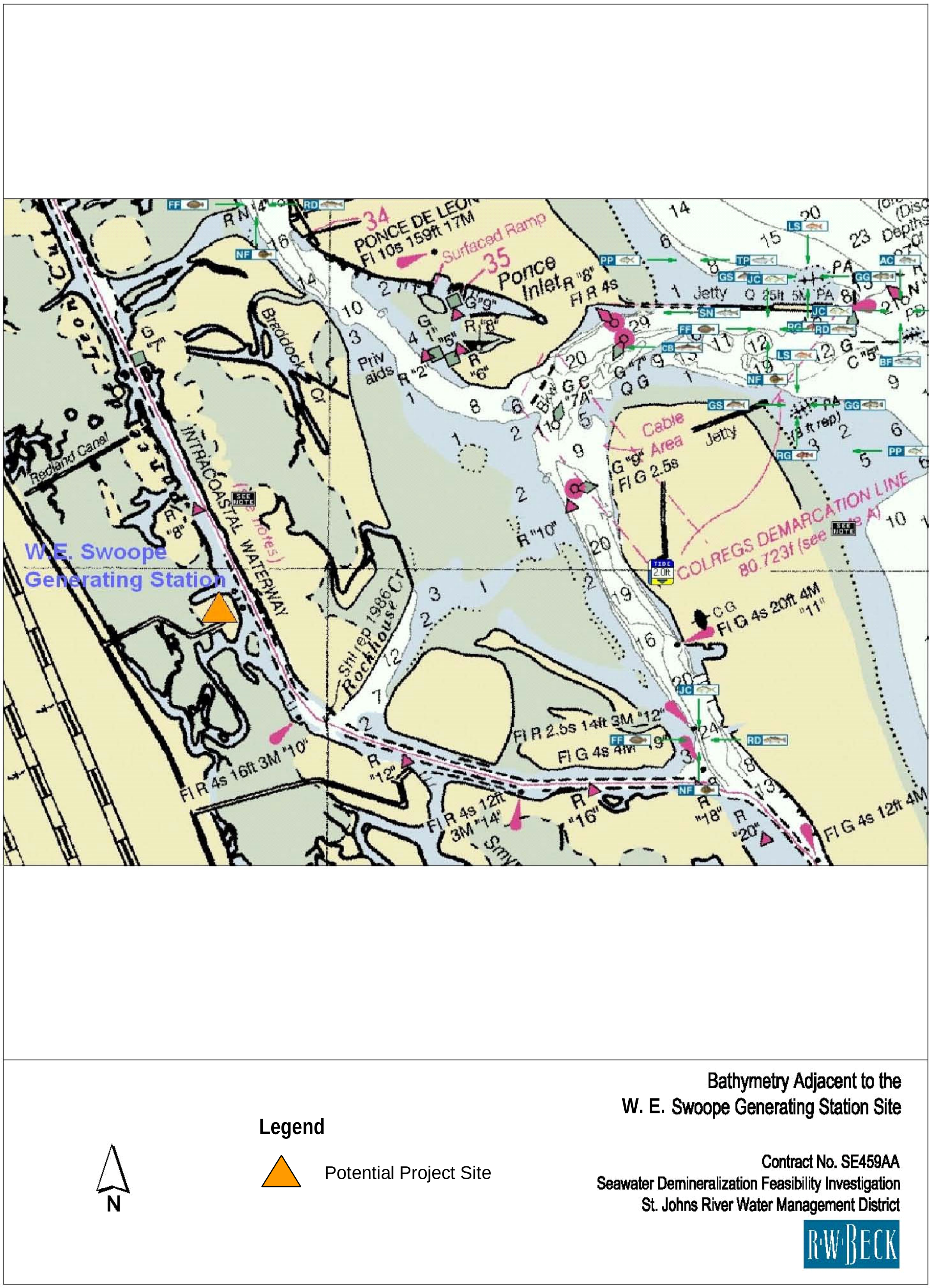


Figure 15. Bathymetry Adjacent to the W. E. Swoope Generating Station Site

Figure 16. W. E. Swoope Generating Station Site - View #1

Figure 17. W. E. Swoope Generating Station Site - View #2

Design Approach

A conceptual design for 5, 10 and 15 mgd capacities for a seawater demineralization plant was developed for the W. E. Swoope Generating Station site in New Smyrna Beach Site. Proposed plant capacities are based upon a range of potential water needs of local communities as defined by SJRWMD. See site location map in Figure 19. The conceptual design approach assumes an initial plant capacity of 5 mgd capacity followed by subsequent expansions in phases to 10 mgd and then 15 mgd. PBS&J collected recent water samples for several locations near the site on Friday, May 16, 2003. All of the water samples had salinities ranging from 31.16 to 34.94 ppt. Therefore, the conceptual design projections used standard seawater at 34.4 ppt as the design source water.

Review of field photos and an aerial map of the site indicate that there are approximately 3 acres available for the seawater demineralization plant, comprised in two parcels. One parcel is approximately 2 acres, while the second parcel is about 1 acre. The conceptual design of the seawater demineralization facility includes a 15% peaking capacity, which means that the design sized the reverse osmosis membrane systems to produce 5.75, 11.5 and 17.25 mgd. Splitting the capacity into trains of 2.875 mgd capacity and providing standby pumps where practical provides redundancy. This includes the source water intake pumping system, high service product water pumping system, and feed water transfer pumping station.

For pretreatment, the conceptual design incorporates conventional gravity sand filtration, which has been used successfully at seawater demineralization plants around the world. Recently, gravity sand filtration has been used successfully at the 28 mgd Trinidad desalination plant. The Tampa Bay Seawater desalination project utilizes a proprietary non-gravity (up-flow) sand filtration process.

An alternative to sand filtration for pretreatment is membrane micro-filtration, which has not been demonstrated on any large seawater desalination plants to date. The capital costs for membrane pretreatment are projected to typically be more expensive than gravity sand filtration pretreatment. Currently there is limited available and verifiable full-scale performance and cost data on membrane micro-filtration operation. In the absence of membrane micro-filtration specific pilot testing operational performance data, an estimate for the delivered water cost ($/1,000 gallons), inclusive of both capital and O&M costs, cannot be reliably estimated.

In any project that moves forward, careful consideration and design of pilot studies will be necessary to select the optimum pretreatment technology for a specific source water. The pilot study will be the key to determining if sufficient life cycle cost benefits may be realized with membrane micro-filtration pretreatment on specific source waters from the extension of the useful life of the reverse osmosis membranes and reduced pretreatment chemical usage.

For product water delivery, routing was considered to be to the largest water demand center in proximity to the site. For the W. E. Swoope Generating Station site, routing was chosen to go to the Daytona Beach Water Treatment Plant. Routing of the product water line was assumed to run along major thoroughfares and existing easements. The use of existing mains and intermediate water delivery points should be explored as part of facility planning for these communities. Figure 18 shows an approximate routing.

Specific Assumptions

The study applies specific assumptions for individual sites in order to develop the concept designs and comparison-level costs. The specific assumptions for this site are:

- Power rate of $0.063/kWHr (published General Service Demand rate for New Smyrna Beach for estimated load)
- Existing facilities would remain on site
- The W. E. Swoope Generating Station site will not have blended concentrate discharge associated with the existing power plant. The design assumes an offshore Atlantic Ocean outfall for concentrate management to a depth of a 30-foot
- Due to the complexity and possible environmental impacts associated with intake and offshore concentrate discharge, intake and concentrate discharge pipelines will be sized for the maximum plant capacity

Flow Rates and Recoveries

The concept design consists of two trains for the 5 mgd plant, four trains for the 10 mgd plant and six trains for 15 mgd plant. Each first pass train will require 106 total pressure vessels of seven seawater reverse osmosis elements each. Each second pass train will require 22 pressure vessels of seven brackish water reverse osmosis elements each. See Figures 20 and 21 for conceptual design layout and the process flow schematic.

When the seawater is the warmest, at 94ºF, it is necessary to use a 2-pass reverse osmosis plant to reduce the chloride concentration to 125 ppm. The first pass operating at a 41% recovery yields a product of a chloride concentration of 140 ppm. Approximately one sixth of the first pass product runs through the second pass at an 85% conversion yielding permeate with about a chloride concentration of 6.3 ppm. The remaining first pass product blends with the second pass product to obtain a blended product with about a chloride concentration of 123 ppm. To obtain 5.75 mgd in two trains, the feed rate to each train would be 4,985 gpm. The high pressure feed pumps must handle 4,985 gpm at 812 psig. The second pass pumps must handle 315 gpm at 114 psig. The recovery during the warmest temperatures is approximately 40%. The estimate of the power consumption at the warm temperatures is approximately 14.48 kWh/kgal.

When the feed water is the coldest, 59ºF, a single pass seawater reverse osmosis plant can produce a chloride concentration of 77 ppm at 43% conversion. To produce 5.75 mgd in two trains requires a feed to each train of 4,643 gpm. The high pressure feed pumps must be capable of delivering this flow at 1000 psig. The recovery at the coldest temperatures is approximately 43%. The estimated power consumption at the cold temperatures is approximately 16.84 kWh/kgal.

The design based the calculated energy costs for the seawater demineralization plant on an annual average basis. This estimated annual average energy cost used an annual average seawater temperature of 77ºF. A conceptual site plan for a seawater demineralization plant located at the W. E. Swoope Generating Station is shown in Figure 20. A process flow diagram for the concept design is presented in Figure 21.

Concentrate Management

The W.E. Swoope Generating Station does not have a cooling water flow rate. It uses diesel generators to meet peak demands. The concept design for a demineralization plant at this site conceives a separate feed water intake structure and offshore discharge. To obtain sufficient blending of the concentrate, the offshore discharge would extend out into the Atlantic Ocean to a depth of 30 ft per the recommendations of the FDEP for satisfactory blending considerations (based on another offshore discharge under consideration in Florida). Given the high current velocities and turbulent flow in Ponce Inlet it may, however, be permittable to extend the discharge only as far as the deeper portions of the inlet, potentially reducing construction costs. This option should be explored in the permitting process.

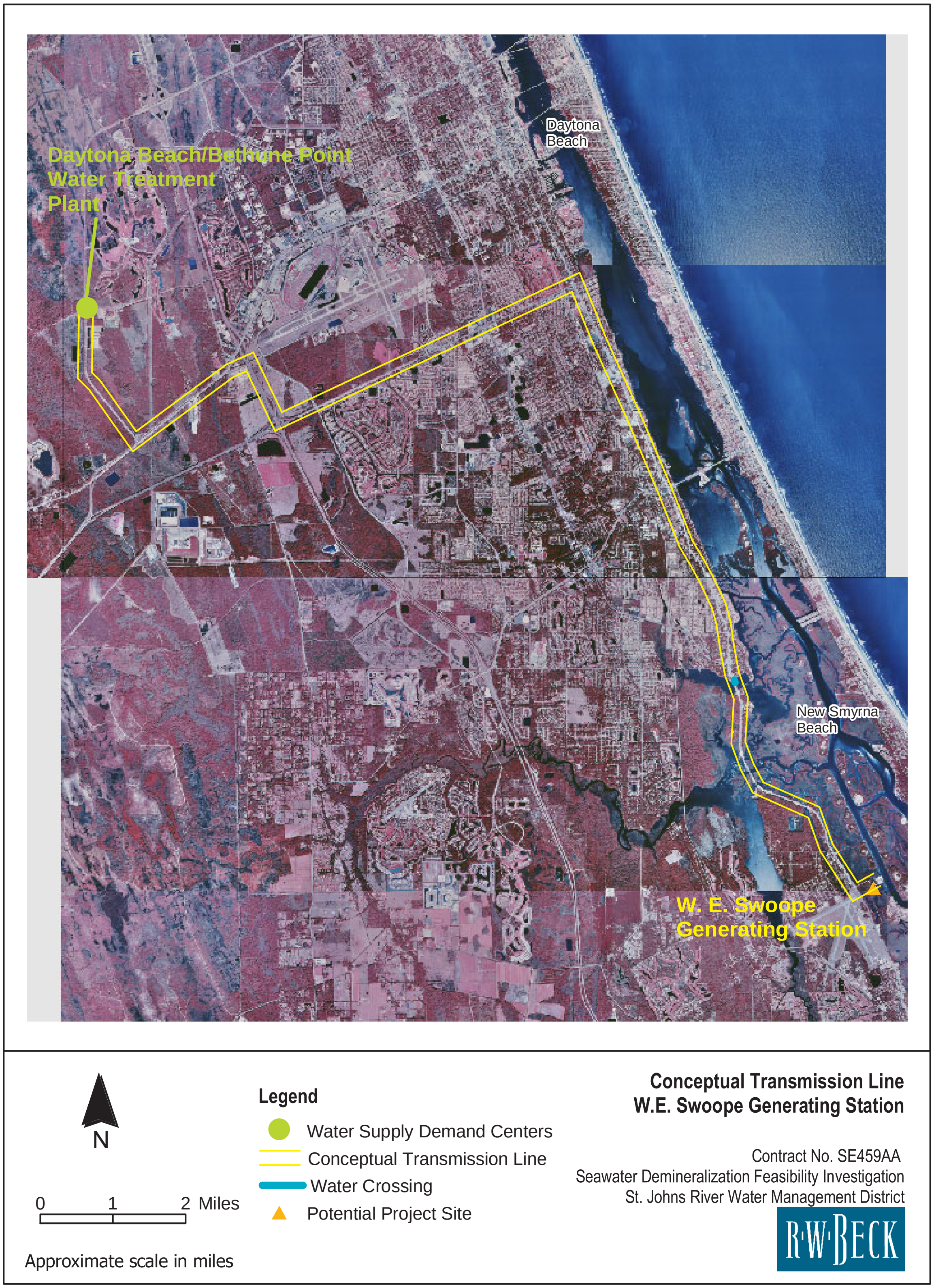
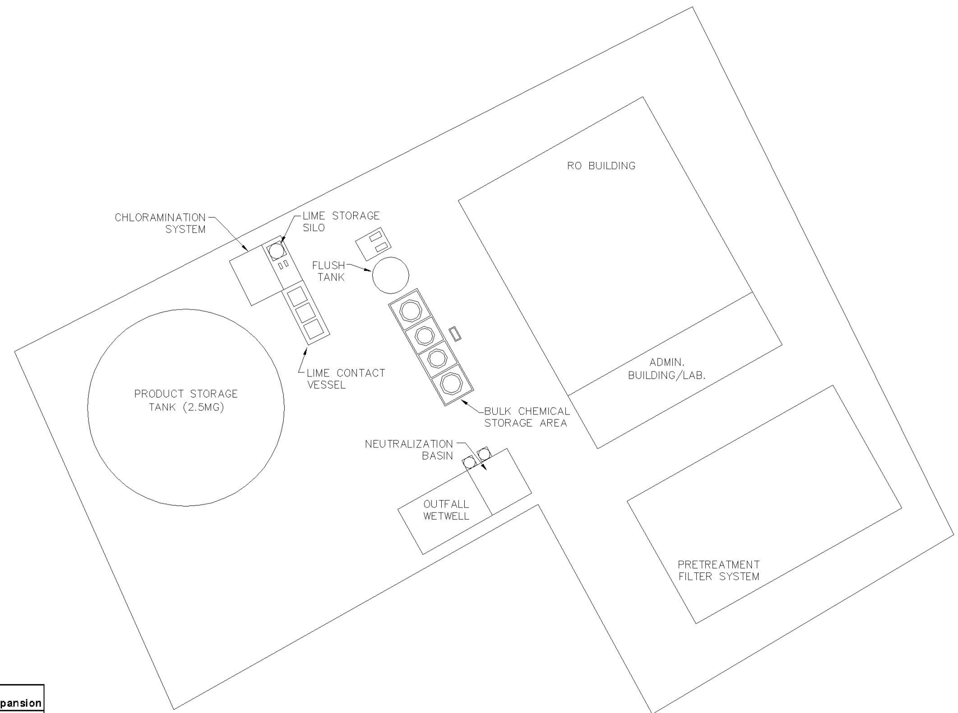


Figure 18. Conceptual Transmission Line – W. E. Swoope Generating Station

Figure 19. W. E. Swoope Generating Station Site Location Map



Equipment	Initial	1st Expansion	2nd Expansion
Feed intake Pump Units	3	5	7
Pretreatment Train Units	2	4	6
Cartridge Filter Housing Units	2	4	6
1st Pass RO Train Units	2	4	6
2nd Pass RO Train Units	2	4	6
Product Booster Pump Units	3	5	7

North

W. E. Swoope Generating Station Conceptual Site Plan
(5/10/15 MGD)

Contract No. SE459AA
Seawater Demineralization Feasibility Investigation
St. Johns River Water Management District

Figure 20. W. E. Swoope Generating Station Conceptual Site Plan

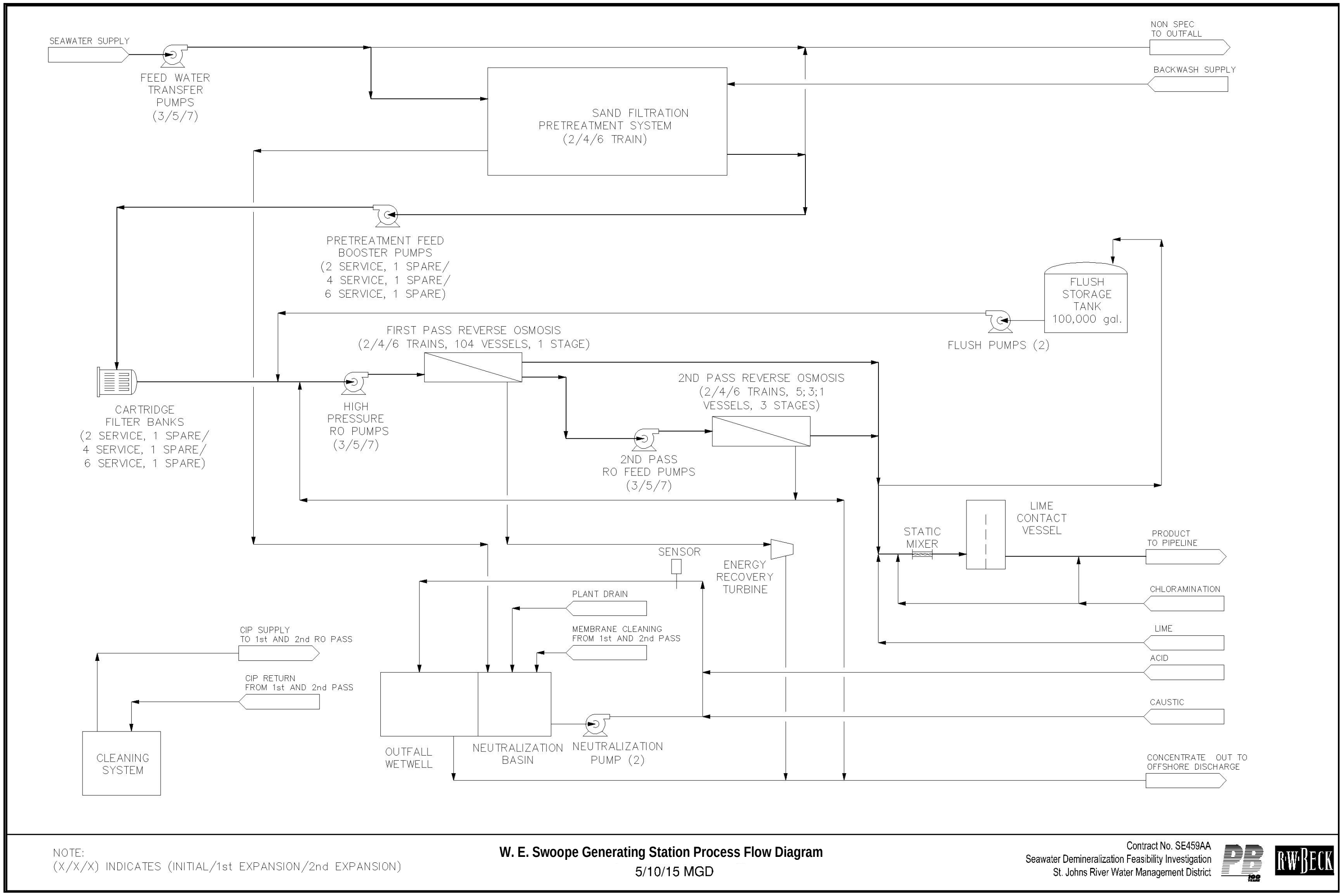


Figure 21. W. E. Swoope Generating Station Process Flow Diagram

Northside Power Plant

Site Description

The Northside Power Plant is a once-through cooled power plant located in Jacksonville, Florida, in Duval County. The facility is owned by JEA. The existing capacity of the facility is 1408 megawatts. This facility presents collocation opportunities including use of the existing cooling water for source water and discharge of concentrate. Though siting opportunities may be limited due to limited space availability at the power plant site, the proposed facility could be located next to the Power Park Generating Station where ample available space is available. Figures 24, 25, 26, and 27 show various views of the project site.

Existing Conditions

The Northside Power Plant site sits on the northern shoreline of the lower St. Johns River in the City of Jacksonville. The site is more specifically located on San Carlos Creek, a small tidal tributary to the St. Johns River. Water depths in the vicinity of the site generally range from one to two ft mean low water (MLW) within San Carlos Creek, to approximately 8 ft MLW at the confluence of the creek and the St. Johns River. Natural water depths in the St. Johns River in this vicinity generally range from 20-30 ft MLW. The power generating station utilizes a cooling water intake/discharge pipeline that extends from the plant site across a small upland peninsula to the deeper waters of the St. Johns River.

The site is located close to the mouth of the St. Johns River, with the Atlantic Ocean confluence being a hydraulic flow distance of approximately seven nautical miles away. The St. Johns River is a major river with mean annual flows in the range of 5,500 cubic ft per second. Consequently, this segment of the river is very well mixed and flushed.

Ambient salinity in this segment of the St. Johns River is extremely variable depending upon river discharge, tidal stage, and wind patterns. Water quality data available from SJRWMD from stations in the general vicinity of the site indicate that for the period 2000-2002, salinity ranged from approximately 7 to 32 ppt, with a mean annual salinity of 23.9 ppt. To augment the available data, additional water quality data were collected by PBS&J environmental scientists on September 22 and 23, 2002. These data showed a salinity range of 13.9 ppt in San Carlos Creek to 18.9 ppt in the St. Johns River. It should be noted that these data were collected during the wet season, during a period of high river and tributary flows. Figure 22 shows salinity trends in this portion of the St. Johns River.

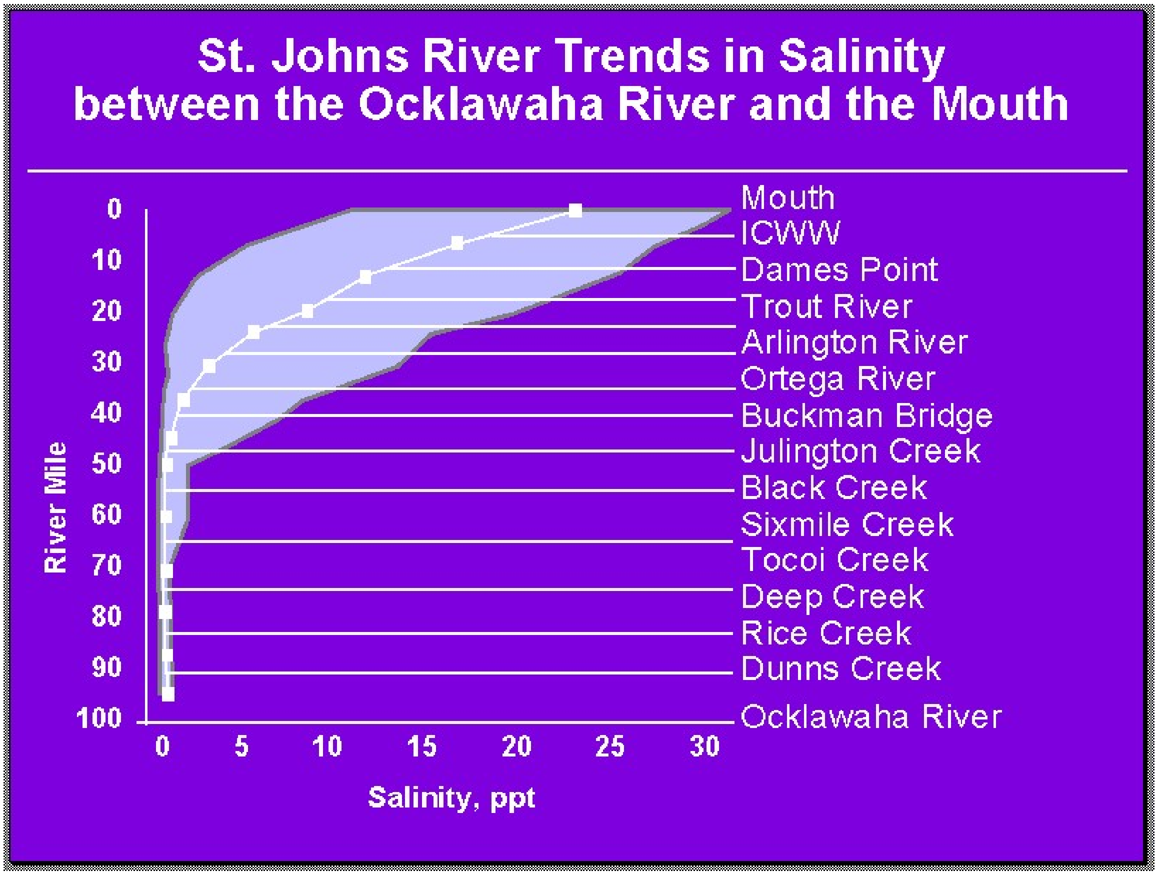


Figure 22. St. Johns River Salinity Trends

The shoreline in the immediate vicinity of the site is filled and hardened (e.g., sea wall or rip-rap stabilization). The adjacent uplands are characterized by pine/oak hammocks with scattered cabbage palms, wax myrtles, and red cedars. The site is surrounded on three sides by extensive salt marshes, composed predominantly of Juncus roemerianus and Spartina alterniflora. Oyster beds and extensive mudflats are present within San Carlos Creek, however, no submerged aquatic vegetation was observed in the site vicinity. Numerous wading birds were observed utilizing the salt marsh mudflat habitats.

Environmental Opportunities and Constraints

The Northside Power Plant site is an existing developed industrial site with an NPDES permit to withdraw once-through cooling water and to discharge a thermal effluent. In addition, the hydraulic characteristics of this segment of the St. Johns River would allow for very efficient dilution and flushing of a demineralization concentrate. Finally, ambient surface water salinities are brackish. These features offer significant engineering, economic, and regulatory opportunities for seawater demineralization plant development. The most significant environmental constraints at this site are the shallow natural depths and environmentally sensitive marsh and benthic habitats in the immediate vicinity of the site. It is likely that no significant new structures or dredge and fill activities would be permitted in San Carlos Creek. Dredge/fill and salinity impacts to these resources could be minimized if the existing intake/discharge pipeline infrastructure to the St. Johns River could be utilized for the seawater demineralization plant.

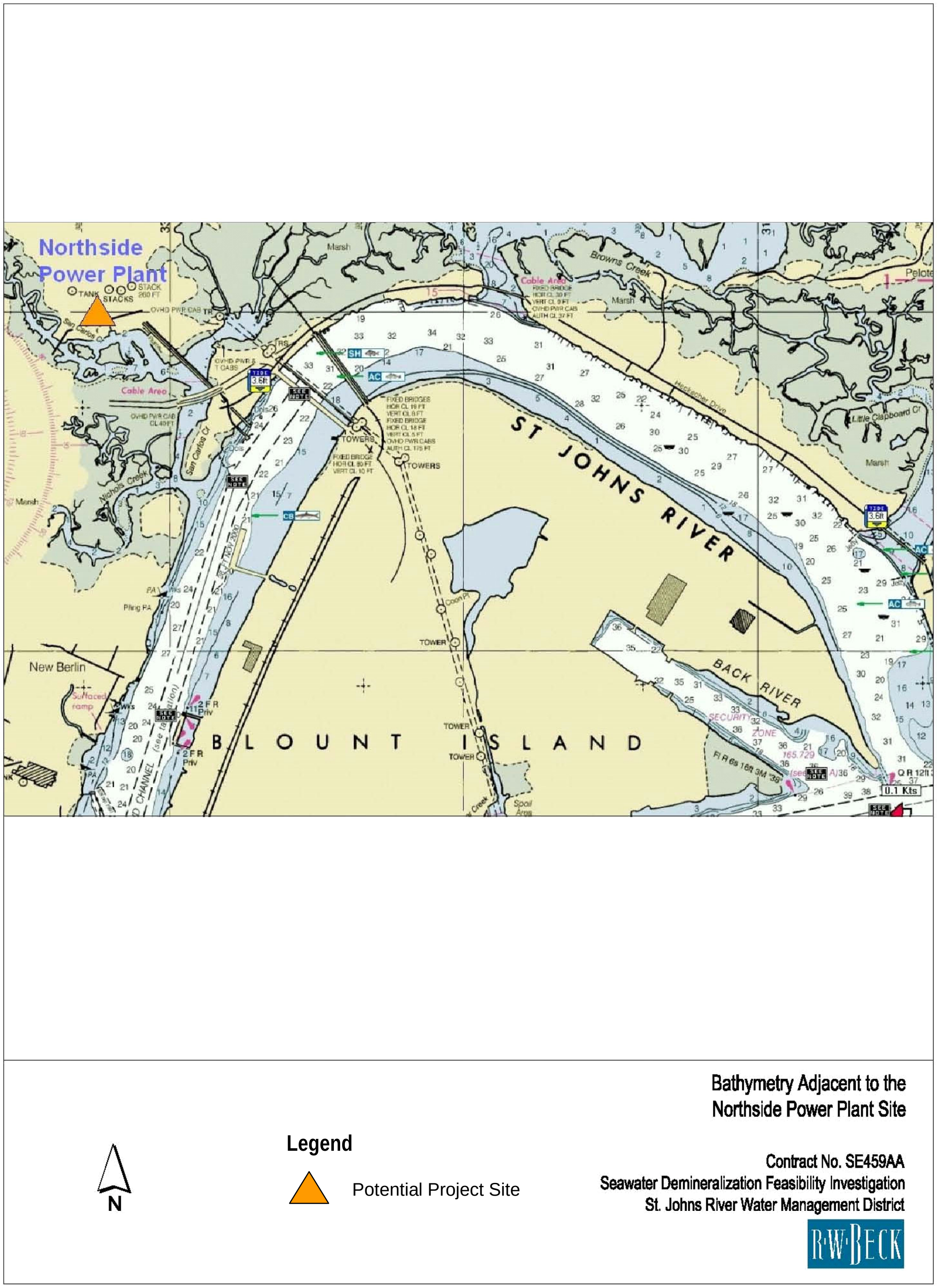


Figure 23. Bathymetry Adjacent to the Northside Power Plant Site

Figure 24. Northside Power Plant Discharge Structure

Figure 25. Northside Power Plant and Intake Structure

Figure 26. Power Park Site - View #1

Figure 27. Power Park Site - View #2

Design Approach

A conceptual design for 10, 20 and 30 mgd capacities for a seawater demineralization plant was developed for the JEA Northside Power Plant site. Proposed plant capacities are based upon a range of potential water needs of local communities as defined by SJRWMD. See Figure 29 for a site location map. The concept design approach used an initial plant capacity of 10 mgd, followed by subsequent expansions to 20 mgd and then 30 mgd. PBS&J obtained and analyzed ambient water quality data from SJRWMD for a sampling station located in the lower St. Johns River, approximately 0.8 nautical miles from the power plant site (Station JAXSJR04). Data collected over the most recent 2.5-year period were compiled, and the range and mean total dissolved solids (TDS) values were calculated. These statistics were considered by PBS&J to be generally representative of seasonal variations in TDS in this segment of the river. This data showed TDS levels ranging from a low of 6,100 mg/L to a high of 38,500 mg/L. The data indicates that the mean TDS was 26,399 mg/L. Therefore, the projections used 26,400 mg/L as the design source water TDS.

Review of photos and aerial maps of the sites indicated that there is an area of about 11 acres available for the seawater demineralization plant at this location. The seawater demineralization plant conceptual design includes a 15% peaking capacity, which results in a reverse osmosis membrane plant capable of producing 11.5 mgd initially, and then 23 mgd and 34.5 mgd after the expansions. Splitting the capacity into trains of 3.833 mgd capacity and providing standby pumps where practical provides redundancy. This includes the source water intake pumping system, high service product water pumping system, and feed water transfer pumping station.

For pretreatment, the conceptual design incorporates conventional gravity sand filtration, which has been used successfully at seawater demineralization plants around the world. Recently, gravity sand filtration has been used successfully at the 28 mgd Trinidad seawater demineralization plant. The Tampa Bay Seawater desalination project utilizes a proprietary non-gravity (up-flow) sand filtration process.

An alternative to sand filtration for pretreatment is membrane micro-filtration, which has not been demonstrated on any large seawater seawater demineralization plants to date. The capital costs for membrane pretreatment are projected to typically be more expensive than gravity sand filtration pretreatment. Currently there is limited available and verifiable full-scale performance and cost data on membrane micro-filtration operation. In the absence of membrane micro-filtration specific pilot testing operational performance data, an estimate for the delivered water cost ($/1,000 gallons), inclusive of both capital and O&M costs, cannot be reliably estimated.

In any project that moves forward, careful consideration and design of pilot studies will be necessary to select the optimum pretreatment technology for a specific source water. The pilot study will be the key to determining if sufficient life cycle cost benefits may be realized with membrane micro-filtration pretreatment on specific source waters from the

extension of the useful life of the reverse osmosis membranes and reduced pretreatment chemical usage.

For product water delivery, routing was considered to be to the largest water demand center in proximity to the site. This routing brings water to the south side of the St. Johns River in JEA system and requires approximately 3 miles of sub aqueous crossings. Other routing of the product water line was assumed to run along major thoroughfares and existing easements. JEA has multiple water treatment plants through their south operating grid. The receiving facility identified represents the Deerwood Water Treatment Plant located centrally in the JEA south delivery grid at 102 North Kernan Blvd. The use of existing mains and intermediate water delivery points should be explored as part of facility planning for these communities. Figure 28 shows an approximate routing.

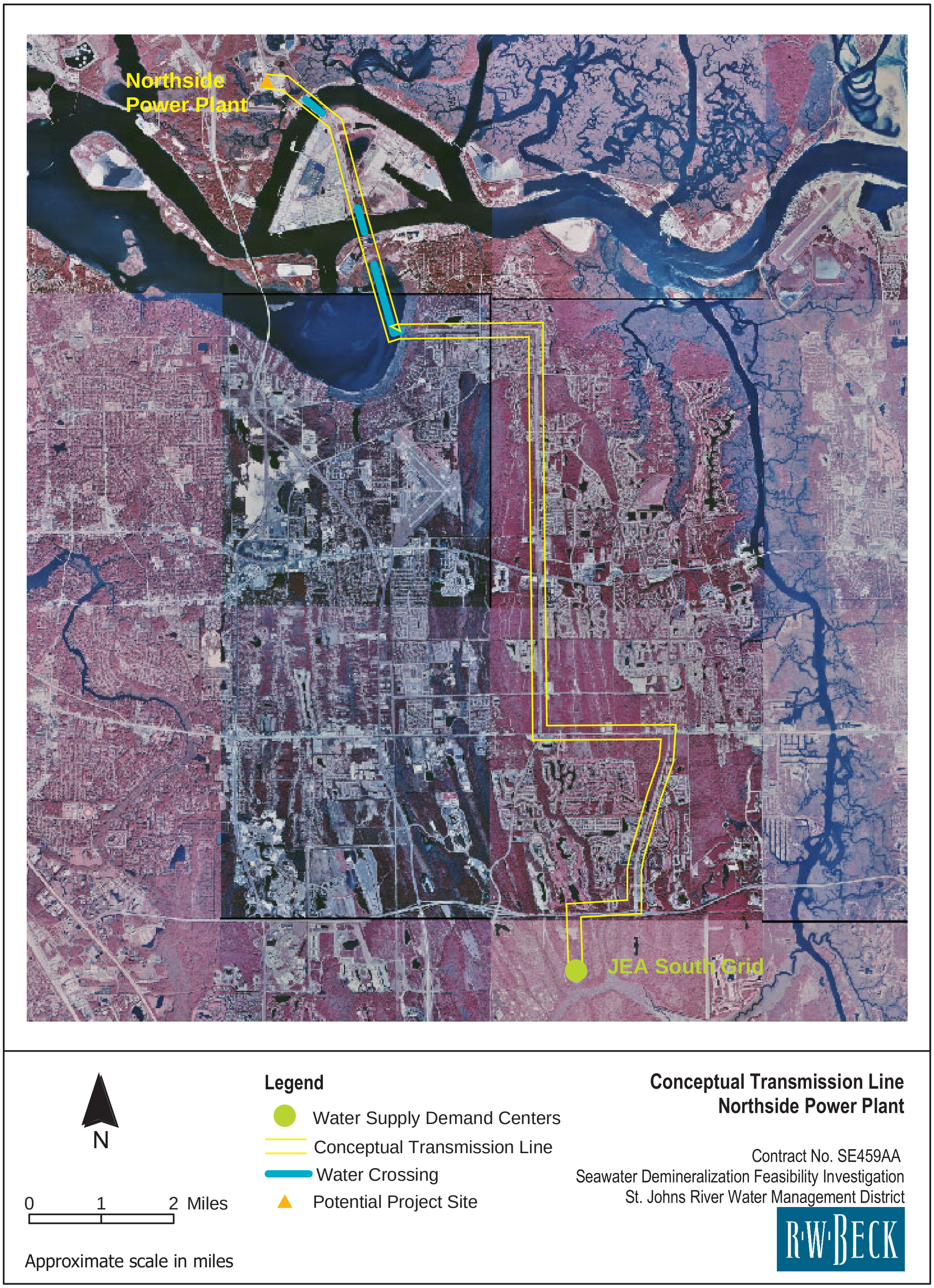


Figure 28. Conceptual Transmission Line - Northside Power Plant

Specific Assumptions

The study applies specific assumptions for individual sites in order to develop the concept designs and comparison-level costs. The specific assumptions for this site are:

- Power rate of $0.0425/kWHr (published GSLDT-3 rate from JEA for estimated load)
- Power Plant downtime of 0% (This is based on an interview with plant operating personnel. This power plant has three generators, two of which are relatively new. This power plant schedules individual outages to avoid complete shutdowns.)
- Use of power plant cooling water discharge for demineralization source water
- Concentrate discharge blended with power plant cooling water discharge

Flow Rates and Recoveries

The concept design for the Northside Power Plant site consists of three trains for the 10 mgd plant, six trains for the 20 mgd plant and nine trains for 30 mgd plant. Each first pass train will require 103 pressure vessels of eight seawater reverse osmosis elements each. This site will not require a second pass due to the lower TDS of the source water. See Figures 30 and 31 for conceptual design layout and process flow schematics for this site.

Operating the first pass at a 46.75% recovery yields a product of a chloride concentration of 97.44 ppm. To obtain 11.5 mgd in three trains requires a feed to each train of 5,694 gpm. The high pressure feed pumps must handle 5,694 gpm at 685 psig. The overall recovery is approximately 46.75%. The typical power consumption at the warm temperature is approximately 11.71 kWh/kgal.

When the feed water is the coldest, 59ºF, a single pass seawater reverse osmosis plant can produce a chloride concentration of 55.05 ppm at 53.5% conversion. To produce 11.5 mgd in three trains requires a feed to each train of 4,976 gpm. The high pressure feed pumps must be capable of delivering this flow at 936 psig. The overall recovery is 53.5%. The power consumption at the low temperature is approximately 18.51 kWh/kgal.

The design calculated the energy costs for the seawater demineralization plant is based on annual average energy usage. The average estimated energy usage is based on an assumed average operating temperature of 86ºF the majority of the time (70% of the time). The remaining 30% of the time, the design assumed the temperature to be at 68ºF. A conceptual site plan for a seawater demineralization plant located at the Northside Power Plant is shown in Figure 30. A process flow diagram for the concept design is presented in Figure 31. It is suggested that a further analysis of years of actual operating data from this power plant be conducted before preliminary design of a seawater demineralization plant.

Concentrate Management

Concentrate would be disposed of through the existing cooling water discharge from the power plant. According to data provided by the power station, the Northside Power Plant uses 101 to 806 mgd of cooling water flow per day. For the design operating case of 43% overall conversion of the seawater demineralization plant, at an average design salinity of 26,400 ppm TDS, and using a 30 mgd RO plant capacity, the concentrate flow rate would be 39.77 mgd at 46,200 ppm TDS at the minimum cooling water flow.

The feedwater flow required would be 69.77 mgd, leaving the cooling water available for dilution at approximately 31.23 mgd at the low power plant flow. The blended concentrate discharge flow at this low flow period would be approximately 71 mgd at 37,500 ppm TDS, which is a 42 % increase from the average TDS of 26,400 ppm. Although the blended TDS is only 9% higher than the standard seawater concentration of 34,400 ppm TDS, it is likely that this plant would have to be supplemented with at least 228 mgd of additional dilution water for concentrate blending under low cooling water flow conditions, at a 30 mgd seawater demineralization plant. This additional dilution water could be provided by using the power plant’s existing cooling water pumps, which have a capacity of up to 806 mgd.

For a capacity of 10 mgd, the resultant salinity increase is 11% under the worst-case scenario of combining the concentrate with the minimum cooling water flows at the power plant. At the minimum cooling water flow rate of 101 mgd, the RO plant capacity would be limited to 9.2 mgd without supplemental dilution water, which could be provided by operating the power plants unused cooling water pumps. At a seawater demineralization plant capacity of 10 mgd, an additional 8 mgd of cooling water flow (for a total of 109 mgd of cooling water flow) would yield a less than 10% increase in salinity.

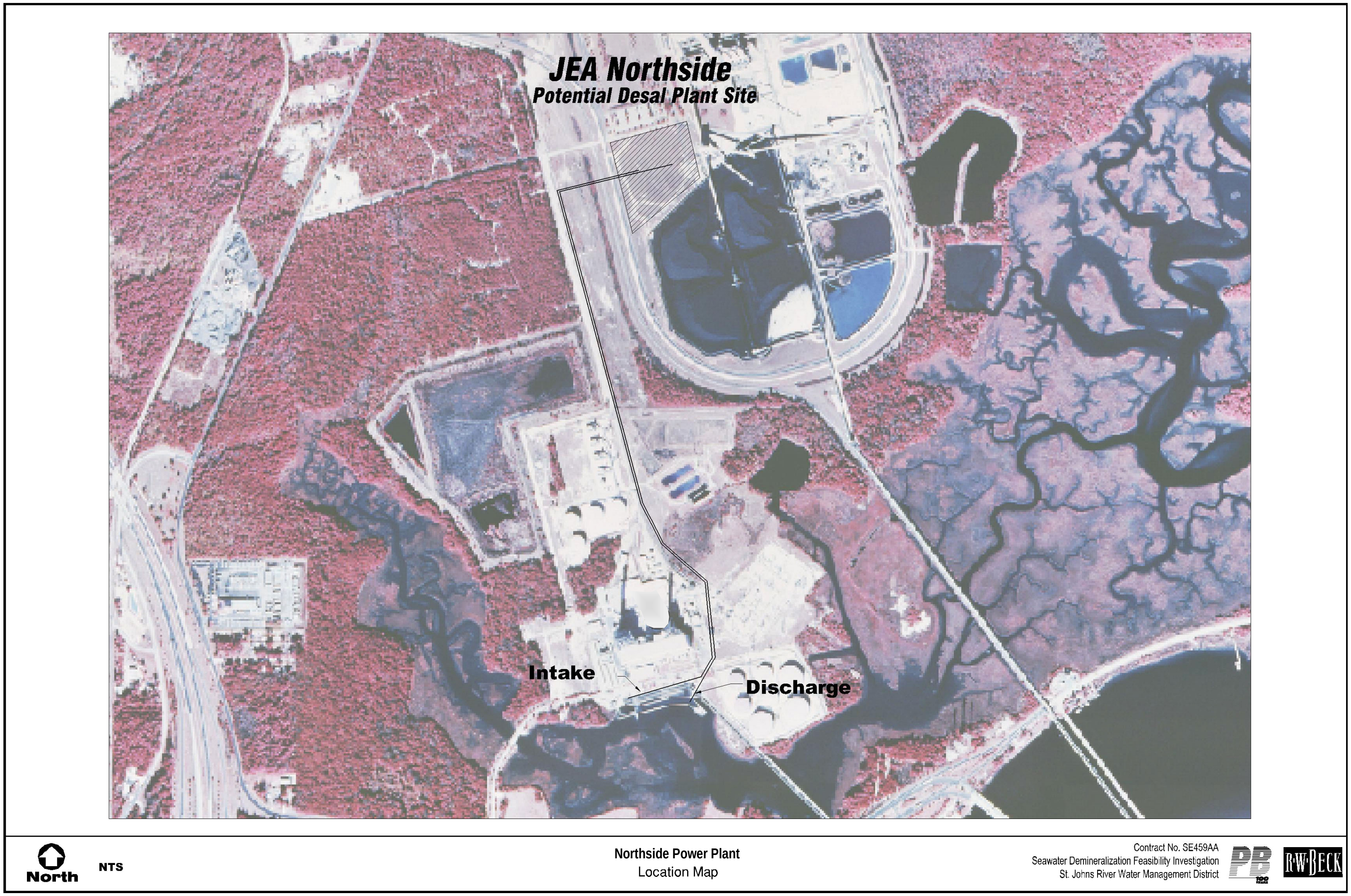
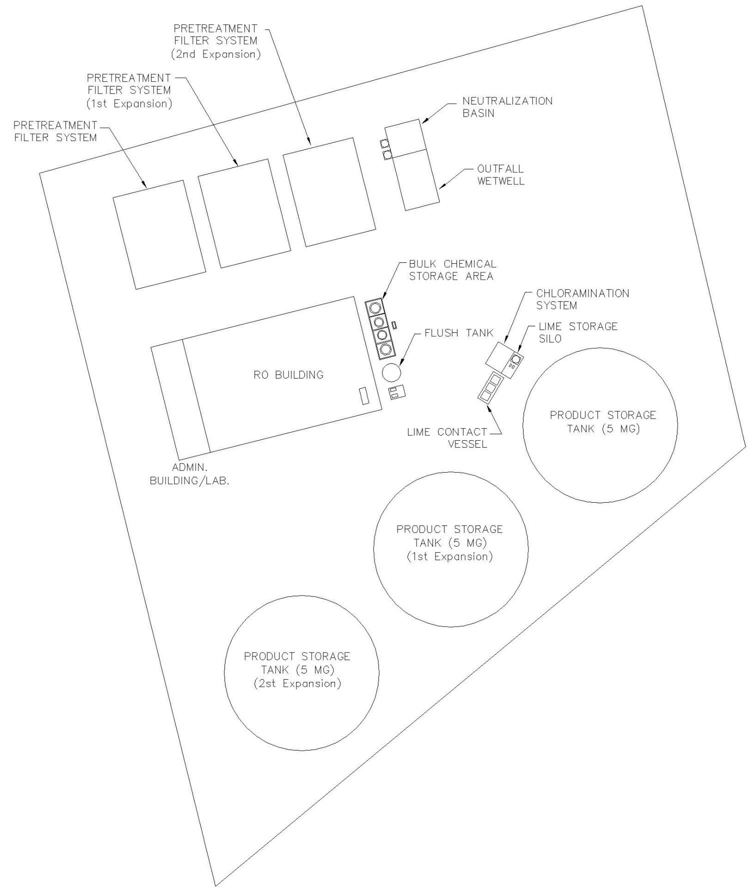


Figure 29. Northside Power Plant Location Map



Equipment	Initial	1st Expansion	2nd Expansion
Feed intake Pump Units	3	5	7
Pretreatment Train Units	3	6	9
Cartridge Filter Housing Units	3	5	7
1st Pass RO Train Units	3	6	9
2nd Pass RO Train Units	0	0	0
Product Booster Pump Units	3	5	7

North

Northside Power Plant Conceptual Site Plan
(10/20/30 MGD)

Contract No. SE459AA
Seawater Demineralization Feasibility Investigation
St. Johns River Water Management District

Figure 30. Northside Power Plant Conceptual Site Plan

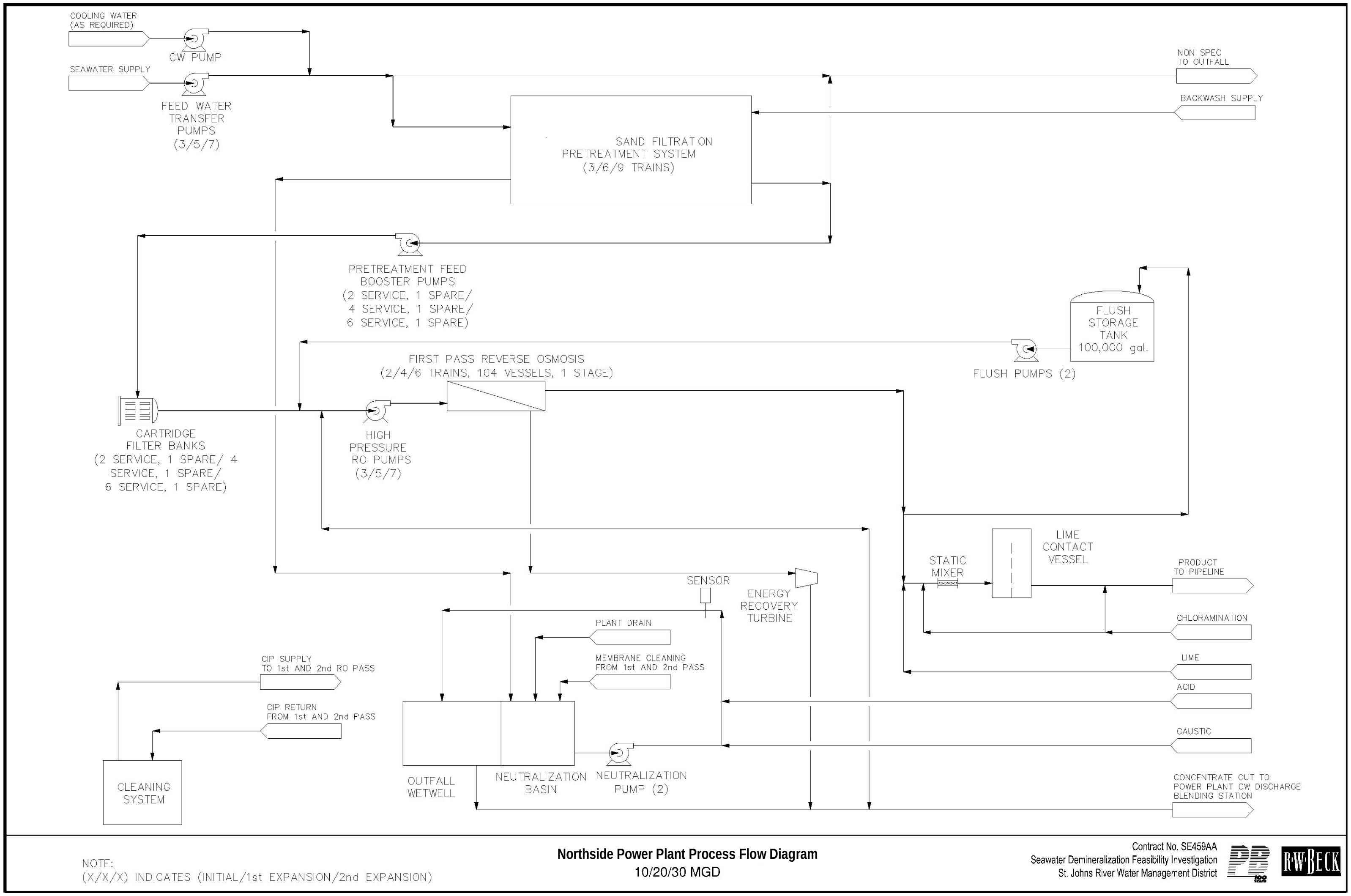


Figure 31. Northside Power Plant Process Flow Diagram

Daytona Beach/Bethune Point Wastewater Treatment Plant

Site Description

The Daytona Beach/Bethune Point Wastewater Treatment Plant site is a 13 mgd (permitted) wastewater plant located in Daytona Beach, Florida, in Volusia County. The facility discharges treated wastewater to the Halifax River. The facility uses advanced treatment processes to enable reuse of the effluent. The facility is permitted for a reuse capacity of 7.6 mgd. The outfall is permitted for 20 mgd (max permitted flow equals 22.8 mgd) and includes combined flows from the Daytona Beach/Bethune Point Wastewater Treatment Plant and Daytona Beach Westside Regional Wastewater Treatment Plant. The wastewater effluent from both facilities is co-mingled at a manhole at the Daytona Beach/Bethune Point Wastewater Treatment Plant. The facility is owned by the City of Daytona Beach. This facility presents collocation opportunities including use of the existing permitted wastewater discharge. Figures 32 and 33 show various views of the shoreline adjacent to the project site.

Existing Conditions

The Daytona Beach/Bethune Point Wastewater Treatment Plant site is located on the western shoreline of the Halifax River in the City of Daytona Beach. Water depths in the vicinity of the site generally range from 1-2 ft mean low water (MLW) along the immediate shoreline to 13-14 ft MLW in the natural channel running north-south in this segment of the Halifax River. The natural channel comes very close to the shoreline near the site, and a public boat ramp is located on the channel water immediately north of the site. The dredged Intracoastal Waterway (ICW) channel also runs north-south and is located approximately 600 ft east of the site. The control depth of the ICW is 12 ft MLW.

This segment of the Halifax River is located a hydraulic flow distance of approximately eight nautical miles from Ponce Inlet, the closest coastal pass that allows for tidal exchange and flushing with the Atlantic Ocean. There are no major freshwater inflows to this segment of the Halifax, however, freshwater is delivered seasonally via numerous minor drainage ditches and urban storm water discharge structures. Consequently, the ambient salinity in this segment is relatively high despite the long hydraulic flow distance to the closest ocean pass. No applicable water quality data from this area were available in public databases, so ambient data were collected in the vicinity of the site by PBS&J environmental scientists on September 22-23, 2003. During this sampling period salinity was determined to be approximately 19 ppt, while dissolved oxygen concentrations ranged from 3.27 to 4.97 mg/l. Since these data were collected during the wet season, it is assumed that 19 ppt generally represents a seasonal low salinity value in the annual range of salinity occurring in this segment of the Halifax River. Samples collected by

PBS&J in May 2003, had salinity closer to standard seawater with salinities ranging from 31 to nearly 35 ppt.

The shoreline on the site is hardened with rip-rap and stabilized with geo-web. A narrow fringe of marsh vegetation (Spartina alterniflora) was observed seaward of, and within the geo-web material. No submerged vegetation, oyster bars, or other sensitive benthic habitats were observed in the vicinity of the site.

Environmental Opportunities and Constraints

The Daytona Beach/Bethune Point Wastewater Treatment Plant site is an existing developed industrial site with an NPDES permit to discharge treated wastewater effluent. These features offer significant engineering, economic, and regulatory opportunities for seawater demineralization plant development. The most significant environmental constraint at this site is the potential for poor tidal flushing due to the relatively long hydraulic flow distance to the closest ocean pass. As part of the permitting process, the dilution and flushing of the concentrate discharge would likely need to be modeled under worst-case conditions to determine the potential for re-entrainment and further concentration of the concentrate.

The close proximity of the site to deep water is a significant benefit in that no pipeline would be needed to discharge concentrate to the portion of the receiving water body with the greatest hydraulic exchange. In addition, the availability of wastewater effluent as a source of dilution water would likely mitigate concerns regarding impacts to ambient salinity patterns. Finally, no sensitive benthic habitats were observed in the immediate vicinity of the site, thus dredge and fill impacts would likely be minimal.

Figure 32. Shoreline Adjacent to Daytona Beach/Bethune Point Wastewater Treatment Plant Site - View #1

Figure 33. Shoreline Adjacent to Daytona Beach/Bethune Point Wastewater Treatment Plant Site - View #2

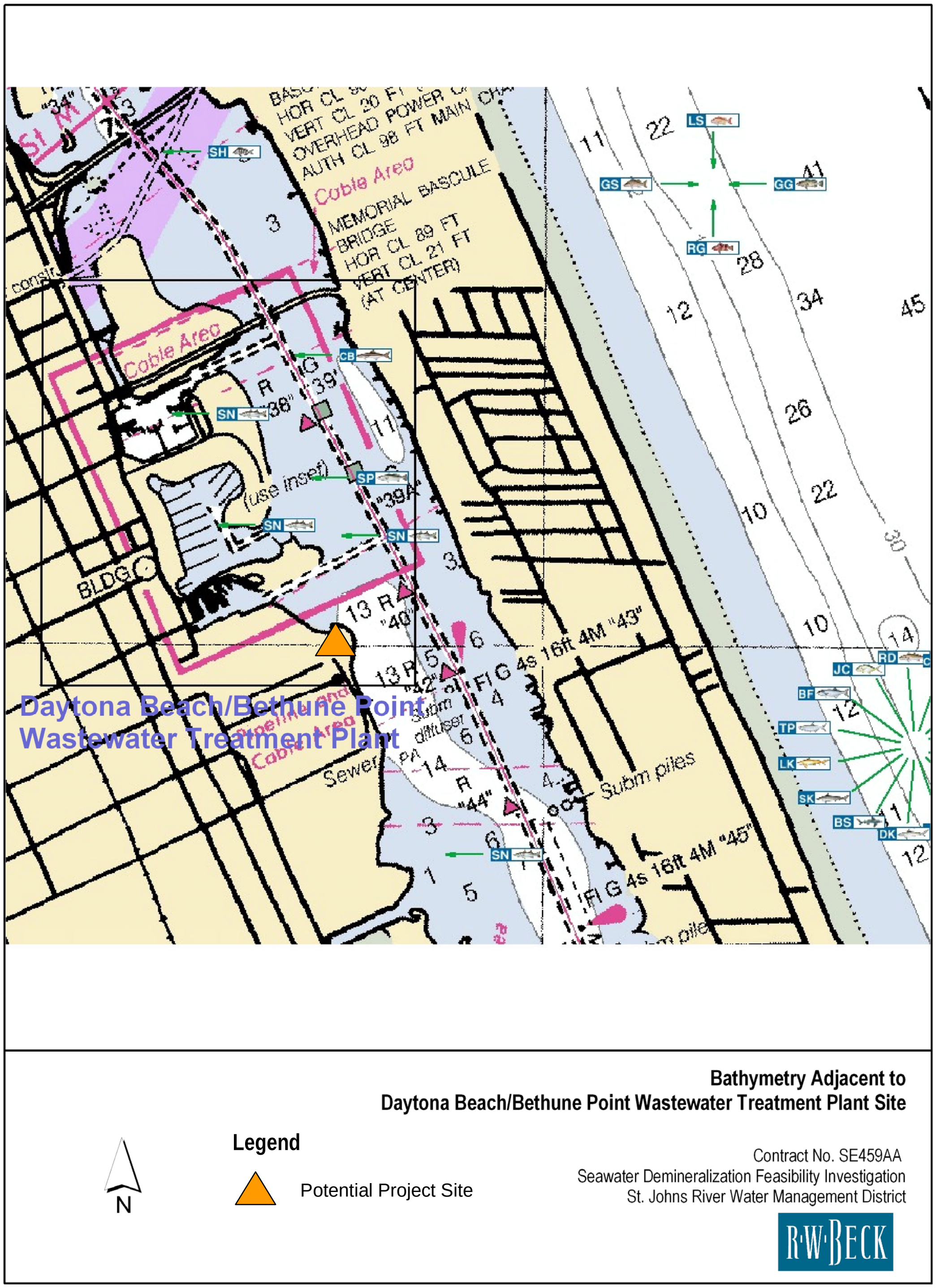


Figure 34. Bathymetry Adjacent to the Daytona Beach/Bethune Point Wastewater Treatment Plant Site

Design Approach

Conceptual designs for a potential seawater demineralization plant at the Daytona Beach/Bethune Point Wastewater Treatment Plant Site were developed for a capacity of 5, 10 and 15 mgd. Proposed plant capacities are based upon a range of potential water needs of local communities as defined by SJRWMD. See Figure 36 for a site location map. The conceptual design approach assumes an initial plant capacity of 5 mgd followed by subsequent expansions in phases to 10 mgd and then 15 mgd. PBS&J collected recent water samples for several locations near the site on Friday, May 16, 2003. All of the water samples had salinities ranging from 31.16 to 34.94 ppt. The conceptual design projections used standard seawater at 34.4 ppt as the design source water consistent with the other conceptual designs for source waters close to standard seawater values

Review of field photos and an aerial map of the site indicate that there are approximately 2.8 acres available for the seawater demineralization plant, comprised of two parcels. The conceptual design of the seawater demineralization facility includes a 15% peaking capacity, which means that the design sized reverse osmosis membrane systems to produce 5.75, 11.5 and 17.25 mgd. Splitting the capacity into trains of 2.875 mgd capacity and providing standby pumps where practical provides redundancy. This includes the source water intake pumping system, high service product water pumping system, and feed water transfer pumping station.

For pretreatment, the conceptual design incorporates conventional gravity sand filtration, which has been used successfully at seawater demineralization plants around the world. Recently, gravity sand filtration has been used successfully at the 28 mgd Trinidad seawater demineralization plant. The Tampa Bay Seawater desalination project utilizes a proprietary non-gravity (up-flow) sand filtration process.

An alternative to sand filtration for pretreatment is membrane micro-filtration, which has not been demonstrated on any large seawater desalination plants to date. The capital costs for membrane pretreatment are projected to typically be more expensive than gravity sand filtration pretreatment. Currently there is limited available and verifiable full-scale performance and cost data on membrane micro-filtration operation. In the absence of membrane micro-filtration specific pilot testing operational performance data, an estimate for the delivered water cost ($/1,000 gallons), inclusive of both capital and O&M costs, cannot be reliably estimated.

In any project that moves forward, careful consideration and design of pilot studies will be necessary to select the optimum pretreatment technology for a specific source water. The pilot study will be the key to determining if sufficient life cycle cost benefits may be realized with membrane micro-filtration pretreatment on specific source waters from the extension of the useful life of the reverse osmosis membranes and reduced pretreatment chemical usage.

For product water delivery, routing was considered to be to the largest water demand center in proximity to the site. For the Daytona Beach/Bethune Point Wastewater Treatment Plant, routing was chosen to go to the Daytona Beach Water Treatment Plant. Routing of the product water line was assumed to run along major thoroughfares and existing easements. The use of existing mains and intermediate water delivery points should be explored as part of facility planning for these communities. Figure 35 shows an approximate routing.

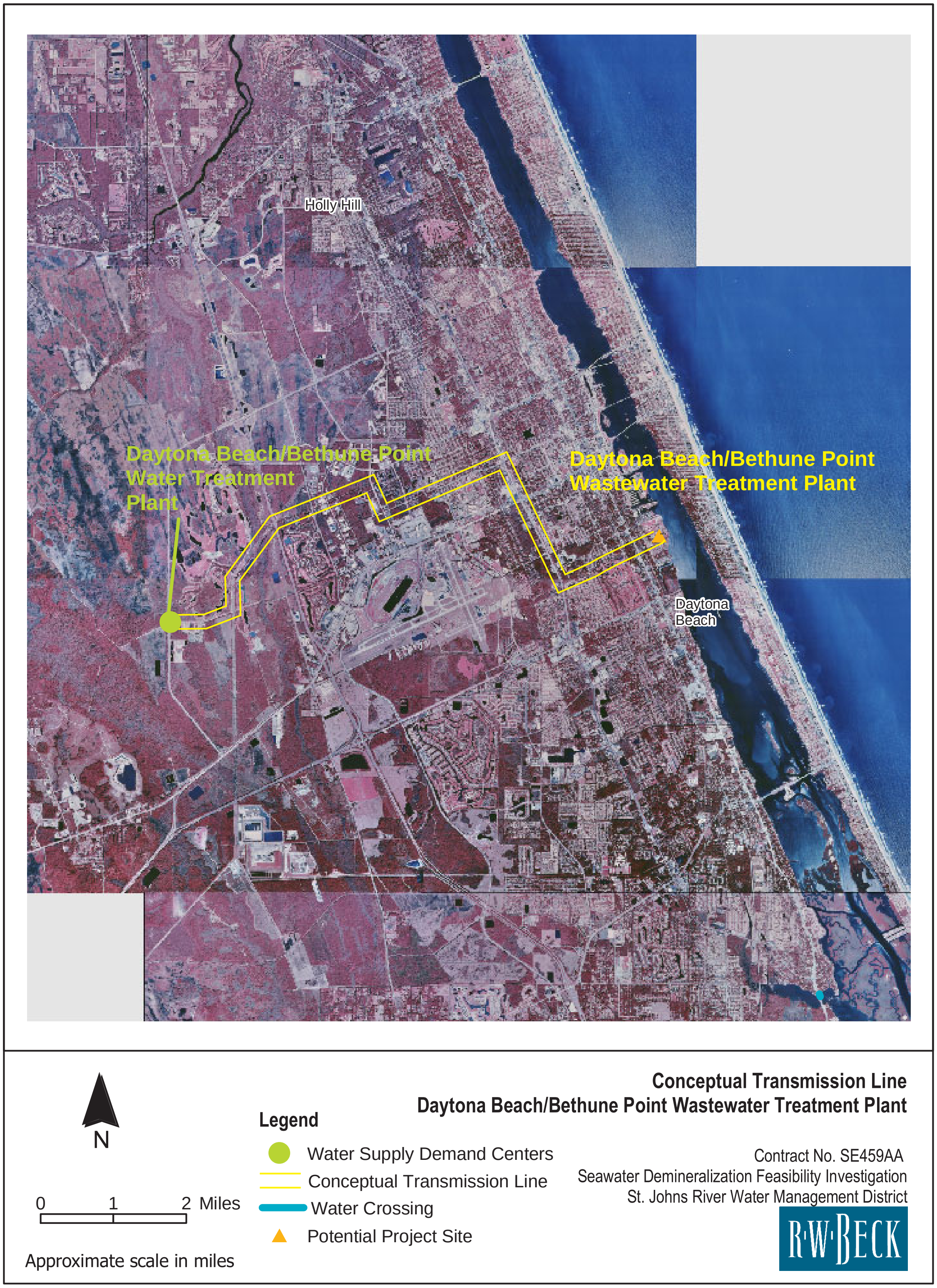


Figure 35. Conceptual Transmission Line Daytona Beach/Bethune Point Wastewater Treatment Plant

Specific Assumptions

The study applies specific assumptions for individual sites in order to develop the concept designs and comparison-level costs. The specific assumptions for this site are:

- Power rate of $0.0533/kWHr (published GSLDT-3 rate from FPL for estimated load)
- Separate feed water intake system feed water for demineralization source water
- Concentrate discharge blended with wastewater treatment plant discharge

Flow Rates and Recoveries

The concept design consists of two trains for the 5 mgd plant, four trains for the 10 mgd plant and six trains for the 15 mgd plant. Each first pass train will require 109 total pressure vessels of seven seawater reverse osmosis elements each. Each second pass train will require 17 pressure vessels of seven brackish water reverse osmosis elements each. See Figure 37 for conceptual design layout and the process flow schematic.

When the seawater is the warmest, at 95ºF, it is necessary to use a two-pass reverse osmosis plant to reduce the chloride concentration to 125 ppm. The first pass operating at a 41% recovery yields a product of a chloride concentration of 140 ppm. Approximately one third of the first pass product goes through the second pass RO system at an 85% conversion yielding permeate with about a chloride concentration of 5.33 ppm. The remaining first pass product blends with the second pass product to obtain a blended product with a chloride concentration of about 100 ppm. To obtain 5.75 mgd in two trains, the feed rate to each train would be 5,130 gpm. The high pressure feed pumps must handle 5,130 gpm at 782 psig. The second pass pumps must handle 707 gpm at 145 psig. The recovery during the warmest temperatures is approximately 39%. The estimated power consumption at the warm temperatures is approximately 15.3 kWh/kgal.

When the feed water is the coldest, 59ºF, a single pass seawater reverse osmosis plant can produce a chloride concentration of 77 ppm at 43% conversion. To produce 5.75 mgd in two trains requires a feed to each train of 4,643 gpm. The high pressure feed pumps must be capable of delivering this flow at 964 psig. The recovery at the coldest temperatures is approximately 43%. The estimated power consumption at the cold temperatures is approximately 16.84 kWh/kgal.

The calculated energy costs for the seawater demineralization plant are based on an annual average basis. This estimated annual average energy cost used an annual average seawater temperature of 77ºF. A conceptual site plan for a potential seawater demineralization plant located at the Daytona Beach/Bethune Point Wastewater

Treatment Plant Site is shown in Figure 36. A process flow diagram for the concept design is presented in Figure 38.

Concentrate Management

The concept design of a demineralization plant at the Daytona Beach/Bethune Point Wastewater Treatment Plant site consists of a separate seawater intake structure and blending the concentrate with the wastewater outfall. The wastewater outfall is permitted for a combined wastewater limit of 20 mgd from the two wastewater treatment plants. For this evaluation, the wastewater plant was considered to operate at or near this 20 mgd permitted capacity. For the RO plant design operating case of 38.92% overall conversion and 15 mgd RO plant capacity with a feedwater TDS of 34,400 ppm, the concentrate flow rate would be approximately 23.54 mgd at 56,300 ppm TDS. Mixing this concentrate stream with 20 mgd of wastewater at an assumed 250 ppm TDS yields a blended stream of 43.54 mgd at 30,554 ppm TDS, which is less than standard seawater. When the feed salinity is lower, the concentrate salinity will be proportionally lower as well.

If this site is selected for a demineralization facility, the capacity of the RO plant with respect to actual wastewater flows available for blending should be carefully evaluated. At present, the Daytona Beach/Bethune Point Wastewater Treatment Plant is operating at approximately 7 mgd and the Westside Regional plant is operating at nearly 8 mgd, for a total combined wastewater flow of 15 mgd. However, approximately 4 mgd is currently going to reuse. Therefore the combined effluent being discharged to the outfall is approximately 10 mgd, which would limit the seawater demineralization plant capacity to 13 mgd if the plant is built today (based on current flow conditions) This would yield a combined discharge TDS of less than 10% above the natural seawater TDS. Current regulatory emphasis is on development of reuse resources. In the foreseeable future any WWTP wastewater stream is likely to be reduced or eliminated as a result of productive use of reuse water.

If this site is selected for installation of a seawater demineralization plant, it will be essential to obtain operating information for all wastewater flows to determine exact dilution water available for blending the concentrate.

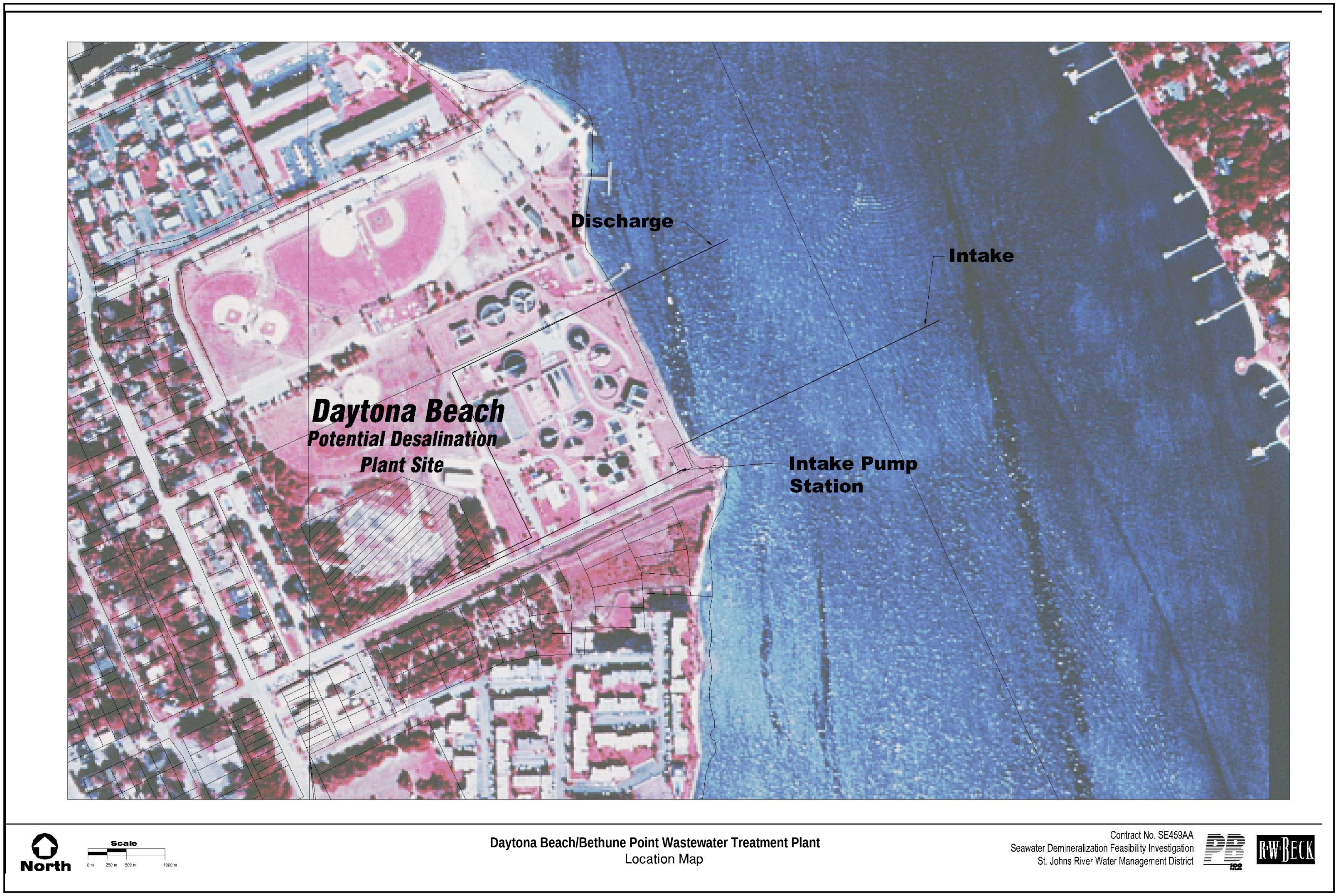
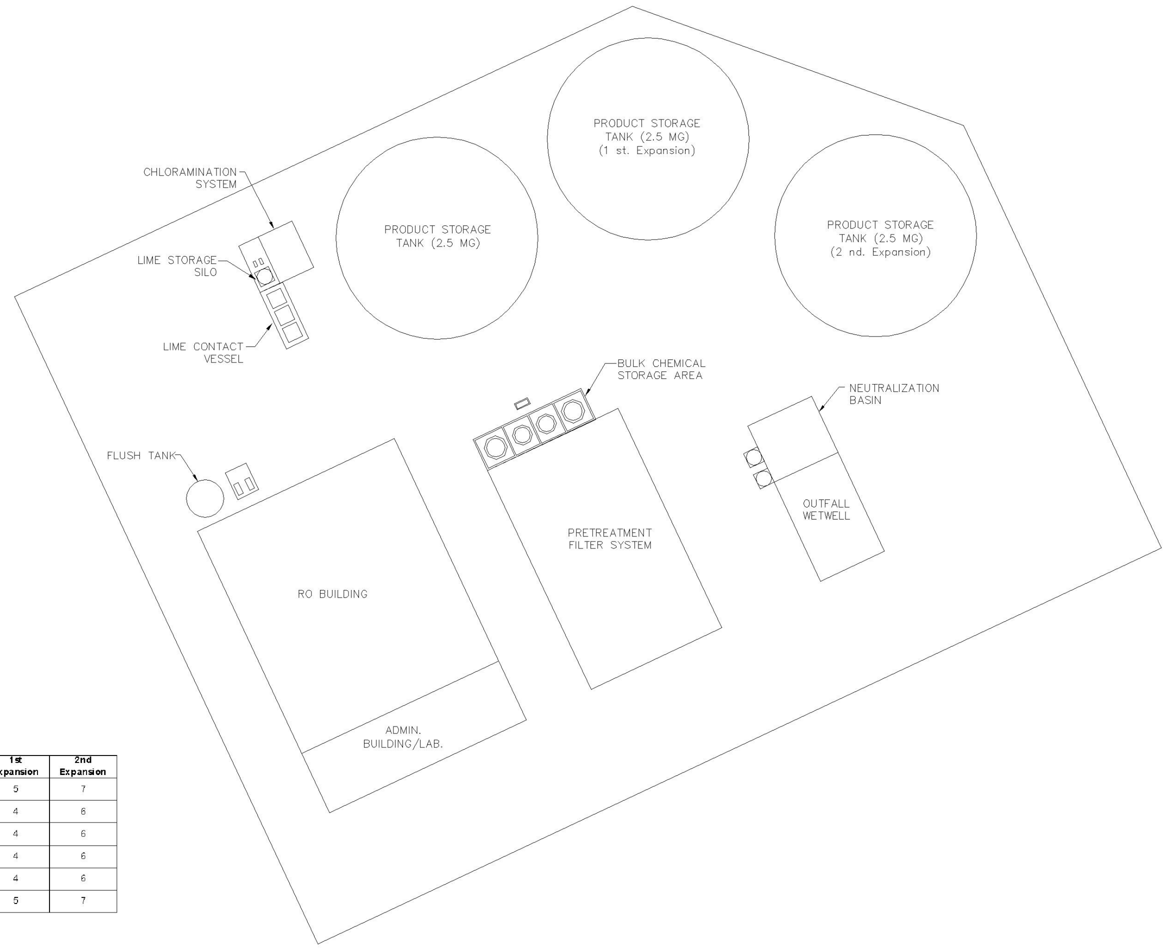


Figure 36. Daytona Beach/Bethune Point Wastewater Treatment Plant Site Location Map



Equipment	Initial	1st Expansion	2nd Expansion
Feed Intake Pump Units	3	5	7
Pretreatment Train Units	2	4	6
Cartridge Filter Housing Units	2	4	6
1st Pass RO Train Units	2	4	6
2nd Pass RO Train Units	2	4	6
Product Booster Pump Units	3	5	7

North

Daytona Beach/Bethune Point Wastewater Treatment Plant Conceptual Site Plan
(5/10/15 MGD)

Contract No. SE459AA
Seawater Demineralization Feasibility Investigation
St. Johns River Water Management District

Figure 37. Daytona Beach/Bethune Point Wastewater Treatment Plant Conceptual Site Plan

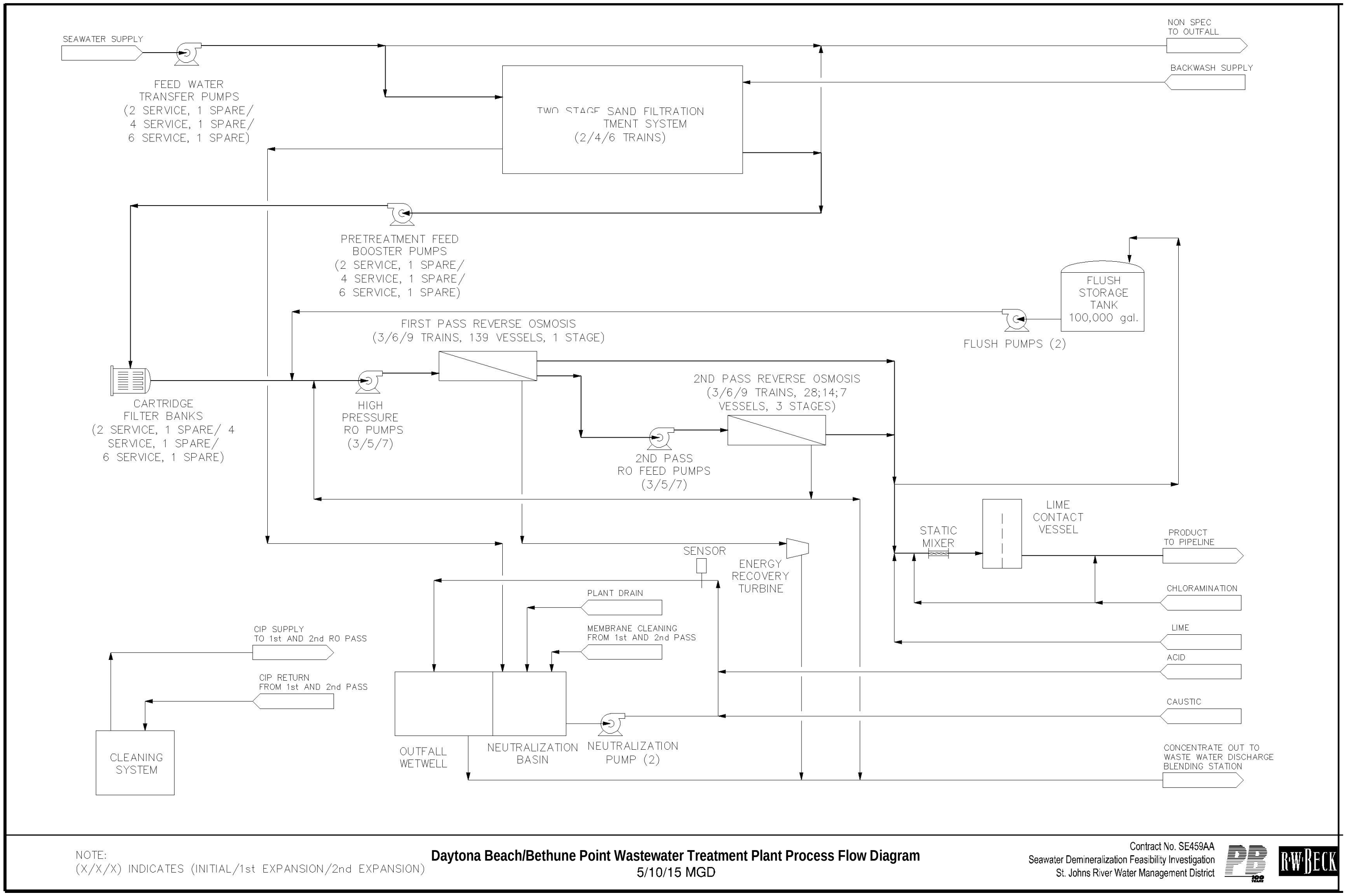


Figure 38. Daytona Beach/Bethune Point Wastewater Treatment Plant Process Flow Diagram

Conceptual Costs

Methodology

The study developed costs for each of the feasible sites and the various capacities using:

- Vendor quotes
- Bid costs
- Reference documents
- SJRWMD guidelines
- Industry standards
- Professional experience/judgment

The comparative project cost estimate elements include:

1. Construction
2. Land
3. Non-construction capital cost
4. Total Capital Cost (inclusive of items 1+2+3)
5. Annual O&M Cost at design capacity in $/ year
6. Equivalent annual cost ($/ year)
7. Unit production cost ($/kgal)

The study applied various assumptions to all sites to develop comparison-level costs, while some assumptions were specific to the individual sites. These are referenced in the conceptual design section of this report. The Cost Estimating and Economic Criteria for 2005 District Water Supply Plan by CH2MHill, included in Appendix A, provides further information on the cost development tools used in this study.

Pipeline cost estimates represent phased construction dependent upon plant capacity in phases, except as noted in the report. This results in slightly lower costs for the initial phase and slightly higher costs for the expansions. It also allows for the possibility that expansion to the full extent does not occur.

Reference Documents Used

References used to develop the costs include the following:

- Cost Estimating and Economic Criteria for 2005 District Water Supply Plan (draft), dated April 3, 2003, prepared by CH2M Hill

- Desalination for Texas Water Supply. HDR Engineering Inc., 2000, Prepared for Texas Water Development Board, Nueces River Authority, Central Power and Light Company, City of Corpus Christi and San Patricio Municipal Water District
- Basis of Design for Gulf Coast Desalination prepared by PB Water, November 2003
- Standard Handbook of Environmental Engineering, 1990

Preliminary Opinion of Costs Based on Concept Designs

The preliminary opinion of costs developed for this study for each of the top five favorable sites are shown in the tables below. These costs are comparative-level costs for the top five sites.

Table 2. Preliminary Opinion of Costs – Cape Canaveral Power Plant Site

Component	Cape Canaveral Power Plant Site Capacity (ADF) (mgd) 10	20	30
PLANT			
Land	$961,000	$961,000	$961,000
Structures (1)	$2,213,129	$4,426,259	$6,639,388
Pretreatment (2)	$1,955,458	$3,910,916	$5,866,374
RO Membranes (2a)	$16,863,254	$33,799,105	$50,666,180
Pumping Systems (3)	$7,512,373	$12,459,806	$16,751,839
Disinfection/ Post Treatment	$260,000	$416,000	$593,000
Pipelines (4)	$4,240,594	$7,091,145	$9,631,984
Storage Tanks	$1,000,000	$2,000,000	$3,000,000
Land Easement & Raw Costs	$443,600	$443,600	$443,600
SUBTOTAL	$35,449,408	$65,507,831	$94,553,365
Mobilization (5 %)	$1,136,772	$2,249,794	$3,360,427
Site Work (10 %)	$2,273,544	$4,499,588	$6,720,854
Yard Piping (5 %)	$1,136,772	$2,249,794	$3,360,427
Electrical (12 %)	$2,728,253	$5,399,506	$8,065,025
I&C (5 %)	$1,136,772	$2,249,794	$3,360,427
Contractor OH&P (10 %)	$2,273,544	$4,499,588	$6,720,854
SUBTOTAL	$46,135,065	$86,655,895	$126,141,379
NONCONSTRUCTION COSTS			
Contingency (20 %)	$9,227,013	$17,331,179	$25,228,276
Engineering, Design Permitting & Admin (25 %)	$11,533,766	$21,663,974	$31,535,345
SUBTOTAL	$66,895,845	$125,651,047	$182,905,000
PRODUCT WATER PIPELINES			
Pipelines	$6,741,926	$9,116,923	$10,495,954
Land Easement	$766,128	$766,128	$766,128
SUBTOTAL	$7,508,054	$9,883,051	$11,262,082
Mobilization (5 %)	$375,403	$494,153	$563,104
Contractor OH&P (10 %)	$750,805	$988,153	$1,126,208
SUBTOTAL	$8,634,263	$11,365,509	$12,951,394
NONCONSTRUCTION COSTS			
Contingency (20 %)	$1,726,853	$2,273,102	$2,590,279
Engineering, Design Permitting & Admin (25 %)	$2,158,566	$2,841,377	$3,237,848
SUBTOTAL	$12,519,681	$16,479,988	$18,779,521
TOTAL CONSTRUCTION(5)	$79,415,526	$142,131,035	$201,684,521
Operation & Maintenance(6)			
Chemicals & Expendables	$290,378	$580,755	$856,133
Membrane Replacement	$402,360	$804,720	$1,207,080
Disposal of Sludge	$229,900	$459,801	$689,701
Energy	$2,456,100	$4,860,200	$7,264,300
Labor	$780,000	$936,000	$936,000
Spare Parts/Parts Replacement	$88,421	$176,842	$265,134
SUBTOTAL	$4,247,159	$7,818,318	$11,218,348
Debt Service (5 percent, 20 years)	$6,373,000	$11,405,000	$16,184,000
TOTAL ANNUAL COST	$10,620,159	$19,223,318	$27,402,348
COST/1000 GALLONS	$3.06	$2.77	$2.63

General Notes:

a. For capacity, maximize the use of existing power plant cooling water intake/discharge systems, or other useful infrastructure.
b. The Total Construction cost is the total amount this study estimates to build the plant in Year 2002 dollars
c. O&M is the estimated annual cost of operating and maintaining the water supply facility when operated at average day capacity.
d. Includes cost for energy to run power plant intake pump(s) during times when the power plant is not operational,

Notes:

(1) Includes buildings, tankage, and laboratory.
(2) Assumes prefabricated sand filters, backwash facilities, and residuals handling.
(2a) Including required chemical feed systems.
(3) Includes raw water, process (including high pressure RO feed pumps), and high service.
(4) Includes intake and outfall pipelines and structures. Excludes all offsite product transmission pipelines.
(5) All labor, equipment, and materials to build a plant with max day capacity equal to ADF x Peaking Factor of 1.15.
(6) Energy, chemicals, membrane replacements, and labor, for ADF in Year 2002 dollars. Also includes filter backwash facilities and residuals handling.

Table 3. Preliminary Opinion of Costs – Indian River Power Plant Site

Component	Indian River Power Plant Site Treatment Capacity (ADF) (mgd) 10	20	30
PLANT			
Land	$668,216	$668,216	$668,216
Structures [(1)]	$2,213,129	$4,426,259	$6,639,388
Pretreatment [(2)]	$1,955,458	$3,910,916	$5,866,374
RO Membranes [(2a)]	$17,545,765	$34,777,868	$51,940,084
Pumping Systems [(3)]	$7,512,373	$12,459,806	$16,751,839
Disinfection/ Post Treatment	$260,000	$416,000	$593,000
Pipelines [(4)]	$3,318,175	$5,247,388	$6,866,348
Storage Tanks	$1,000,000	$2,000,000	$3,000,000
Land Easement & Raw Costs	$0	$0	$0
SUBTOTAL	$34,493,656	$63,926,452	$92,345,249
Mobilization (5 %)	$1,148,718	$2,276,552	$3,401,942
Site Work (10 %)	$2,297,435	$4,553,104	$6,803,885
Yard Piping (5 %)	$1,148,718	$2,276,552	$3,401,942
Electrical (12 %)	$2,756,922	$5,463,725	$8,164,661
I&C (5 %)	$1,148,718	$2,276,552	$3,401,942
Contractor OH&P (10 %)	$2,297,435	$4,553,104	$6,803,885
SUBTOTAL	$45,291,602	$85,326,042	$124,323,506
NONCONSTRUCTION COSTS			
Contingency (20 %)	$9,058,320	$17,065,208	$24,864,701
Engineering, Design Permitting & Admin (25 %)	$11,322,900	$21,331,511	$31,080,877
SUBTOTAL	$65,672,822	$123,722,761	$180,269,084
PRODUCT WATER PIPELINES			
Pipelines	$4,888,013	$6,609,926	$7,609,747
Land Easement	$555,456	$555,456	$555,456
SUBTOTAL	$5,443,469	$7,165,382	$8,165,203
Mobilization (5 %)	$272,173	$358,269	$408,260
Contractor OH&P (10 %)	$544,347	$716,538	$816,520
SUBTOTAL	$6,259,989	$8,240,190	$9,389,987
NONCONSTRUCTION COSTS			
Contingency (20 %)	$1,251,993	$1,648,038	$1,877,997
Engineering, Design Permitting & Admin (25 %)	$1,564,997	$2,060,047	$2,347,496
SUBTOTAL	$9,076,984	$11,948,275	$13,615,476
TOTAL CONSTRUCTION[(5)]	$74,749,806	$135,671,036	$193,884,560
Operation & Maintenance[(6)]			
Chemicals & Expendables	$290,378	$580,755	$856,133
Membrane Replacement	$402,360	$804,720	$1,207,080
Disposal of Sludge	$229,900	$459,801	$689,701
Energy	$2,775,344	$5,560,495	$8,438,100
Labor	$780,000	$936,000	$936,000
Spare Parts/Parts Replacement	$88,421	$176,842	$265,134
SUBTOTAL	$4,566,402	$8,518,612	$12,392,148
Debt Service (5 percent, 20 years)	$5,998,000	$10,887,000	$15,558,000
TOTAL ANNUAL COST	$10,605,402	$19,446,612	$27,991,148
COST/1000 GALLONS	$3.06	$2.80	$2.69

General Notes:

a. For capacity, maximize the use of existing power plant cooling water intake/discharge systems, or other useful infrastructure.
b. The Total Construction cost is the total amount this study estimates to build the plant in Year 2002 dollars
c. O&M is the estimated annual cost of operating and maintaining the water supply facility when operated at average day capacity.
d. Includes cost for energy to run power plant intake pump(s) during times when the power plant is not operational.

Notes:

(1) Includes buildings, tankage, and laboratory.
(2) Assumes prefabricated sand filters, backwash facilities, and residuals handling.
(2a) Including required chemical feed systems.
(3) Includes raw water, process (including high pressure RO feed pumps), and high service.
(4) Includes intake and outfall pipelines and structures. Excludes all offsite product transmission pipelines.
(5) All labor, equipment, and materials to build a plant with max day capacity equal to ADF x Peaking Factor of 1.15.
(6) Energy, chemicals, membrane replacements, and labor, for ADF in Year 2002 dollars. Also includes filter backwash facilities and residuals handling.

Table 4. Preliminary Opinion of Costs – W. E. Swoope Generating Station Site

W. E. Swoope Generating Station Site Capacity (ADF) (mgd)			
Component	5	10	15
PLANT			
Land	$384,000	$384,000	$384,000
Structures [1]	$1,106,565	$2,213,129	$3,319,694
Pretreatment [2]	$1,022,816	$2,045,632	$3,068,448
RO Membranes [2a]	$12,737,250	$21,273,469	$29,803,307
Pumping Systems [3]	$4,529,757	$7,512,373	$10,099,723
Disinfection/ Post Treatment	$163,326	$260,074	$370,614
Pipelines [4]	$13,303,992	$13,519,585	$13,735,179
Storage Tanks	$500,000	$1,000,000	$1,500,000
Land Easement & Raw Costs	$0	$0	$0
SUBTOTAL	$33,747,707	$48,208,262	$62,280,964
Mobilization (5 %)	$776,498	$1,339,615	$1,903,103
Site Work (10 %)	$1,552,996	$2,679,230	$3,806,206
Yard Piping (5 %)	$776,498	$1,339,615	$1,903,103
Electrical (12 %)	$1,863,595	$3,215,076	$4,567,448
I&C (5 %)	$776,498	$1,339,615	$1,903,103
Contractor OH&P (10 %)	$1,552,996	$2,679,230	$3,806,206
SUBTOTAL	$41,046,787	$60,800,645	$80,170,134
NONCONSTRUCTION COSTS			
Contingency (20 %)	$8,209,357	$12,160,129	$16,034,027
Engineering, Design Permitting & Admin (25 %)	$10,261,697	$15,200,161	$20,042,533
SUBTOTAL	$59,517,841	$88,160,935	$116,246,694
PRODUCT WATER PIPELINES			
Pipelines	$5,164,896	$9,073,574	$12,277,584
Land Easement	$1,019,040	$1,019,040	$1,019,040
SUBTOTAL	$6,183,936	$10,092,614	$13,296,624
Mobilization (5 %)	$309,197	$504,631	$664,831
Contractor OH&P (10 %)	$618,394	$1,009,261	$1,329,662
SUBTOTAL	$7,111,526	$11,606,507	$15,291,118
NONCONSTRUCTION COSTS			
Contingency (20 %)	$1,422,305	$2,321,301	$3,058,224
Engineering, Design Permitting & Admin (25 %)	$1,777,882	$2,901,627	$3,822,779
SUBTOTAL	$10,311,713	$16,829,435	$22,172,121
TOTAL CONSTRUCTION[5]	$69,829,554	$104,990,370	$138,418,815
Operation & Maintenance[6]			
Chemicals & Expendables	$156,289	$290,378	$436,466
Membrane Replacement	$201,600	$403,200	$604,800
Disposal of Sludge	$114,950	$229,900	$344,851
Energy	$1,647,690	$3,296,604	$4,947,744
Labor	$780,000	$780,000	$780,000
Spare Parts/Parts Replacement	$44,642	$89,203	$133,926
SUBTOTAL	$2,945,171	$5,089,286	$7,247,787
Debt Service (5 percent, 20 years)	$5,603,000	$8,425,000	$11,107,000
TOTAL ANNUAL COST	$8,548,171	$13,514,286	$18,354,787
COST/1000 GALLONS	$4.93	$3.90	$3.53

General Notes:

a. For capacity, maximize the use of existing power plant cooling water intake/discharge systems, or other useful infrastructure.
b. The Total Construction cost is the total amount this study estimates to build a plant in Year 2002 dollars
c. O&M is the estimated annual cost of operating and maintaining the water supply facility when operated at average day capacity.

Notes:

(1) Includes buildings, tankage, and laboratory.
(2) Assumes prefabricated sand filters, backwash facilities, and residuals handling.
(2a) Including required chemical feed systems.
(3) Includes raw water, process (including high pressure RO feed pumps), and high service.
(4) Includes intake and outfall pipelines and structures. Excludes all offsite product transmission pipelines.
(5) All labor, equipment, and materials to build a plant with max day capacity equal to ADF x Peaking Factor of 1.15.
(6) Energy, chemicals, membrane replacements, and labor, for ADF in Year 2002 dollars. Also includes filter backwash facilities and residuals handling.

Table 5. Preliminary Opinion of Costs – Northside Power Plant Site

Component	Northside Power Plant Site Capacity (ADF) (mgd) 10	20	30
PLANT			
Land	$1,147,838	$1,147,838	$1,147,838
Structures (1)	$2,213,129	$4,426,259	$6,639,388
Pretreatment (2)	$1,677,650	$3,355,229	$5,032,949
RO Membranes (2a)	$13,919,307	$27,697,300	$41,465,379
Pumping Systems (3)	$7,512,373	$12,459,806	$16,751,839
Disinfection/ Post Treatment	$260,074	$415,675	$592,919
Pipelines (4)	$3,545,324	$6,431,585	$9,171,002
Storage Tanks	$1,000,000	$2,000,000	$3,000,000
Land Easement & Raw Costs	$0	$0	$0
SUBTOTAL	$31,275,694	$57,933,761	$83,801,315
Mobilization (5 %)	$953,508	$1,894,727	$2,836,532
Site Work (10 %)	$1,907,016	$3,789,453	$5,673,064
Yard Piping (5 %)	$953,508	$1,894,727	$2,836,532
Electrical (12 %)	$2,288,419	$4,547,344	$6,807,676
I&C (5 %)	$953,508	$1,894,727	$2,836,532
Contractor OH&P (10 %)	$1,907,016	$3,789,453	$5,673,064
SUBTOTAL	$40,238,669	$75,744,192	$110,464,714
NONCONSTRUCTION COSTS			
Contingency (20 %)	$8,047,734	$15,148,838	$22,092,943
Engineering, Design Permitting & Admin (25 %)	$10,059,667	$18,936,048	$27,616,178
SUBTOTAL	$58,346,070	$109,829,078	$160,173,835
PRODUCT WATER PIPELINES			
Pipelines	$15,064,685	$21,567,902	$24,604,853
Land Easement	$766,128	$766,128	$766,128
SUBTOTAL	$15,830,813	$22,334,030	$25,370,981
Mobilization (5 %)	$791,541	$1,116,702	$1,268,549
Contractor OH&P (10 %)	$1,583,081	$2,233,403	$2,537,098
SUBTOTAL	$18,205,435	$25,684,135	$29,176,628
NONCONSTRUCTION COSTS			
Contingency (20 %)	$3,641,087	$5,136,827	$5,835,326
Engineering, Design Permitting & Admin (25 %)	$4,551,359	$6,421,034	$7,294,157
SUBTOTAL	$26,397,880	$37,241,996	$42,306,110
TOTAL CONSTRUCTION(5)	$84,743,950	$147,071,074	$202,479,945
Operation & Maintenance(6)			
Chemicals & Expendables	$271,434	$520,668	$769,902
Membrane Replacement	$402,360	$804,720	$1,207,080
Disposal of Sludge	$195,660	$391,320	$586,980
Energy	$2,218,133	$4,436,266	$6,654,400
Labor	$780,000	$936,000	$936,000
Spare Parts/Parts Replacement	$73,744	$147,021	$220,297
SUBTOTAL	$3,972,493	$7,257,318	$10,386,143
Debt Service (5 percent, 20 years)	$6,800,000	$11,801,000	$16,248,000
TOTAL ANNUAL COST	$10,823,331	$19,118,995	$26,704,659
COST/1000 GALLONS	$3.12	$2.76	$2.57

General Notes:

a. For capacity, maximize the use of existing power plant cooling water intake/discharge systems, or other useful infrastructure.
b. The Total Construction cost is the total amount this study estimates to build a plant in Year 2002 dollars
c. O&M is the estimated annual cost of operating and maintaining the water supply facility when operated at average day capacity.
d. Includes cost for energy to run power plant intake pump(s) during times when the power plant is not operational.

Notes:

(1) Includes buildings, tankage, and laboratory.
(2) Assumes prefabricated sand filters, backwash facilities, and residuals handling.
(2a) Single pass RO system including required chemical feed systems.
(3) Includes raw water, process (including high pressure RO feed pumps), and high service.
(4) Includes intake and outfall pipelines and structures. Excludes all offsite product transmission pipelines.
(5) All labor, equipment, and materials to build a plant with max day capacity equal to ADF x Peaking Factor of 1.15.
(6) Energy, chemicals, membrane replacements, and labor, for ADF in Year 2002 dollars. Also includes filter backwash facilities and residuals handling.

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Table 6. Preliminary Opinion of Costs – Daytona Beach/Bethune Point Wastewater Treatment Plant

Daytona Beach/Bethune Point Wastewater Treatment Plant Capacity (ADF) (mgd) Component	5	10	15
PLANT			
Land	$348,750	$348,750	$348,750
Structures [1]	$1,106,565	$2,213,129	$3,319,694
Pretreatment [2]	$1,046,730	$2,093,460	$3,140,190
RO Membranes [2a]	$11,959,654	$19,977,475	$28,100,695
Pumping Systems [3]	$4,529,757	$7,512,373	$10,099,723
Disinfection/ Post Treatment	$163,326	$260,074	$370,614
Pipelines [4]	$1,475,122	$1,690,715	$1,906,308
Storage Tanks	$500,000	$1,000,000	$1,500,000
Land Easement & Raw Costs	$0	$0	$0
SUBTOTAL	$21,129,904	$35,095,975	$48,785,974
Mobilization (5 %)	$738,814	$1,277,207	$1,821,560
Site Work (10 %)	$1,477,627	$2,554,414	$3,643,119
Yard Piping (5 %)	$738,814	$1,277,207	$1,821,560
Electrical (12 %)	$1,773,153	$3,065,297	$4,371,743
I&C (5 %)	$738,814	$1,277,207	$1,821,560
Contractor OH&P (10 %)	$1,477,627	$2,554,414	$3,643,119
SUBTOTAL	$28,074,753	$47,101,720	$65,908,635
NONCONSTRUCTION COSTS			
Contingency (20 %)	$5,614,951	$9,420,344	$13,181,727
Engineering, Design Permitting & Admin (25 %)	$7,018,688	$11,775,430	$16,477,159
SUBTOTAL	$40,708,392	$68,297,494	$95,567,521
PRODUCT WATER PIPELINES			
Pipelines	$2,457,840	$4,325,798	$5,849,659
Land Easement	$491,568	$491,568	$491,568
SUBTOTAL	$2,949,408	$4,817,366	$6,341,227
Mobilization (5 %)	$147,470	$240,868	$317,061
Contractor OH&P (10 %)	$294,941	$481,737	$634,123
SUBTOTAL	$3,391,819	$5,539,971	$7,292,411
NONCONSTRUCTION COSTS			
Contingency (20 %)	$678,364	$1,107,994	$1,458,482
Engineering, Design Permitting & Admin (25 %)	$847,955	$1,384,993	$1,823,103
SUBTOTAL	$4,918,138	$8,032,958	$10,573,996
TOTAL CONSTRUCTION[5]	$45,626,530	$76,330,452	$106,141,517
Operation & Maintenance[6]			
Chemicals & Expendables	$147,200	$294,399	$441,599
Membrane Replacement	$303,240	$505,400	$707,560
Disposal of Sludge	$117,978	$235,957	$353,935
Energy	$1,741,668	$3,484,539	$5,229,388
Labor	$780,000	$780,000	$780,000
Spare Parts/Parts Replacement	$60,995	$103,006	$145,596
SUBTOTAL	$3,151,041	$5,403,300	$7,658,079
Debt Service (5 percent, 20 years)	$3,661,000	$6,125,000	$8,517,000
TOTAL ANNUAL COST	$6,812,041	$11,528,300	$16,175,079
COST/1000 GALLONS	$3.93	$3.32	$3.11

General Notes:
a. For capacity, maximize the use of existing discharge systems, or other useful infrastructure.
b. The Total Construction cost is the total amount this study estimates to build a plant in Year 2002 dollars
c. O&M is the estimated annual cost of operating and maintaining the water supply facility when operated at average day capacity.

Notes:
(1) Includes buildings, tankage, and laboratory.
(2) Assumes prefabricated sand filters, backwash facilities, and residuals handling.
(2a) Including required chemical feed systems.
(3) Includes 3 pump systems; raw water, process (including high pressure RO feed pumps), and high service.
(4) Includes intake and outfall pipelines and structures. Excludes all offsite product transmission pipelines.
(5) All labor, equipment, and materials to build a plant with max day capacity equal to ADF x Peaking Factor of 1.15.
(6) Energy, chemicals, membrane replacements, and labor, for ADF in Year 2002 dollars. Also includes filter backwash facilities and residuals handling.

Recommendation and Conclusions

A summary of the order of magnitude costs for siting of seawater demineralization facilities is as follows:

Table 7. Order of Magnitude Costs*

Summary of Costs			
Indian River Power Plant			
Treatment Capacity (mgd)	10	20	30
Cost/ 1,000 Gallons	$3.06	$2.80	$2.69
Cape Canaveral Power Plant			
Treatment Capacity (mgd)	10	20	30
Cost/ 1,000 Gallons	$3.06	$2.77	$2.63
Daytona Beach/Bethune Point Wastewater Treatment Plant			
Treatment Capacity (mgd)	5	10	15
Cost/ 1,000 Gallons	$3.93	$3.32	$3.11
W. E. Swoope Generating Station			
Treatment Capacity (mgd)	5	10	15
Cost/ 1,000 Gallons	$4.93	$3.90	$3.53
Northside Power Plant			
Treatment Capacity (mgd)	10	20	30
Cost/ 1,000 Gallons	$3.12	$2.76	$2.57

* - Lifecycle costs including capital and O&M costs for a 20 year period

The estimated unit costs of water produced in terms of $/1000 gallon delivered water cost were much lower for the three sites rated for 10, 20 and 30 mgd capacity (Cape Canaveral, Indian River Power Plant and Northside Power Plants) than those for the two sites rated for 5, 10 and 15 mgd capacity (W. E. Swoope Generating Station and Daytona Beach/Bethune Point Wastewater Treatment Plant). The Northside Power Plant site yielded the lowest at 20 and 30 mgd. The Indian River Power Plant site and Cape Canaveral Power Plant site yielded the lowest estimated costs for water produced at a 10 mgd capacity. The unit costs ranged from $3.12/1000gal to $2.57/1000gal for the Northside Power Plant site. The unit costs ranged from $3.06/1000gal to $2.69/1000gal for the Indian River Power Plant site. The unit costs ranged from $3.06/1000gal to $2.63/1000gal for the Cape Canaveral Power Plant site. The W. E. Swoope Generating Station site yielded the highest estimated unit costs for water produced at lower capacities. The W. E. Swoope Generating Station unit costs ranged from $4.93/1000gal to $3.53/1000gal. Higher costs are expected on a $/1000 gallon basis for a smaller capacity facility primarily due to economies of scale. However, other factors contributing to the higher costs for this facility are related to the separate concentrate discharge pipeline outfall to the ocean. This re-affirms previously observed (or assumed) cost savings associated with blending the concentrate with available power plant cooling water discharges where feasible.

As a comparison the Tampa Bay Water Seawater Desalination Facility cost of produced water per 1,000 gallons is estimated at $2.02 for the first year of operation and $2.49 for the average cost for the life of the project. Note that significant comparison differences exist since the basis for the Tampa project is 30 years while the basis for the proposed SJRWMD projects is 20 years. A longer term basis may reduce the overall project price by stretching out capital costs over a longer term period.

The Indian River Power Plant and Northside Power Plant appear to have site characteristics that may limit the size of a potential seawater demineralization facility under low cooling water flow circumstances. Under a worst case scenario where the power plants would be discharging a maximum concentrate flow combined with a minimum cooling water flow, the blended concentrate stream would generate a TDS concentration increase above FDEP requirements. Additionally for the Indian River Power Plant, in the case of discharging a maximum concentrate flow (from a 30 mgd demineralization plant) combined with a maximum cooling water flow, the blended concentrate stream would generate a TDS concentration increase above FDEP requirements. This may be resolved by running the power plant's dilution water pumps, reduction of operating capacity of the demineralization facility during periods when lower cooling water flow is available, installation of additional cooling water pumps, modification of FDEP requirements through permit conditions or other alternatives. Without these modifications it is likely that the demineralization plant would be limited to a capacity of 22 mgd.

The Daytona Beach/Bethune Point Wastewater Treatment Plant site may be limited to a demineralization plant capacity of 13 mgd based on current flow conditions. This would yield a combined (with wastewater effluent) concentrate discharge TDS of less than 10% above the natural seawater TDS. Current regulatory emphasis is on development of reuse resources. In the foreseeable future any WWTP wastewater stream is likely to be reduced or eliminated as a result of productive use of reuse water. This in turn may increase the potential demineralization plant capacity. If this site is selected for installation of a seawater demineralization plant, it will be essential to obtain operating information for all wastewater flows to determine exact dilution water available for blending with the concentrate.

Recommendations

Following are recommendations concerning seawater demineralization in SJRWMD.

- SJRWMD should continue to seek a water utility(ies) to consider development of a seawater demineralization facility. Water utilities to be considered that are currently identified as recipients of demineralized water, depending on the collocation site, include
    - City of Titusville
    - City of Daytona Beach/ Water Authority of Volusia
    - JEA
    - City of New Smyrna Beach/ Water Authority of Volusia

  These facilities include those that have water treatment facilities that exceed 5 mgd in size and are identified as having water supply deficits. Additional water utilities may also include those that may be in close proximity to the proposed product water transmission routing. Other regional water providers, such as the City of Cocoa, in the vicinity of these sites may also want to be considered.

- More detailed engineering and environmental analysis should be conducted for the most favorable site(s) prior to development of a seawater demineralization plant
- Conduct discussions with owners of collocation facilities
  - Negotiations with the appropriate power utility owner should begin to determine their level of interest in collocation of a seawater demineralization plant
  - Obtain and review operational records from the power company to verify cooling water flows, operational shut downs, available flow for blending, temperature of available water, and water quality. Records should be reviewed as needed to determine long term trends and seasonal fluctuations
  - Discussions with each owner of the property are necessary to confirm preferred parcel and acreage available for each demineralization plant
- Continue monitoring of regulations pertaining to reduction/ elimination of the use of once through cooling for power plants. Modification of these requirements may reduce the preference to collocate demineralization at power plants
- Perform a pilot study(ies)
  - Further evaluation of the preferred pretreatment method is required. Membrane-type pretreatment may be favorable due to the water quality variations and recent pilot studies that show membrane pre-filtration may extend the life of reverse osmosis membranes under certain conditions
  - Installation of a pilot plant at the potential demineralization site/power plant site is strongly recommended and will be essential to developing the design of the pretreatment system and the RO process. The pilot study should be operated for a sufficient period of time necessary to experience seasonal changes such as temperature, water quality, and salinity
- Continue monitoring of regulations pertaining to concentrate discharge to surface waters, and particularly to the open ocean. Preliminary meetings with the FDEP are suggested to discuss potential site-specific plans for concentrate discharge and blending requirements
- Monitoring of the operating conditions and plans and status of permitting actions of the various power plant sites is recommended to determine issues that may affect siting of a seawater demineralization facility
- Continue monitoring reuse objectives at WWTP's if combined discharge at these facilities will be pursued in the future.

Appendix

Appendix A – Cost Estimating and Economic Criteria for 2005 District Water Supply Plan

Cost Estimating and Economic Criteria for 2005 District Water Supply Plan (draft)

PREPARED FOR: Patrick Burger/SJRWMD
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COPIES: Barbara Vergara/ SJRWMD
Jerry Salsano/TAURANT

DATE: April 3, 2003

Purpose

This memo provides cost definitions and cost estimating and economic criteria to be used in the development of water supply facilities costing for the 2005 District Water Supply Plan (DWSP). The costing evaluation is primarily in support of the SJRWMD optimization and decision models. However, these criteria should also be applied to all cost estimates and economic comparisons developed as part of the 2005 DWSP to ensure that all costs are directly comparable. These criteria provide a consistent set of definitions and criteria for the development of comparable planning level life cycle cost estimates for all water supply alternatives.

Once the cost criteria are approved, they will be used to develop generalized conceptual planning level cost estimating equations or procedures to provide water supply alternative costs for the SJRWMD decision model.

Definitions

The following definitions will be used in this evaluation and throughout the remainder of the 2005 DWSP project and should be adhered to when applicable. For the most part, these definitions are the same as used by SJRWMD as well as SWFWMD in the development of the initial 2000 DWSPs.

Construction Cost

The construction cost is the total amount expected to be paid to a qualified contractor to build the required facilities at peak design capacity.

Non-Construction Capital Cost

Non-construction capital cost is an allowance for construction contingency, engineering design, permitting and administration associated with the constructed facilities.

Land Cost

The market value of the land required to implement the water supply option.

Land Acquisition Cost

The estimated cost of acquiring the required land.

Total Capital Cost

Total capital cost is the sum of construction cost, non-construction capital cost, land cost, and land acquisition cost.

Operation and Maintenance Cost

The estimated annual cost of operating and maintaining the water supply option when operated at average day capacity.

Equivalent Annual Cost

Total annual life cycle cost of the water supply option based on service life and time value of money criteria established for this project. Equivalent Annual Cost accounts for Total Capital Cost and O&M costs with facility operating at average day design capacity.

Present Worth

The equivalent present value of current and future expenditures for a specified planning period.

Unit Production Cost

Annual cost divided by annual water production. The Unit Production Cost will be expressed in terms of dollars per 1,000 gallons.

Criteria

Cost estimating and economic criteria are guidelines for estimating costs associated with water supply options.

Peak Flow Ratio

Capital cost of water supply facilities will be based on maximum installed capacity designed to accommodate peak or maximum daily flow (MDF) requirements. O&M costs and annual water production are based on the average daily flow (ADF) produced. The peak flow ratio (MDF/ADF) for an individual water supply system depends on the characteristics of the service area. For public supply systems the peak ratio is generally at least 1.25 for large systems and can be greater than 2.0 for small systems.

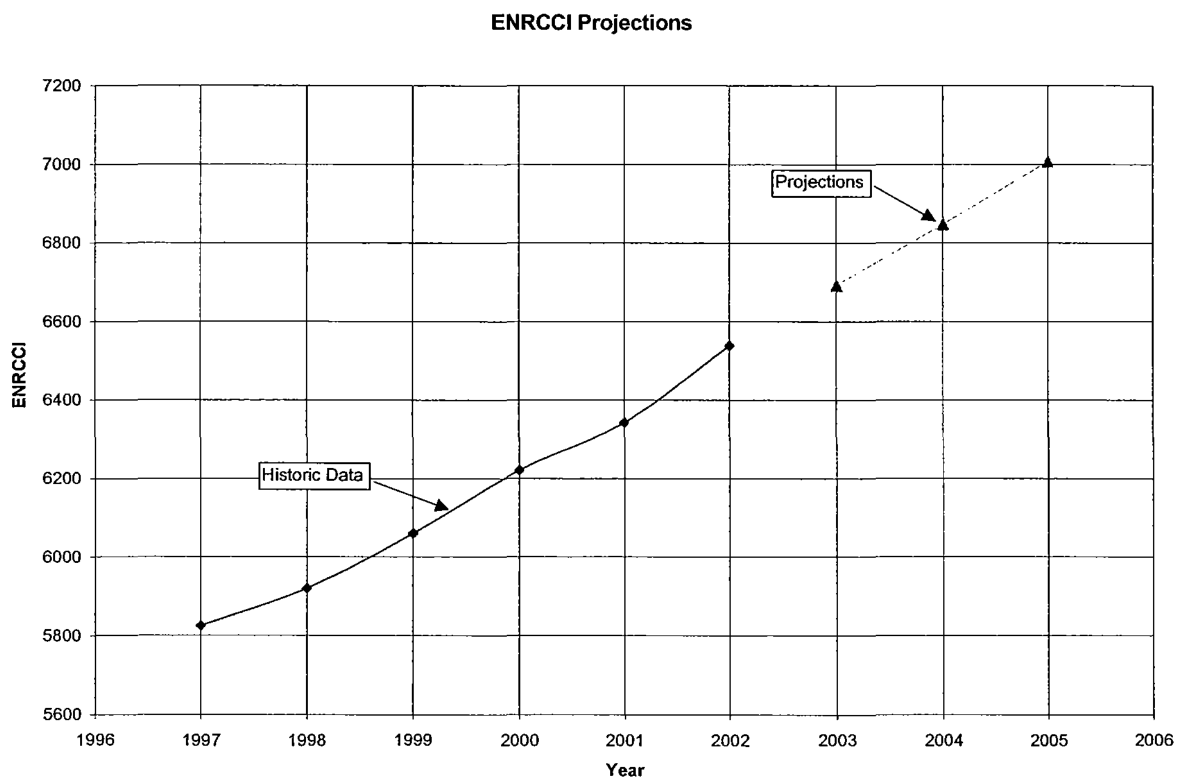
For water supply options where the service area peak flow ratio is known, this value can and should be used in the cost estimating and economic calculations. For regional planning applications, including application of the SJRWMD decision model, a peak ratio of 1.5 will be used. This MDF/ADF ratio was applied in the 2000 DWSP.

Cost Index

The Engineering News Record (ENR) publishes a monthly Construction Cost Index (CCI) that can be used to adjust the cost basis of a given project forwards or backwards in time. The ENRCCI is based on the following construction items: 200 hours of common labor at the 20-city average of common labor rates, plus 25 cwt of standard structural steel shapes at the mill price prior to 1996 and the fabricated 20-city price from 1996, plus 1.128 tons of Portland cement at the 20-city price, plus 1,088 board-ft of 2 x 4 lumber at the 20-city price.

Because much of the work associated with the 2005 DWSP project will be completed in the coming years and reported in 2005, all cost estimates will be expressed in estimated year 2005 dollars. Estimating year 2005 costs involves the projection of the year 2002 ENRCCI (2002 mean annual ENRCCI = 6, 538) to year 2005 ENRCCI. Exhibit 1 shows the recent historic ENRCCI trend, as well as, ENRCCI projections for years 2003, 2004, and 2005. The projected ENRCCI for year 2005 is 7,000. This projection is based on the historically observed 2.34% mean annual growth rate for the period 1997 to 2002.

EXHIBIT 1
ENRCCI Projection to 2005
Cost Estimating & Economic Evaluation Criteria



The cost basis for the 2000 DWSP was March 1996 with a corresponding ENRCCI value of 5537. Using the projected year 2005 ENRCCI value of 7000 represents an increase in the cost basis of about 26 percent.

Non Construction Capital Cost

Non construction capital cost will equal 45% of the planning level estimated construction cost. This includes a 20% allowance for construction contingency and a 25% allowance for engineering design, permitting, and administration. This value is unchanged from the 2000 DWSP.

Land Cost

Unit land cost ($/acre) for each parcel are based upon land use classification and size as supplied by SJRWMD land acquisition staff for the 2000 DWSP. An evaluation of current land values, as per recent SJRWMD land purchases, did not provide an adequate basis for revising the 2000 DWSP values. If actual site specific land values are available for a given parcel and water supply option the site specific value should be used in lieu of these typical regional values.

General land use classifications include urban, suburban, and rural. Size is based on acreage, where *small* refers to parcels 50 acres or less in size and *large* refers to parcels greater than 50 acres in size. Exhibit 2 provides the unit land cost matrix for parcels.

EXHIBIT 2
Unit Land Cost for Parcels
Cost Estimating & Economic Evaluation Criteria

Land Use Classification	Parcel Size	
	Small (< or = 50 acres) ($/acre)	Large (> 50 acres) ($/acre)
Urban	$ 100,000	N/A
Suburban	$ 20,000	$ 10,000
Rural	$ 5,000	$ 3,000

Unit land costs ($/ft^2)for pipeline corridors vary based on the land use classification and whether or not the parcel is adjacent to public right of way (ROW) or in an undeveloped (new) area, and whether an easement or full ROW is required. Exhibit 3 provides the unit cost matrix for pipeline corridors. These values are the same as used in the 2000 DWSP.

EXHIBIT 3
Unit Land Cost for Pipeline Corridors
Cost Estimating & Economic Evaluation Criteria

Land Use Classification	Adjacent to Public ROW		New Area	
	Easement ($/ft2)	ROW ($/ft2)	Easement ($/ft2)	ROW ($/ft2)
Urban	$ 4.00	$ 6.00	$ 3.00	$ 5.00
Suburban	$ 1.50	$ 3.00	$ 1.00	$ 2.00
Rural	$ 0.75	$ 1.00	$ 0.50	$ 0.75

Land Acquisition Cost

Land acquisition costs will be estimated as 25% of land cost. This is the same value used in the 2000 DWSP.

Interest Rate

The interest rate, to be used in all annual cost and present worth calculations, is based on typical rates for long term municipal bonds. The current (March 2003) average rate for high quality (AAA) 30 year municipal bonds is 4.87 percent. Based on this current municipal bond rate, an interest rate of 5% is chosen for all for all 2005 DWSP economic calculations.

Economic Life of Facilities

The economic service life of facilities is based on the criteria adopted for the 2000 DWSP. Exhibit 4 provides the economic service life, in years based on component type. These values will be used in all annual cost and present worth calculations.

In all cases, land is considered a permanent resources and therefore has an infinite service life.

EXHIBIT 4
Economic Service Life
Cost Estimating & Economic Evaluation Criteria

Component Type	Service Life (years)
Water Conveyance Structures	40
(pipelines, collection and distribution systems)	
Other Structures	35
(buildings, tankage, site improvements, etc.)	
Wells	30
Process and Auxiliary Equipment	20
(treatment equipment, pumps motors, mechanical equipment, etc.)	
Reverse Osmosis Membranes	5

Present Worth

A 20 year planning period will be used in present worth calculations. This present worth planning period was also used in the 2000 DWSP.

Summary

For the most part definitions and cost estimating and economic criteria applied to the 2005 DWSP will be the same as those applied to the 2000 DWSP. The main exceptions are the cost basis which will be estimated year 2005 cost whereas the 2000 DWSP was developed using March 1996 dollars. The second major adjustment is the interest rate used in the economic calculations. An interest rate of 7 percent was used for the 2000 DWSP and an interest rate of 5 percent will be used for the 2005 DWSP. All other definitions and criteria remain unchanged.