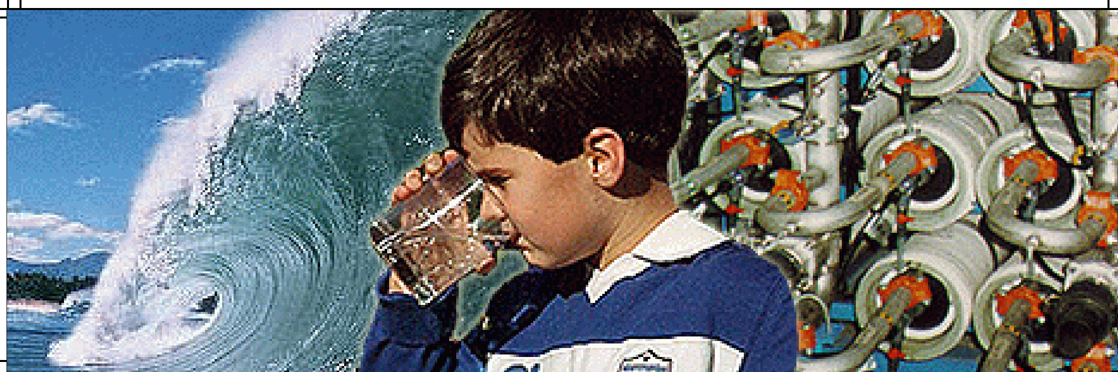
FEASIBILITY STUDY FOR CO-LOCATING REVERSE OSMOSIS TREATMENT FACILITIES WITH ELECTRIC POWER PLANTS



PREPARED
FOR
FOR THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT
AND
FLORIDA POWER & LIGHT

JUNE 2002

Water Resource Associates, Inc.
Planning, Engineering, Environmental Science
Tampa, Florida

In cooperation with

URS
Planning and Economics Group
Scheda Ecological Associates

EXECUTIVE SUMMARY

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The South Florida Water Management District (SFWMD) is charged with managing water and related resources for the benefit of the public and in keeping with the needs of the region. The key elements of the SFWMD's Missions include environmental protection enhancement, water quality protection, water supply, and flood protection.

In order to accomplish the Water Supply Mission Element, the SFWMD has undertaken a Water Supply Planning Initiative. This initiative is investigating the feasibility of a wide range of water supply sources including the desalination of brackish water and seawater. Co-locating seawater Reverse Osmosis (RO) potable water treatment facilities with electric power plants has been demonstrated to provide significant volumes of drinking water at a moderate cost. In addition, this alternative water supply would provide a dependable source of water during periods of drought.

In February 2001, the SFWMD initiated a cooperative study with the Florida Power & Light Company (FPL) titled, Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants (Study). The objective of this Study was to evaluate the technical, and regulatory feasibility of co-locating seawater/brackish RO potable water treatment facilities with electric power plants. The methodology employed used a three-step evaluation process to evaluate 23 existing and planned electric power plants located within the SFWMD. A series of 56 criteria were applied to the 23 potential sites to identify the most feasible sites for future implementation. In addition, a Desalination Feasibility Cost Model (Model) was developed to readily generate project planning costs for the selected sites.

As an initial component of the Study, the Tampa Bay Desalination Project was reviewed to determine the criteria that made that project feasible for the Tampa Bay Region. Project costs were evaluated to estimate the cost savings resulting from the unique features of the project including co-location with the Tampa Electric Company Big Bend Power Plant, advances in RO technology, plant capacity, competition and financing terms. It was determined that the unique benefits of this project resulted in an approximate 40 percent savings over conventional RO project costs.

The benefits of co-located RO facilities and electric power plants are found in two main categories: environmental compliance and cost. The environmental compliance benefit is realized in the ability to dispose of the desalination process concentrate by blending it with the power plant's cooling water discharge. This disposal method was recently permitted by the Florida Department of Environmental Protection in conjunction with the Tampa Bay Desalination Project. The second benefit is derived from the cost savings of using existing and permitted intake and discharge structures to provide raw water to the plant and provide a means for concentrate disposal. These two items can otherwise involve large capital costs, and the time associated with permitting such new structures can be lengthy and costly. The other significant advantage of using the power plant cooling water is that by using the heated cooling water (as it exits the power plant) as the supply for the RO process, the pressure necessary to produce the product water and the associated energy used in the RO process are both significantly reduced. There is also the potential for additional co-location advantages of a less significant impact, such as shared land, labor, and facilities.

The initial 23 sites were evaluated and two sites were selected for a more detailed evaluation and cost analysis. The FPL Ft. Myers Power plant located in Lee County and the FPL Port Everglades Power Plant located in Broward County were ranked as " highly desirable" sites.

Based on the Study, the capital cost of the co-located facility located at Ft. Myers would be \$17.3M, yielding a unit cost of \$1.33 per 1000 gallons for a 10 mgd facility and the capital cost of the 25 mgd facility would be \$35.5M, yielding a unit cost of \$1.16 per 1000 gallons. The capital cost of the co-located facility at Port Everglades would be \$37.6M yielding a unit cost of \$2.40 per 1000 gallons for a 10 mgd facility and the capital cost of a 25 mgd facility would be \$78.6M yielding a unit cost of \$2.14 per 1000 gallons.

In conclusion, the Study finds:

Seawater desalination by RO is a technically feasible water supply source for Florida, offering high quality potable water on a dependable basis regardless of hydrologic conditions.

- The FPL Ft. Myers site was determined to be a "highly desirable" co-location site due to the lower salinity and quantity of the available cooling water supply, extended life span of the power plant, adequate land availability, proximity to a major utility transmission line and growing potable water demand in service area.

- The FPL Port Everglades site was determined to be a "highly desirable" co-location site due to the quantity of the available cooling water supply, expected life span of the power plant, adequate land availability and growing potable water demand in service area.

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LIST OF ACRONYMS USED IN REPORT

ACOE	US ARMY CORPS OF ENGINEERS
ASR	AQUIFER STORAGE AND RECOVERY
BGD	BILLION GALLONS PER DAY
CC	COMBINED CYCLE
CDBG	COMMUNITY DEVELOPMENT BLOCK GRANT
CERP	COMPREHENSIVE EVERGLADES RESTORATION PLAN
C	CELSIUS
CT	COMBINED TURBINE
CUP	COMSUMPTIVE USE PERMIT
CWA	CLEAN WATER ACT
DBO	DESIGN-BUILD-OPERATE
DBOOT	DESIGN-BUILD-OPERATE-OWN-TRANSFER
DISTRICT	SOUTH FLORIDA WATER MANAGEMENT DISTRICT
DOH	DEPARTMENT OF HEALTH
EPA	US ENVIRONMENTAL PROTECTION AGENCY
EPC	ENGINEERING, PROCUREMENT AND CONSTRUCTION
EPRI	ELECTRIC POWER RESEARCH INSTITUTE
ERP	ENVIRONMENTAL RESOURCE PERMIT
ERT	ENERGY RECOVERY TUBES
F	FAHRENHEIT
FAC	FLORIDA ADMINISTRATIVE CODE
FDA	FLORIDA DEPARTMENT OF AGRICULTURE
FDEP	FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
FDOT	FLORIDA DEPARTMENT OF TRANSPORTATION
FFWCC	FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION
FKEC	FLORIDA KEYS ELECTRIC COOPERATIVE
FPL	FLORIDA POWER & LIGHT
GAL	GALLONS
GOVERNING BOARD	GOVERNING BOARD OF THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT
GPD	GALLONS PER DAY
GPM	GALLONS PER MINUTE
GT	GAS TURBINE
HRSG	HEAT RECOVERY STEAM GENERATOR
HUD	HOUSING AND URBAN DEVELOPMENT
ICW	INTRACOASTAL WATERWAY
IRL	INDIAN RIVER LAGOON
IWWF	INDUSTRIAL WASTEWATER FACILITY
kWh	KILLOWATTS PER HOUR
LLC	LIMITED LIABILITY CORPORATION
M	MILLION
MFL	MINIMUM FLOWS AND LEVELS
MG	MILLION GALLONS
mg/L	MILLIGRAMS PER LITER
MGD	MILLION GALLONS PER DAY
MIT	MECHANICAL INTEGRITY TESTING
MODEL	DESALINATION FEASIBILITY COST MODEL
MW	MEGAWATT
NPDES	NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
NPS	NATIONAL PARK SERVICE

NRC	NUCLEAR REGULATORY COMMISSION
O&M	OPERATION AND MAINTENANCE
OFW	OUTSTANDING FLORIDA WATER
PPM	PARTS PER MILLION
PSIG	POUNDS PER SQUARE INCH GRAVITY
R&D	RESEARCH AND DEVELOPMENT
RECLAMATION	US DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION
RO	REVERSE OSMOSIS
SDI	SILT DENSITY INDEX
SF/LF	SQUARE FEET PER LINEAR FOOT
SFWMD	SOUTH FLORIDA WATER MANAGEMENT DISTRICT
SR	STATE ROAD
SRFs	STATE REVOLVING FUNDS
ST	STEAM TURBINE
STUDY	FEASIBILITY STUDY FOR CO-LOCATING REVERSE OSMOSIS TREATMENT FACILITIES WITH ELECTRIC POWER PLANTS
SWFWMD	SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
SWRO	SEAWATER REVERSE OSMOSIS
SWTR	SURFACE WATER TREATMENT RULE
T&E	THREATENED AND ENDANGERED
TAC	TECHNICAL ADVISORY COMMITTEE
TBD	TAMPA BAY DESAL
TBW	TAMPA BAY WATER
TDS	TOTAL DISSOLVED SOLIDS
TECO	TAMPA ELECTRIC COMPANY
USACOE	US ARMY CORPS OF ENGINEERS
USDW	UNDERGROUND SOURCE OF DRINKING WATER
USFWS	US FISH AND WILDLIFE SERVICE
VA	DEPARTMENT OF VETERANS AFFAIRS
WRA	WATER RESOURCE ASSOCIATES
WRI	WATER RESOURCE INVESTIGATIONS
WS	WATER SUPPLY

INTRODUCTION

1.0 INTRODUCTION

1.1 PURPOSE AND OBJECTIVE OF STUDY

The South Florida Water Management District (SFWMD) is charged with managing water and related resources for the benefit of the public and in keeping with the needs of the region. The key elements of the SFWMD's Mission are:

- Environmental Protection and Enhancement;
- Water Quality Protection;
- Water Supply; and
- Flood Protection.

The Mission is accomplished through the combined efforts of planning and research, operations and maintenance, community and government relations, land management, regulation and construction. The SFWMD's area of responsibility extends over sixteen counties from Orlando to Key West and serves a population of over 6 million people. Eight (8) of these counties have coastal boundaries.

In order to accomplish the Water Supply Mission Element, the SFWMD has undertaken a Water Supply Planning Initiative. The goal of this Initiative is to provide for improved management of South Florida's water resources. An important component of this initiative is the development of water supply plans. These plans provide analyses of the water resources through computer simulations using both regional and sub-regional models. A variety of water supply alternatives were evaluated using these models to determine actions that might be taken in the future to improve the water supply availability for all water supply demands, including the environment. These water supply plans include the Comprehensive Everglades Restoration Plan (CERP) and regional and sub-regional water supply plans, which recommend methods to be used or investigated to ensure adequate future water supplies. Technologies that have been recommended for use or further study include brackish water (including seawater) reverse osmosis (RO) and aquifer storage and recovery (ASR). Because of its historical high cost, seawater desalination was not recommended in the CERP or water supply plans as a method to be used in meeting water supply needs.

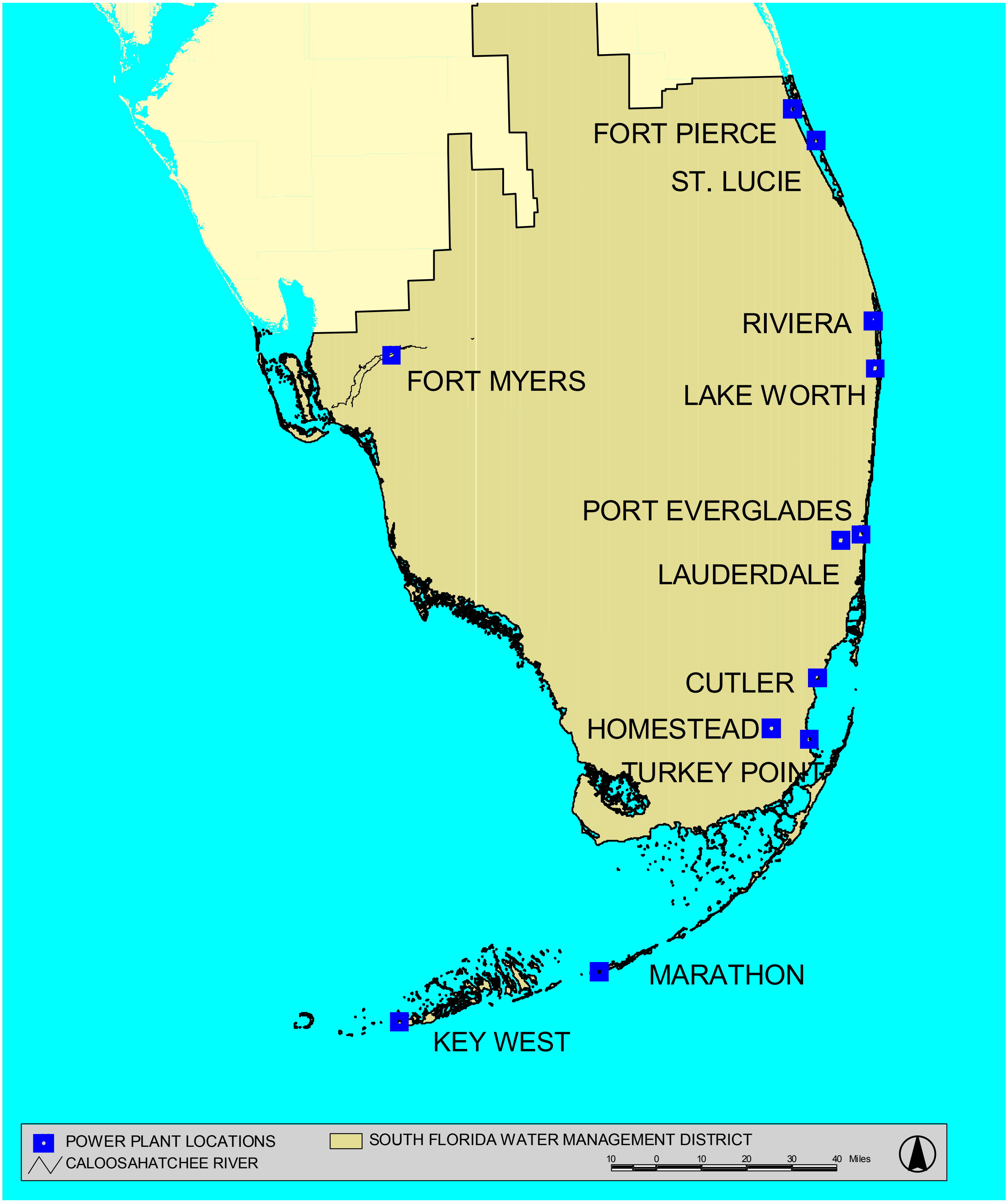
Construction recently began on a "seawater" RO treatment facility to be co-located at Tampa Electric Company's Big Bend Power Plant abutting Tampa Bay. The most significant advantage of co-locating a seawater RO facility with a power plant is that the power plant's cooling water can be used to dilute the RO facility's discharge reject (concentrate). Cost per thousand gallons for the 30-year life cycle of production at the Tampa Bay facility has been quoted at $2.08 per 1000 gallons, which is significantly lower than any other existing or currently proposed seawater desalination facility.

Co-locating seawater RO potable water treatment facilities with coastal electrical power plants could possibly provide significant volumes of drinking water at moderate cost. Because the water source (seawater) is not affected by seasonal weather conditions, it provides a secure and stable source of potable water even during droughts. The ability to provide potable drinking water from a seawater source at moderate cost could help to meet future water demands thereby reducing the dependence on fresh water deliveries from the SFWMD's regional system.

This feasibility study also includes an evaluation of RO technology to treat brackish water (e.g. Caloosahatchee River) in the interior of the SFWMD. RO technology should also improve compliance capability to meet new drinking water quality criteria being proposed by the U.S. Environmental Protection Agency (EPA) and the Florida Department of Environmental Protection (FDEP). Co-located seawater RO and power plant facilities could play an important role in the water supply planning effort of the SFWMD.

OBJECTIVE

The objective of this feasibility study is to evaluate the technical, regulatory, and economic feasibility of co-locating seawater/brackish RO potable water treatment facilities with electrical power plants. The results of the feasibility study will assist the SFWMD in determining if co-locating seawater RO potable water treatment facilities with electrical power plants in the SFWMD's area of jurisdiction, constitutes a feasible method to help ensure adequate future water supplies. (See Figure 1-1 for location of existing power plants under review.)



Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 1-1: GENERAL LOCATION MAP OF EXISTING POWER PLANTS

Prepared for:
South Florida Water Management District
Florida Power & Light Company

1.2 SCHEDULE OF STUDY AND ROLE OF SFWMD & FPL

The study was initiated on February 23, 2001, with a project kick-off meeting. Representatives attended from the SFWMD, Florida Power & Light Company (FPL) and Water Resource Associates (WRA). A 12-month project schedule was agreed upon with project milestones identified. Major tasks identified in the scope of work included the following:

TASK 1	**Preparation of Executive Report on Cost factors with a Power Point Presentation, and Development of a Cost Model**
TASK 2	**Development of Feasibility Study Methodology**
TASK 3	**Feasibility Study Implementation**

In addition to the SFWMD, FPL agreed to become a cooperator in the project. FPL is a cooperator in this study for the purpose of evaluating the feasibility of co-locating an RO desalination facility with FPL's coastal power plants located within the SFWMD. FPL has committed funds to assist the SFWMD in financing the study and provided staff time for coordination, data collection, and study review. FPL has solely committed to participate in the feasibility phase of this co-location investigation and has not made any commitment to implement any element of this study. Sites selected for final feasibility evaluation will be offered to FPL as information only, and not obligate FPL in any way to implement any component of the evaluation or recommendations.

Project management for the Study was the responsibility of Mr. Paul Linton for the SFWMD and Ms. Jill Watson for FPL. Mr. Linton was reassigned during the term of the project and the Project Manager role was then transferred to Mr. Ashie Akpoji. Mark Farrell, P.E., was the Project Manager for WRA.

1.3 BENEFITS OF CO-LOCATING A DESALINATION PLANT WITH AN ELECTRICAL POWER PLANT

As part of the power generation process at large coal-, oil-, and gas-fired power plants, steam produced in large boilers is used to drive a steam turbine, which is connected by a shaft to a generator. As the steam turbine-generator turns, electricity is produced. The steam must then be condensed and pumped back into the boiler. To accomplish this, the steam passes through a condenser filled with thousands of small tubes. Large amounts (typically hundreds of thousands of gallons per minute) of cooling water are pumped through the tubes, causing the steam that flows on the outside of the tubes to condense. Each generating unit has its own inlet pipes, condenser, and outlet pipes. For a plant with several units, the inlet pipes are typically located adjacent to each other in an inlet canal, and the outlets typically discharge close to each other, into a discharge canal that leads back to the cooling water source at a point some distance from the inlet. This allows for additional cooling of the discharge water, and prevents the warm water from re-entering the inlet.

Three primary types of cooling water systems are typically used: 1) once-through cooling, where the cooling water is pumped from the source, through the condenser tubes, and back into the source, 2) a cooling tower, where the water is pumped from the source, through the condenser tubes, into a cooling tower for evaporative cooling, and then back into the source, and 3) cooling ponds, where water is cycled the same as a cooling tower but uses the large pond for evaporation. Cooling water is typically taken from the ground, rivers, reservoirs, streams, lakes, or seawater, and then returned to the source somewhat warmer, having picked up some of the heat from the condensing steam. This study targets power plant units that use once-through seawater or brackish water as a cooling water as a source and point of discharge.

The most important environmental issue that must be addressed in the feasibility of a desalination facility is the ability to properly dispose of the process concentrate. Desalination concentrate, sometimes referred to as brine, is concentrated saline water (from the desalination process) that is rejected by the desalination process in the production of the potable product water. The direct discharge of the concentrate to surface water will result in an acute and chronic toxicity to marine life, as defined by Florida Statutes and Department of Environmental Protection Rule FAC 62-302. The requirement to discharge the concentrate to surface water is determined by the ability to reduce the salinity of the concentrate through blending the concentrate with a lower salinity discharge such as normal seawater, brackish water, or domestic wastewater. An alternative to a surface discharge is to deep well inject the concentrate to appropriate (and permittable) geologic zones. This alternative is considerably more expensive than a blended discharge and presents additional environmental and permitting concerns.

When considering the volumes of concentrate from a large scale seawater desalination facility (>10 MGD) the volumes needed for blending the concentrate become quite large. Blending ratios can range from 5:1 to 20:1 depending on the salinity of the blending source. Assuming a seawater concentrate discharge volume equal to approximately 100 percent of the desired product water quantity, the necessary blending quantities are typically not available from sources other than water-cooled power plants. The ability to locate a desalination facility to take advantage of the significant cooling water flow available at a power plant provides the opportunity to design a less expensive and more environmentally acceptable concentrate discharge system.

OTHER CO-LOCATION BENEFITS:

Shared Intake and Discharge Facilities

The use of existing intake and discharge facilities such as cooling water canals provides significant project cost savings and reduces permitting issues.

Permitting

An existing power plant will have permits to intake and discharge large volumes of water from either a brackish surface water or seawater source. These permits will already be conditioned to comply with major regulatory issues such as entrainment or marine life, discharge temperature and consumptive use. The co-located desalination facility would take the source water from the existing cooling water stream and discharge in the same cooling water canal system. Therefore, many of the major regulatory issues would not be considered new impacts and reduce regulatory permitting concerns.

Shared Facilities and Manpower

Depending upon the level of involvement taken by the power company, a cost advantage can be realized by sharing existing power plant manpower for plant operation and maintenance and other common facilities such as laboratories.

Increased Reverse Osmosis Process Efficiency

The elevated temperature of the power plant cooling water discharge has the affect of increasing the ability of the water to pass through the membranes for higher product water yields with less energy cost

In summary, co-locating a desalination facility with a power plant provides significant quantifiable benefits, in terms of cost, permitting and environmental compliance.

1.4 WILLINGNESS OF UTILITIES TO PURCHASE A DESALINATED WATER SUPPLY

Assessment of Utility Willingness to Accept Desalinated Water

The potential market for water produced by a desalination facility lies with existing water utilities in the vicinity of the desalination facility. The principal factors that bear on the willingness of a water utility to purchase desalinated water are the following:

- Cost of water available from the desalination facility
- Cost of pumping and treating raw water available from the utilities' existing and expected future supplies
- Typical end user charges for potable water
- Impact on end user water charges of using desalinated water
- Price-elasticity of demand for potable water by end users
- Advantages of water supply from a desalination facility

Price Elasticity of Demand for Potable Water by Residential Customers

Price elasticity of demand is a measure of the response of consumers to a change in price, usually presented as the percentage change in demand in response to a one percent change in price. Price elasticity of demand is almost always negative, because consumers almost always reduce demand in response to higher prices, everything else equal. Unitary elasticity of demand, or –1.0, occurs where a one percent change in price produces a one percent change in the amount demanded. Demand is defined as inelastic when the measured elasticity is between 0 and –1.0. Most utility services, such as water and electricity, have been found to have inelastic demand.

Few definitive studies of demand for potable water have been conducted in South Florida. Probably the most research in this field has been conducted by the Southwest Florida Water Management District (SWFWMD), which has experienced severe water shortages, and has pursued implementation of economics-driven water management strategies. In a study done by the SWFWMD in 1993 and updated in 1999, the SWFWMD found that price elasticity of demand for potable water varied depending on the price per 1000 gallons. At a relatively low charge of up to $1.50 per 1000 gallons, elasticity was found to be about –0.39, a fairly inelastic demand. This rather inelastic demand indicates that at low prices, consumers are not very concerned about price change for a commodity that is (1) viewed as inexpensive and (2) needed for many purposes.

At a higher price of $1.50 to $3.00, however, price elasticity increased to –0.69, much closer to unitary demand elasticity, indicating that while the commodity is needed for many purposes, it is no longer viewed as inexpensive, and the consumer develops an interest in decreasing discretionary uses of the commodity. However, at a cost of over $3.00 per 1000 gallons, the level of price elasticity declines to –0.24, indicating that the consumer has already reduced demand considerably and is unable or unwilling to make substantial additional reductions due to price increases.

It is important to note that the demand for many commodities, including water, is influenced by another type of elasticity, income elasticity of demand. The price elasticity of demand generally shifts to a more inelastic level where income levels are higher, where the cost for water constitutes a very small fraction of the consumer’s discretionary income.

Advantages of water supply from desalination facility

Desalination offers two major advantages over many other sources of potable water – improved quality over water produced from conventional water treatment facilities and reliable supply during drought conditions. In areas with severe water shortages, a third advantage may be ability to permit or retain permitted quantities.

The Governing Board of the South Florida Water Management District (Governing Board) noted that certain public water supply utilities currently within areas that are subject to water restrictions have made significant investments in alternative water supplies. Such alternatives include desalinization of saline water through reverse osmosis, increasing storage through Aquifer Storage & Recovery Systems (ASR), and providing additional water supply through reuse of domestic wastewater.

The Governing Board, therefore, directed staff “to encourage the use of alternative sources through various means”. One such method is to provide some relief from water shortage cutbacks when water conditions warrant. Utilities that have used twenty percent (20%) or more of the water pumped to serve their service areas during normal operations, as defined by the period between October 1, 1999 and September 31, 2000, are affected by this ORDER. The Executive Director has determined modification of restrictions currently applicable to those public water supply utilities will provide a reward for and encourage the diversification of supply sources to those alternative sources.” These rewards will include:

- public recognition of successful utilities;
- long-term secured sources of alternative supply;
- longer duration permits;
- reduced permit costs;
- reduced reporting requirements during water shortages; and
- ability to maintain revenue stream during shortages.

In conclusion, the most likely customers for water produced through desalination appear to fall into four categories:

- Water utilities with high costs - water utilities with relatively high costs to end-users would appear to present a market opportunity for water produced through desalination. Demand for water from these utilities is likely to be more inelastic, and the charge increase would be less on a percentage basis.
- Water utilities with poor quality raw water supplies - water utilities with poor quality raw water supplies can improve their finished water quality and often avoid a costly water treatment process through use of desalinated water.

- Water utilities with very limited raw water supplies - water utilities with very limited raw water supplies may find that the only viable source of increased supply is desalinated water.
- Water utilities whose customers are characterized by very high income - areas whose residents enjoy high income often experience high demand for water and other utilities in spite of relatively high unit costs

BACKGROUND

2.0 BACKGROUND

2.1 ASSUMPTIONS

A number of specific assumptions, data collection sources and major considerations for desalination plant siting criteria were used in the preparation of a list of sites recommended for further consideration by the SFWMD. The following assumptions were employed in the analysis of potential sites:

- The methodology used in this report evaluates power plant sites that use seawater or brackish water for cooling purposes within the SFWMD.
- Water use data was limited to the information provided by the SFWMD including the water supply assessments, estimated water use reports and data provided by SFWMD staff from the SFWMD Regulatory Data Base.
- This investigation considered only the RO process for seawater or brackish water desalination.

2.2 CONSTRAINTS (SCOPE OF WORK LIMITATIONS)

Water Resource Associates, Inc. (WRA) has provided to the SFWMD a set of "Draft Feasibility Study Criteria and Methodology" for the analysis of potential seawater desalination sites, as described in the Scope of Work agreed upon for SFWMD Contract No. C-11833. An addition to the Scope of Work included expanding the number of sites evaluated to include eleven (11) power plant sites proposed for development within the SFWMD.

2.3 DATA COLLECTION SOURCES

Maps and/or data of site selection criteria were used to screen and evaluate potential representative sites for seawater desalination plants. Data was collected from a variety of sources. Pertinent reference sources are included in the bibliography of this report. These generally included the following:

- SFWMD Water Supply and Management Plans
- SFWMD Regulatory Data Base
- SFWMD Water Quality Monitoring Program
- Environmental Permit Documents
- Ten Year Power Plant Site Plans
- Power Plant Site Certification Documents
- Power Company Web Sites
- State and Local Agency Web Sites
- Florida Statutes
- Utilities Maps
- Local Government Comprehensive Plans
- Numerous Venders of Aerial Photographs, Maps and Other Electronic Data
- Evaluation Model and Key Parameters for Alternative Water Resource / Supply Management Strategies in the Southern Water Use Caution Area, Hazen & Sawyer,
- Electric Power Research Institutes "Desalination Study of Florida Power & Light Power Plants" report prepared for the Electric Power Research Institute (EPRI) and funded by the Florida Power & Light (FPL) Corporation.[1]

[1] The EPRI report "Desalination Study of Florida Power & Light Power Plants" report prepared for the Electric Power Research Institute (EPRI) and funded by the Florida Power & Light (FPL) Corporation was reviewed from several aspects. These included the review of the methodologies and general criteria used in the evaluation of several candidate sites. These criteria were modified and expanded to cover all of the aspects of this study and to build upon the results of EPRI study. Cost and other data were updated to more completely reflect current conditions.

SUMMARY OF TAMPA BAY DESALINATION PROJECT

3.0 SUMMARY OF TAMPA BAY DESALINATION PROJECT

3.1 KEY ELEMENTS OF TAMPA BAY PROJECT

Competition for potable water in the Tampa Bay region has been an issue for the past forty years. The ever growing needs of a major metropolitan area have strained the primarily groundwater supply system. The demands are expected to exceed the ability of the groundwater sources to concurrently supply agricultural, environmental, and urban needs.

A number of public supply wellfields are located in Hillsborough and Pasco Counties. These wellfields supply water to both coastal and inland communities. These wellfields were primarily developed by the City of St. Petersburg and Pinellas County. The City of St. Petersburg and Pinellas County originally were self sufficient for water supply. As these areas grew in the 1900's the combination of additional demand and water quality problems forced these communities to look for more inland sources.

Cumulative environmental impacts, primarily to lake and wetland water levels, took place as a result of overpumping from the public supply wellfields. Years of costly litigation and reliance on traditional sources like groundwater, exacerbated the problem taxing the existing systems and creating additional environmental impact.

Two major events took place to set the region on a new course in the development of sustainable alternative water supply projects. The West Coast Regional Water Supply Authority, the regional utility for the area at the time, was institutionally reformed in a manner to more effectively address water supply development as Tampa Bay Water (TBW). The second change was the Partnership Agreement between TBW and the Southwest Florida Water Management District (SWFWMD). This agreement requires significant funding by the SWFWMD for alternative water supply projects such as seawater desalination in return for the reduction of pumping at existing groundwater wellfield facilities by TBW.

The overall need for new water sources in Tampa Bay is great. This is not only because of the agreed upon wellfield cutbacks, but the increased demand that is associated with rapid population growth of the area. By the year 2003 a total reduction of 44 mgd in permitted withdrawal capacity is required. By 2008 the required withdrawal reduction will increase by another 53 mgd for a total reduction of 97 mgd.

Beginning in January 1997, TBW began the process of soliciting proposals for a seawater desalination plant. After two problematic bid solicitations, the bid specifications were revised and the final bids from four developers were received in January 1999. Two proposals were sited on or about the Florida Power Company Anclote Power Plant on the Gulf of Mexico in Pasco County and two proposals were sited on the Tampa Electric Company (TECO) Big Bend Power Plant site on Tampa Bay, in Hillsborough County. The third bid by TBW was successful with the low bidder: S&W Water LLC awarded the project located at the TECO Big Bend site. (Figure 3-1) The contract was awarded in February 1999 to S&W Water LLC and work was started immediately after the award. S&W Water LLC, a limited liability corporation, which formed a partnership between Poseidon Resources and Stone & Webster Engineering, changed the name of the business entity to Tampa Bay Desal in January 2001. This name change was made to reflect a change in organization partners. Stone & Webster Corporation, the original engineering, procurement and construction partner was replaced by Covanta Water, Inc. and Poseidon Resources remained the general partner. Tampa Bay Desal (TBD), will be the owner of the project. The Engineering, Procurement and Contracting (EPC) contractor and O&M operator will be Covanta Water and the site lease will be held by Tampa Electric Company.

3.2 SOURCES OF FUNDS

The total capital project cost of $116,028,000 will be funded by several sources of financing. The capital will be financed by a combination of 10 percent equity from Poseidon Resources and 90 percent equity financed by State of Florida private activity bonds. These bonds were sponsored by Tampa Bay Water for the project and secured by the water purchase agreement. The debt service on project bonds will be paid from project revenues.

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 3-1: Rendering of Seawater Desalination Plant Located at Tampa Electric Company Big Bend Site, Tampa Bay, FL

Prepared For:
South Florida Water Management District
Florida Power & Light Company

Additionally, a project subsidy is being provided by the SWFWMD. The SWFWMD, through its Partnership Agreement with TBW, pledged to buy down the capital cost of the project. The funding was limited to 90 percent of the capital cost to a maximum of $85,000,000. The funding has been completed in the form of a trust agreement between TBW and the SWFWMD. The trust will be fully funded when the project has been accepted by TBW. The trust will provide reduction in cost to the water purchase price paid by TBW. In the first year this will account for a reduction of $0.63 per 1,000 gallons from the $2.08 life cycle cost purchase price.

Tax-Exempt Debt	$101,960,000
Developer Equity	11,329,000
Construction Earnings	2,739,000
Total Sources	$116,028,000

3.3 COMPARISON TO FUTURE DESALINATION PROJECTS

The Tampa Bay Project entailed many unique aspects that will pave the way for future seawater desalination projects in the United States and elsewhere. Many of the aspects are unique to the Tampa Bay Project and should be clearly identified so that expectations are realistic for future projects with varying components.

First and foremost, the Tampa Bay Project was a private sector project and bidding was extremely competitive. This project was considered a marquis project by the four bidders. It is important to note that cost concessions may have been included in the bids. The actual quantification of any profit reduction concessions cannot be accurately identified, but it should be recognized that the bidding reflected an aggressive pricing schedule for delivery of the product water.

Items that can be generally assessed are the more obvious cost savings derived due to items particular to the Tampa Bay Project, such as the lower salinity raw water quality, and the effects of co-locating with an existing power plant.

Table 3-1 shows a representative breakdown of the Tampa Bay Project cost components in comparison to a stand-alone typical desalination plant. Costs are broken into eight major categories with representative savings incurred as a result of conditions particular to the Tampa Bay Project.

Table 3-1: Tampa Bay Desalination Project Cost Breakdown				
Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electrical Power Plants				
	Project Life Cycle Costs (dollars per 1,000 gallons supplied)			
Reference Seawater	**Capital**	**O&M**	**Total**	**Co-Location**
Desalination Plant	**1.62**	**1.82**	**3.44**	**Benefit**
Tampa Bay Specific Savings Estimates	**Estimate of Cost Saving**			
Private Financing & Term	0.47	0.00	0.47	No
Finished Water Quality and Recovery	0.04	0.22	0.26	Yes
Salinity of Feedwater	0.04	0.16	0.19	No
Competition & BOOT	0.09	0.06	0.15	No
Intake and Outfall Structure	0.10	0.04	0.13	Yes
Temperature of Feedwater	0.02	0.06	0.09	Yes
Membrane Cost Factors	0.01	0.02	0.04	No
Other Factors - Land Cost and Automation,	0.04	0.00	0.04	Yes
Savings Subtotal of Co-location benefits	0.23	0.28	0.51	15%
Adjusted Cost with Co-Location Benefits	1.39	1.54	2.93	85%
Savings Subtotal for Tampa Bay Big Bend	0.80	0.56	1.36	40%
Adjusted Cost for Tampa Bay Big Bend	0.81	1.27	2.08	60%

Notes:
BOOT: Build, Own, Operate, and Transfer
Cost saving estimates include benefit of economics of scale for a 25 mgd facility
Tampa Bay Big Bend Cost of $2.08 includes 14 miles of pipeline transmission costs

The items that generated the greatest cost savings was the financing term of 30 years versus the traditional 20-year term. Benefits not attributable to co-location such as financing term, competition and lower salinity of the feed water, cumulatively accounted for an estimated 25 percent cost reduction. Co-location benefits such as temperature of the feedwater from the power plant and the existence of intake and outfall structures accounted for another 15 percent reduction.

Future seawater desalination projects will each have unique features that will undoubtedly yield costs that vary from the Tampa Bay Project. Review of the parameters involved in the Tampa Bay Project will give guidance for major cost items that will be subject to change including such items as ability to co-locate, salinity and financial terms. The Desalination Feasibility Cost Planning Model, developed as part of this Study, will allow the comparison of many features to accurately project typical cost that would be expected in the development of future desalination projects.

CRITERIA AND METHODOLOGY

4.0 CRITERIA AND METHODOLOGY

4.1 BACKGROUND

The purpose of this study was to identify issues affecting the feasibility of co-locating a seawater or brackish water RO desalination facilities with power plants and to identify representative sites within the boundaries of the SFWMD. A methodology was established to identify and select representative sites in order to identify potential co-location sites, and to evaluate the feasibility of representative sites. The initial culling process was focused on identifying major limiting issues (fatal flaws such as the plant closing or being repowered without a cooling water flow). Once this had been accomplished, those potential sites were thoroughly evaluated based on suitability factors. Detailed cost estimates were developed for the representative sites selected by this two-phase culling process.

An objective of this project was to identify seawater or brackish water sources and power plant sites that could be used to provide potable water in areas of the SFWMD where current supply sources may be unable to meet demands through the year 2020. Sites were identified and evaluated using a series of criteria including expected cost, environmental impacts, land availability, socio-political constraints, ability to serve users and permittability.

Evaluation screening criteria was used in a structured three-step evaluation process to identify sites that have the greatest potential to meet the criteria identified by the SFWMD for future water supply projects.

4.2 DESCRIPTION OF EVALUATION CRITERIA AND METHODOLOGY

The proposed site screening criteria and methodology anticipates three layers of screening. These are described below:

- <u>First Tier Screening Process</u> Identification of mandatory requirements and culling of sites not meeting these requirements (Fatal Flaw Analysis)
- <u>Second Tier Screening Process</u> Identification of desirable elements or features and qualitative scoring of each site.

- Third Tier Screening Process Selection of representative sites based on the qualitative ranking, the compatibility with FPL future use, and the ability to be representative of feasible applications within the SFWMD.

SFWMD and FPL staff were consulted to develop a series of criteria to identify the most feasible sites for further investigation of a co-located desalination facility. FPL staff was consulted to provide both qualitative and quantitative information as to which of their power plant sites have desirable characteristics for the co-location of a desalination facility.

In consideration of the objectives set forth by the SFWMD for this report, the review of potential sites were limited to those sites that could provide 10 to 25 million gallons per day (mgd) water supply.

It was determined that a large (>50mgd) sustained cooling water flow (for dilution) would be needed to minimize the potential for any adverse environmental impacts associated with concentrate discharge to a surface water body, if that alternative is selected. This required dilution source is generally only available at power plant locations using once through cooling. These criteria were utilized to identify areas where the location of such facilities may or may not feasible.

4.2.1 FIRST TIER CRITERIA – FATAL FLAW SCREENING PROCESS

A Fatal Flaw Screening Process was used to screen the twelve potential sites referenced in the Scope of Work. All of the facilities listed in the Scope of Work, with the exception of the cities of Key West, Homestead, Lake Worth, and Ft. Pierce Utilities sites, are owned and operated by Florida Power & Light Company (FPL). In addition, the evaluation addressed eleven sites proposed for development. The "Fatal Flaw Analysis" was designed to quickly eliminate those sites that should not be subjected to further detailed analysis. All sites referenced above would either "pass" or "fail" the Fatal Flaw Analysis. These plants include:

- Cutler
- Ft. Myers
- Ft. Pierce Utilities
- Homestead Utilities
- Key West Utilities
- Lake Worth Utilities

- Lauderdale
- Marathon / FKEC
- Port Everglades
- Riviera
- St. Lucie
- Turkey Point, Nuclear
- Turkey Point, Oil & Gas

Sites Proposed for Development

- AES Coral / Lake Worth
- Competitive Power Ventures / St. Lucie
- Decker / St. Lucie
- Duke / Ft. Pierce
- El Paso / Broward Energy Center
- Enron / Deerfield Beach
- Enron / Miami
- Enron / Midway
- Enron / Pompano Beach
- FPL / Midway
- Marathon / FKEC

The criteria for the Fatal Flaw Analysis is illustrated on the attached Table 4-2 and includes:

COOLING WATER SOURCE: If the source of cooling water is not seawater or brackish water, the site was excluded from further analysis because it does not meet the minimum objectives of the study stated by the SFWMD. The scope is limited to evaluation of brackish water and seawater sources to prevent potential conflicts with current users.

COOLING SYSTEM TYPE: If a power plant did not use a once through cooling system, discharging to a seawater or brackish water body, that site was not considered for further evaluation.

FUEL TYPE: If the fuel source used in the power plant is uranium (nuclear), the site was dropped from further consideration because of the expected public aversion towards potable water produced at a water plant associated with a nuclear power plant. This problem is in addition to the additional regulatory complexity of dealing with the Nuclear Regulatory Commission (NRC). If the proposed desalination facility withdraws its feed water from the discharge side of the power plant (after passing through the condensers), the public could perceive that the water could be “contaminated”.

PLANT LIFE SPAN: If a plant is scheduled for retirement during the planning horizon of this study (through year 2020), then that site would not meet the goals of providing a reliable long term potable water source. Therefore, it would not justify the cost of construction. Repowering of the units at a plant may allow the plant to continue as a feasible site, depending on the choice of power generation and cooling technology.

REGULATORY ISSUES: Some sites may have regulatory or permitting issues that could cause that site to be unbuildable, regardless of other criteria that appeared to be favorable for the construction of that site. Such issues could include enforcement actions, consent orders, impending rules, regulations or other such actions limiting construction at that site.

THREATENED AND ENDANGERED SPECIES: The existence of threatened and endangered species (T&E), or discharging to an area that contains habitat that was important to the breeding, foraging, roosting, nesting or wintering of T&E species, could halt, delay or complicate the construction of a desalination plant in an area.

ARCHEOLOGICAL AND HISTORICAL RESOURCES: The existence of historical or archeological resources, or both, could delay the construction of a desalination plant. The locations of known archeological and historical sites were available from the State of Florida.

4.2.2 SECOND TIER CRITERIA

Sites passing the First Tier Screening (Fatal Flaw Analysis) were subjected to a more detailed level of screening. This level of analysis consists of thirty-four (34) additional criteria, falling within six (6) general categories. The criteria, grouped into these six (6) categories, are provided in the attached summary Table 4-3. By using these criteria, the evaluation of the remaining potential sites resulted in an initial ranking for each potential site. The second tier screening criteria may be used with a general “high, medium, or low”, “good, fair or poor” or with a numerical value.

Additionally, weighting factors may be added to increase the importance of criteria associated with the constructability of a particular site. However, the use of numerical scores and weighting factors were deemed unnecessary and both overly complicated and restrictive for selection of representative sites. The use of numerical scores and weighting factors to develop an impartial process is commensurate with the level of effort and detail required for a site selection study. Specifically, a site selection study is required to rank the potential sites by factors such as costs, constructability and permittability. The top-ranked sites resulting from the siting study are the most cost-effective sites and are not necessarily representative of the range of feasible locations. The objective of this study was to identify sites that represent the feasible range of seawater desalination alternatives. Second tier evaluation criteria will include these six major categories and individual criteria:

PHYSICAL CHARACTERISTICS OF PLANT SITES

LOCATION OF AVAILABLE LAND: The site of the proposed desalination plant site should have enough available land, either on-site or nearby, to accommodate the proposed desalination facility. The power plant site should be located reasonably close to the water-demand area.

AVAILABLE LAND AREA: The proposed site should contain at least 5 acres (10 acres preferred) required to construct the proposed desalination facility. Land availability could be an important consideration at some of the more compact sites.

LAND FOR FUTURE EXPANSION: The criterion identifies the value of additional land to facilitate future expansion. A proposed site got a high score if it contains additional area that could be used to expand the proposed desalination plant in the future.

LAND USE AND ZONING: The land use and zoning of the site should allow for the construction of a desalination facility. Generally, the industrial or public utility land use and zoning classifications required for a power plant should allow for the construction and operation of a desalination facility.

POWER PLANT CHARACTERISTICS

PLANT STATUS: If a plant is shut down, scheduled for retirement or will be repowered using a technology that does not use seawater or brackish water for cooling purposes, that site was dropped from further evaluation.

NUMBER OF UNITS: The higher the number of units at the power plant site, the less likely that the plant would have all of the units shut down for maintenance or other reasons at any one time. This fact would help to ensure that there would be sufficient cooling water flow at all times to meet dilution requirements of a desalination plant. Multiple base load units can provide cooling water flow for dilution at all times.

MEGAWATT (MW) RATING: Generally, the larger the MW rating of an individual generating unit or power plant, the higher the cooling water flow. This would allow for greater volumes of water for cooling purposes and dilution of desalination process concentrate.

BASE LOAD FACILITY: The proposed desalination plant location should be sited with a base load power plant. This will help to ensure that there is a minimum continuous cooling water flow for dilution purposes.

CYCLING FACILITY: Cycling facilities are generating units that are brought on line to run during prescribed periods of the day. If the proposed facility is to be co-located with a cycling facility, it is necessary that such a facility is used very frequently and/or it has continuous cooling water flow to meet the dilution requirements of the desalination plant.

PEAKING FACILITY: A peaking facility is usually dispatched by the utility to generate at “peak” times of customer demand, such as summer afternoons or winter mornings. If the proposed facility is to be co-located with a peaking facility, it may not be suitable due to a lack of continuous cooling water flow.

PLANT IN SERVICE DATE: The date that a power plant began operations can give an indication of its useful life. While most power plants were originally designed for a 30-year life, most have been operated far longer. Utilities are taking advantage of upgrade technologies to continue to operate older, low-cost power plants. If the plant is an older plant, it may be scheduled for retirement, upgrading or repowering. Upgrades and repowering will extend the life of the power plant.

PLANNED PLANT EXPANSION (DATE AND MW): It is necessary to determine the type, approximate schedule and magnitude of proposed plant expansions to determine the alterations in the power plant facility that may affect the development of a co-located desalination plant.

PLANNED PLANT EXPANSION (COOLING SYSTEM CHANGES): Changes to the plant's cooling system, related to repowering or other plant changes, need to be evaluated when considering a power plant site for co-location.

PLANNED PLANT REPOWERING OPTIONS: Some power plants may be scheduled for repowering. The type of repowering technology chosen affects the ability of the facility to support co-location of a desalination plant. If the older boilers are replaced with simple cycle gas-fired gas turbines, which do not use cooling water, the dilution source will not be available. Repowering with gas-fired combined cycle units (which incorporate gas turbines and steam turbines) will still require cooling water, but the flow, source, or other factors (addition of a cooling tower) may change the cooling water flow rate and duration.

PLANNED PLANT EXPANSION FOR CO-GENERATION: If a proposed site is also the site of a proposed co-generation facility, this may make it easier and less costly to co-locate a desalination plant. Instead of using electric-driven forwarding pumps in the desalination plant, steam from the power plant may be available for driving them (instead of using electric driven pumps), lowering overall operation costs.

NATURAL GAS FUEL SOURCE: Natural gas has been noted by the SFWMD as a desirable fuel source for a power plant co-located with a desalination plant. This is largely because of the common perception that a natural gas plant is a cleaner burning plant, and therefore, may not be subjected to as much public pressure to close down or to restrict plant expansion in the future.

INTAKE AND DISCHARGE OPTIONS

INTAKE SOURCE: The source of the intake feed water for the desalination plant was an important consideration. Generally, brackish waters associated with estuarine areas may be more difficult to permit because of potential impacts to marine nursery areas.

DISCHARGE LOCATION: The location of the cooling water discharge was an important factor in the selection of a potential site for a desalination facility. Whether the discharge is to seawater or brackish water may impact the permittability of a proposed facility. Recent discussions with FDEP staff indicate that obtaining a permit for a new discharge that would cause degradation beyond ambient conditions would be extremely difficult.

WATER QUALITY CLASSIFICATION: The classification of the receiving water bodies will determine the likelihood of success of permitting a proposed facility. Permitting a desalination plant within an Outstanding Florida Water (OFW) could be very difficult. For OFWs, an applicant would be required to show that the new discharge would not have any adverse water quality effects on the receiving water compared to ambient conditions. However, if the discharge was located upstream of an OFW (e.g., in a tidal creek or stream) and it could be shown that the effluent would cause no adverse effects, it is possible that a discharge could be permitted. Due to the unlikelihood of obtaining a wastewater permit for a new Reverse Osmosis concentrate discharge into an OFW, locations of potential desalination plants may be restricted to non-OFW designated water bodies. If a desalination plant were to be sited in such a location, deep well injection may be required for concentrate disposal. (Refer to Table 4-1)

TABLE 4-1 SURFACE WATER CLASSIFICATIONS FOR THE STATE OF FLORIDA (62-302.400, F.A.C.).		
Surface Water Classification	**Designated Use**	**Water Quality Criteria**
CLASS 1	**Potable Water Supplies**	**Stringent**
CLASS 2	**Shellfish Propagation or Harvesting**	**Most Stringent**
CLASS 3	**Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife**	**Moderately stringent**
CLASS 4	**Agricultural Water Supplies**	**Less stringent**
CLASS 5	**Navigation, Utility and Industrial Use**	**Least stringent**

FLOW RATE PER UNIT AND TOTAL: Discharge rates from the individual generating units and from the discharge canal need to be sufficient to support the dilution requirements of the desalination facility. The higher the cooling water discharge rates, the lower the increase in total dissolved solids and other constituents by dilution of the process concentrate. It is important to determine the cooling water discharge flow rate by unit, and for the total plant, based upon the minimum number of units in operation at any given time.

DESALINATION SOURCE WATER: The source of water for the desalination process is an important aspect of plant design and of the quality of water that may be expected from a given plant. Feed waters with a lower total dissolved solids concentration can yield a higher quality of water at a lower unit cost. Waters that fluctuate widely in quality, such as brackish water that may vary between high flow and low flow seasons and incoming or outgoing tides, may require additional process considerations.

DESALINATION DISCHARGE METHOD: The method of concentrate disposal will have an impact upon the permittability of a plant site. Those areas where concentrate from the desalination process is an issue, such as brackish water estuaries, could be more difficult to permit. Conversely, those sites situated on open water bodies, such as the Atlantic Ocean or the Gulf of Mexico may not be perceived to have as great a concentrate disposal issue. Some plant locations may require that the concentrate be disposed in deep injection wells. This also creates substantial permitting issues, as well as adding costs to the desalination plant process.

COMPATIBILITY OF REJECT WATER: Water quality impacts resulting from the production of desalinated water is primarily due to the changes in concentrations of ions, which existed in the original source water (seawater). Seawater contains a number of constituents including metals, salts, and organic compounds. As seawater passes through a reverse osmosis membrane, many of these chemicals are removed, leaving a fresh, purified water product. The removed constituents, termed concentrate, are now at a greater concentration than the source water. This condition can result in changes in salinity in the receiving water when the concentrate is discharged. Increased salinity may result in physiological stress or toxicity for a number of different aquatic organisms. Co-location of a desalination plant with a power plant takes advantage of the large (hundreds of millions of gallons per day) cooling water flow associated with base loaded power plants to dilute the concentrate.

WATER DEMAND AND TRANSMISSION

POTENTIAL USERS: Identification of potential users of the product water located near the proposed reverse osmosis facility and order-of-magnitude estimates of the cost to deliver water to the potential users.

YEAR 2010 DEMANDS: Any proposed facility should be “on line” to meet anticipated future demands. The need to meet future water demands should be made in concert with other proposed water development plans.

YEAR 2020 DEMANDS: The same considerations as the above criteria should apply to the year 2020 demands. In this instance, additional opportunities for co-location, co-generation, or facility expansions should have presented themselves.

PROXIMITY TO DEMAND: Only sites within a reasonable distance of existing or projected water demand were evaluated. Most of the potable water demand and the existing and projected supply deficits are located near the coastal portion of the study area. It is also necessary to locate the plants close to the demand centers in order to reduce transmission costs.

PROXIMITY TO TRANSMISSION LINES AND POINTS OF CONNECTION: The proposed facilities should be close to existing water transmission lines or points of connection (water treatment or storage facilities) to reduce pumping costs and to provide potable-water blending opportunities.

OTHER WATER SUPPLY OPTIONS: Desalination facilities may be given additional consideration in areas where no or few other water supply options are available. On the contrary, less consideration was given to locations where the cost of desalinated seawater would not be competitive with other less costly options.

ENVIRONMENTAL CONSIDERATIONS

REGULATORY STATUS: There are a number of permits that would be required to construct and operate a seawater desalination plant in Florida. Concerns about existing or proposed conditions at a power plant site, including requirements for thermal discharge studies could impact that site. Similarly, any proposal or regulatory requirement for conversion to off-stream cooling systems (cooling tower or reservoir) or other power plant regulatory-compliance issues could affect the viability of a site.

PERMITTABILITY: Any desalination facility must have the potential to be permittable to be considered as a representative candidate. The two most important permit issues would be discharge of the concentrate and wetland impacts associated with the construction of the plant and transmission lines. The FDEP issues an Industrial Wastewater Facility (IWWF) permit to address the concentrate discharge criteria. The discharge of the concentrate is the most difficult permit to obtain due to the FDEP Antidegradation Policy. The basis of the Policy is that new or increase discharges pass the public interest test in addition to meeting all other FDEP rules. The discharge is not allowed to degrade the quality of the receiving waters below the state standards. This policy would make it very difficult to permit a discharge in an Outstanding Florida Water (OFW) water body. Wetland impacts would be permitted through the Environmental Resource Permit process. In this process, the applicant must demonstrate avoidance and minimization of impacts to wetland systems. Those wetlands, which cannot be avoided, are then required to be mitigated at ratios specified by the SFWMD or FDEP dependent on a host of ecological factors. Air emission permits would also be required. Additionally, port authority and other permits from local and regional agencies would be required.

ENVIRONMENTAL IMPACTS: The primary environmental considerations for the siting of any proposed desalination plant are:

- Impacts to water quality (particularly salinity) within the source or receiving waters.
- Impacts to aquatic flora and fauna in the source or receiving waters.
- Impacts to inland habitats disturbed or destroyed by the physical construction (dredge and fill) of the desalination facility, associated intake and discharge structures, and transmission lines.
- Potential impacts to threatened and endangered species.

OTHER

PUBLIC ACCEPTANCE: Public acceptance will be extremely important in identifying viable desalination sites. Otherwise, potential sites could fail if the public strongly opposes that site. Consideration will be given to serious demonstrated opposition to proposed alternative water-supply options.

DESIRE TO CO-LOCATE: There may be situations where an electric utility would like to co-locate with a desalination plant. There may be other situations where a privately owned or municipally owned electric utility would desire to expand their services to include water supply. Conversely, a utility may not want to have a desalination or other industrial facility co-located on its property, due to operational or liability issues. With recent changes in utility industry regulation, generating units and entire power plants may be sold to other companies. Having a desalination plant co-located with the power plant may be seen as a disadvantage by potential buyers, particularly if they are interested in repowering the plant or changing the method of unit dispatch.

4.2.3 THIRD TIER CRITERIA

The final sites selected for feasibility evaluation were determined by a series of fourteen (14) criteria. Each criterion assessed the information and data specific to these final sites. In addition to information collected by the WRA project team for the first and second tier evaluation, information collected during site visits and provided by FPL was used in assessing these sites.

It is important to recognize that the objective of the third tier evaluation was not to rank the final sites but rather to provide a concise evaluation of the feasibility of co-locating a desalination facility at each selected site to assist in identifying representative sites.

POWER PLANT OPERATIONS DESCRIPTION: Descriptions have been provided on plant location and conditions, general operational information including power produced, fuel type and power production technology employed. Information obtained from on-site visits has been described. Pertinent permits that would impact the co-location of a desalination facility discharge will be described. Finally, future operational plans for the power plants, that may impact the longevity of a co-located desalination facility, have been identified.

TREATMENT TECHNOLOGY: Based on the source water quality and desired product water quality, various reverse osmosis treatment technologies will be employed. Brackish water and seawater systems involve different treatment components and differing operational requirements such as pump pressures. Product-water quality limits may require additional treatment sequences if higher product water quality (lower TDS) is desired.

DESALINATION PLANT OPERATIONS: Desalination plant operation descriptions were developed. These are conceptual plans for operating the desalination facility to produce the desired product water while maximizing the co-location benefits of the power plant operation. Descriptions of source water intake and concentrate discharge have been provided, including piping and plant facility locations. Operational elements particular to each power plant operation that would impact the operation of the desalination facility have been identified.

SOURCE WATER QUALITY: Co-located facilities will use power-plant cooling water as the source water. Source water quality is an important factor in determining and designing the reverse osmosis process. Power plant cooling water was characterized based on information identified in the Ten-Year Site Plans, operating permits and information provided by FPL.

Description of the desalination facility source water addresses water quality characteristics critical to the desalination process design including temperature, salinity and any additives introduced as a result of the power plant cooling water operation. Additionally, source water quantities required to produce the desired product water were identified based upon the efficiency of the desalination process.

PRETREATMENT REQUIREMENTS: Source-water pretreatment requirements were identified and described. Pretreatment is critical to the reverse osmosis process in order to maintain productivity and membrane life. Pretreatment requirements may vary based upon the water quality conditions at each site.

PRODUCT WATER YIELD AND POST TREATMENT: Description of product water quantity and quality including finished water salinity and other primary drinking water standards were provided for the final sites. Product water yield was quantified based on projected system efficiency for each of the final sites.

Post treatment stabilization and disinfection options for the product water were evaluated. Also, the sequencing of the chemical addition, along with the preliminary selection of the chemicals that would be used for the product water were analyzed.

CONCENTRATE MANAGEMENT: Concentrate disposal is critical to the successful environmental management of a desalination facility. In a water-cooled power plant co-location, the desired method of concentrate disposal was to blend the concentrate with the cooling water discharge from the power plant operation. Required dilution factors to meet State of Florida IWWF discharge standards have been described. As an alternative to blending, deep well injection may provide another option. This option was only described if the blending option was not feasible.

PERMIT REQUIREMENTS: Permits will be required for all aspects of the desalination operation including the concentrate discharge, plant construction, air emissions, chemical handling system discharges, solid waste disposal and pipeline construction. Power plant operations may require the modification of existing IWWF permits for a decreased discharge. Each permit has been described and a preliminary assessment was made regarding the ability to obtain that permit.

ENVIRONMENTAL ISSUES: Environmental issues may affect the ability to operate a desalination facility. These issues may include items such as impacts to threatened or endangered species, wetland impacts for desalination plant and pipeline construction, and consumptive water use regulatory issues such as Minimum Flows and Levels.

LAND USE COMPATIBILITY: Existing and future land use classifications that could impact the construction or operation of a desalination facility have been discussed. An identification and description of adjacent land uses that may be incompatible and impact the construction or operation of a desalination facility has been provided.

SERVICE AREAS AND DEMAND: Service areas for product water proposed by the proposed desalination facility were identified and described. Service areas include both public and private water utilities that can be reasonably supplied by the desalination facility. Demand quantities for the desalinated water were assessed using SFWMD Water Supply Plans and SFWMD Water Shortage phased restrictions. An assessment of the ability of the potential users to accept the cost of the desalinated water source has been provided in general terms.

CAPITAL COST: Major desalination facility capital cost items have been identified and cost summary prepared. These items are more fully described in the Desalination Feasibility Cost Planning Model. Specifically, these items include:

- Intake System
- Pretreatment System
- R.O. Process
- Post-treatment System
- Concentrate Disposal System
- Infrastructure
- Land
- Distribution System
- Professional Services

OPERATION AND MAINTENANCE (O&M) COSTS: Major desalination facility O&M cost items have been identified and cost summary prepared. These items are more fully described in the Desalination Feasibility Cost Planning Model. Specifically, these items include:

- Pre-Treatment System
- Reverse Osmosis Process
- Post-Treatment System
- Concentrate Disposal
- Energy Consumption
- Other O&M

LIFE CYCLE COST: A life cycle cost for each proposed desalination facility has been computed using the Desalination Feasibility Cost Planning Model. Life cycle costs have been prepared for 20 and 50-year terms. Life cycle costs are expressed in $ per 1000 gallons of product water.

4.3 DESCRIPTION OF DESALINATION FEASIBILITY COST PLANNING MODEL

PURPOSE OF THE MODEL

The Desalination Feasibility Cost Planning Model (Model) was developed to provide the user with the ability to efficiently evaluate a large range of desalination project options to determine potential project impacts. Project components are broken down into major capital and operation and maintenance (O&M) cost items. Finally, the cost information is presented in 20 and 50 year life cycle cost with graphical cost breakdowns to visually depict major cost elements.

This Model was developed to be applied to the final selected sites for this study. The ease of application provided by the Model allows the evaluation of a number of project development options including such alternatives as financing terms, private versus public ownership, application of grant funds and co-location opportunities. Verification of the Model results shows Model generated costs within 10 percent of documented costs from existing seawater and brackish desalination projects.

COST FORMULA DEVELOPMENT

The algorithms and formulas used to calculate the capital, O&M and life cycle costs were developed with the expertise of individuals with significant experience in the field of reverse osmosis desalination projects. Formulas were configured to be intuitive in assigning values for specific items based on significant experience and documented values developed from a large variety of existing seawater and brackish desalination projects, including the Tampa Bay desalination project.

MODEL LAYOUT

The Model was created as a spreadsheet cost model in Microsoft Excel and will run on any version of the program. The spreadsheet layout is designed with a user-friendly interface that mimics a stand-alone Windows application. Incorporated into the user interface are dropdown menus for input selections, hyperlinks for more efficient navigation through the model sheets, and error messages that let the user know when an invalid input value has been entered.

The model consists of eight (8) cost analysis sheets that are visible to the user, and five (5) additional hidden sheets that house the Model's code (Refer to Figure 4-1).

VISIBLE SHEETS

The visible sheets consist of two input sheets, three output sheets, two sheets displaying the output data in a graphical format, and one sheet that offers a description of each term used throughout the Model. The sheet names are listed and described in more detail below.

1. Master Data Input
2. Advanced Inputs
3. Capital Cost Outputs
4. O&M Cost Output
5. Project Summary
6. Charts – Color
7. Charts – B&W
8. Definitions

1. Master Data Input

The *Master Data Input* sheet allows the user to input a series of values for various parameters that have been determined to materially affect the capital and O&M costs of the desalination facility. The *Master Data Input* sheet has been designed for a user with little or no requisite knowledge of the desalination process or its economic components. Input values are either selected from dropdown menus or manually typed into input cells. The *Master Data Input* sheet has been designed so that error messages appear and offer instructions if an invalid input has been entered. The following is a list of the parameters that require input values on the *Master Data Input* sheet:

- Project Name
- Raw Water Source
- Source Water Quality
- Source Water Temperature
- Distance to Source Water
- Land Cost for Intake Pipeline
- Product Water Quantity
- Product Water Quality
- Distance to Point of Use
- Land Cost for Transmission Pipe
- Cost of Energy
- Concentrate Disposal Method
- Land Cost for Disposal Pipeline
- Distance to Disposal Point
- Acquisition Method for Plant Site Land
- Cost of Plant Site Land
- Type of Ownership
- Subsidies
- Rate of Growth
- Nominal Interest Rate
- Inflation Rate
- State Sales Tax
- Local Sales Tax

2. Advanced Inputs

The *Advanced Inputs* sheet is designed for a user with a significant understanding of the RO desalination process or detailed, project specific information. The *Advanced Inputs* sheet allows the user to customize up to eight different default settings programmed into the Model's cost calculations. The following is a list of the cost components that can be adjusted by modifying their default settings on the *Advanced Inputs* sheet:

- Engineering Services
- Permitting
- Legal Services
- Contingency
- Cost of Financing
- Construction Insurance
- Water Quality Monitoring
- Operating Insurance

<u>3. Capital Cost Outputs</u>

The *Capital Cost Outputs* sheet displays the up-front cost of all individual facility components and professional services required to develop the project. The *Capital Cost Outputs* sheet also displays the total overall capital cost of the project, including a contingency percentage and other financing costs that can be adjusted using the *Advance Inputs* sheet. The capital costs are based on the values entered on the *Master Data Input* sheet, and any default values customized on the *Advance Inputs* sheet. The following is a list of the costs displayed on the *Capital Cost Outputs* sheet:

- Surface Water Pump Station
- Raw Water Structure
- Intake Pipeline
- Supply Well System
- Pretreatment Equipment
- Membrane System
- R.O. Pumps
- Energy Recovery System
- Post-Treatment Equipment
- Disposal Pump Station
- Disposal Pipeline
- Deep Wells
- Building Cost
- Cost of Site Work
- Land Cost for Plant Site
- Land Cost for Intake Pipeline
- Land Cost for Disposal Pipeline
- Land Cost for Transmission Pipeline
- Product Water Pump Station
- Ground Storage Tanks
- Transmission Pipeline
- Engineering Services
- Permitting
- Legal Services
- Subtotal
- Contingency
- Sales Tax
- Subsidies
- Net Total
- Capitalized Interest
- Cost of Financing
- Construction Insurance
- Grand Total

<u>4. O&M Cost Outputs</u> (Refer to Table 4-4)

The *O&M Cost Outputs* sheet displays the individual annual costs associated with plant operation. The *O&M Cost Outputs* sheet also displays the total O&M cost annualized over both a 20 and 50-year life cycle. The O&M costs are based on the values entered on the

Master Data Input sheet, and any default values customized on the *Advance Inputs* sheet. The following is a list of the costs displayed on the *O&M Cost Outputs* sheet:

- Pretreatment Chemicals
- Membrane Replacement
- Post-treatment Chemicals
- Water Quality Monitoring
- Cost of Energy
- Replacement Parts
- Cost to Lease Land
- Labor
- Operation insurance
- Annualized O&M Costs

5. Project Summary

The *Project Summary* sheet displays a listing of the key input parameters and output components that significantly effect the capital and O&M costs for the project. In addition, the *Project Summary* sheet displays the life cycle cost for water production based on both a 20 and 50-year life cycle period. The following is a list of the costs displayed on the *Project Summary* sheet:

- Raw Water Source
- Source Temperature
- Source Quality
- Intake Quantity
- Intake Pipe Diameter
- Intake Pipe Unit Cost
- Length of Intake Pipeline
- Concentrate Disposal Method
- Injection Wells Required
- Disposal Quantity
- Disposal Pipe Diameter
- Disposal Pipe Unit Cost
- Length of Disposal Pipeline
- Product Water Quality
- Product Water Quantity
- Transmission Pipe Diameter
- Transmission Pipe Unit Cost
- Transmission Pipe Length
- Plant Site Acreage
- Intake Pipeline Acreage
- Disposal Pipeline Acreage
- Transmission Pipeline Acreage
- Subsidies
- Nominal Interest Rate
- Escalation Rate
- Period of Construction
- Total Capital Cost
- Annualized O&M Cost
- Unit Cost for Water Production

6. Charts-Color

The *Charts-Color* sheet generates a series of eight (8) unique color charts that allow the user to visualize the relative cost contributions to the desalination facility. A bar graph and pie chart are displayed to show the relative cost contribution of each facility component to the total capital cost. Similarly, a bar graph and pie chart are displayed to show the relative cost contribution of each annual O&M cost to the total annual O&M cost. Finally, a chart is displayed to show the relative cost contribution of both the capital and O&M unit costs to the total life cycle unit cost.

7. Charts-B&W

The *Charts-B&W* sheet generates graphs identical to those found on the *Charts-Color* sheet. These graphs are generated in grayscale and are formatted for a black and white printer.

8. Parameter Definitions

The Parameter *Definition*s sheet displays the definitions of all input parameters and output components used throughout the model. The *Parameter Definitions* sheet is design so that a user unfamiliar with an input parameter or output component can quickly refer to the definitions to gain a better understanding of the term. The user can simply click on a term in the Model to jump to its description on the *Definition* sheet, and then click on the term on the *Definitions* sheet to return back to its place in the model.

HIDDEN CODE SHEETS

The Model calculates over fifty (50) output values including capital, O&M and life cycle costs based on a total of twenty-eight (28) input values. Due to the large number and complexity of many of these calculations, the model has been designed to run all calculations in the hidden code sheets, displaying only the end results on the visible cost analysis sheets. The code sheets are listed and described below.

1. Code – Dropdowns
2. Code – Capital Costs
3. Code – O&M Costs
4. Code – Unit Costs
5. Code – Charts

TABLE 4-2 FIRST TIER CRITERIA – FATAL FLAW SCREENING PROCESS								
SCREENING CRITERIA	**COOLING WATER SOURCE**	**COOLING SYSTEM TYPE**	**FUEL TYPE**	**PLANT LIFE SPAN**	**REGULATORY ISSUES**	**THREATENED & ENDANGERED SPECIES**	**ARCHEOLOGICAL AND HISTORICAL RESOURCES**	**FATAL FLAW RESULTS (PASS OR FAIL)**
PLANT LOCATION								
CUTLER								
FT. MYERS								
FT. PIERCE UTILITIES								
HOMESTEAD UTILITIES								
KEY WEST UTILITIES								
LAKE WORTH UTILITIES								
LAUDERDALE								
PORT EVERGLADES								
RIVIERA								
ST. LUCIE								
TURKEY POINT, NUCLEAR								
TURKEY POINT, OIL & GAS								
SITES PROPOSED FOR DEVELOPMENT								
AES CORAL / LAKE WORTH								
COMPETITIVE POWER VENTURES / ST. LUCIE								
DECKER / ST. LUCIE								
DUKE / FT. PIERCE								
EL PASO / BROWARD								
ENRON / DEERFIELD BEACH								
ENRON / MIAMI								
ENRON / MIDWAY								
ENRON / POMPANO BEACH								
FKEC / MARATHON								
FPL / MIDWAY								

TABLE 4-3 SECOND TIER CRITERIA							
	PLANT LOCATION						
Note: Scored: high, medium, low or good, fair, poor	**CUTLER**	**FT. MYERS**	**FT. PIERCE**	**LAUDERDALE**	**PORT EVERGLADES**	**RIVIERA**	**TURKEY POINT**
PHYSICAL CHARACTERISTICS OF PLANT SITES							
LOCATION OF AVAILABLE LAND							
AVAILABLE LAND AREA							
LAND FOR FUTURE EXPANSION							
LAND USE AND ZONING							
POWER PLANT CHARACTERISTICS							
PLANT STATUS							
NUMBER OF UNITS							
MEGAWATT (MW) RATING							
BASE LOAD FACILITY							
CYCLING FACILITY							
PEAKING FACILITY							
PLANT IN SERVICE DATE							
PLANNED PLANT EXPANSION (DATE AND MW)							
PLANNED PLANT EXPANSION							
(COOLING SYSTEM CHANGES)							
PLANNED PLANT REPOWERING OPTIONS							
PLANNED PLANT EXPANSION FOR CO-GENERATION							
NATURAL GAS FUEL SOURCE							
INTAKE AND DISCHARGE OPTIONS							
INTAKE SOURCE							
DISCHARGE LOCATION							
WATER QUALITY CLASSIFICATION							
FLOW RATE, PER UNIT AND TOTAL							
DESALINATION SOURCE WATER							
DESALINATION DISCHARGE METHOD							

TABLE 4-3 SECOND TIER CRITERIA							
	PLANT LOCATION						
Note: Scored: high, medium, low or good, fair, poor	**CUTLER**	**FT. MYERS**	**FT. PIERCE**	**LAUDERDALE**	**PORT EVERGLADES**	**RIVIERA**	**TURKEY POINT**
PHYSICAL CHARACTERISTICS OF PLANT SITES							
COMPATIBILITY OF REJECT WATER							
WATER DEMAND AND TRANSMISSION							
POTENTIAL USERS							
YEAR 2010 DEMANDS (mgd)							
YEAR 2020 DEMANDS (mgd)							
PROXIMITY TO DEMAND							
PROXIMITY TO TRANSMISSION LINES AND POINTS OFCONNECTION							
OTHER WATER SUPPLY OPTIONS							
ENVIRONMENTAL CONSIDERATIONS							
REGULATORY STATUS							
PERMITTABILITY							
ENVIRONMENTAL IMPACTS							
OTHER							
PUBLIC ACCEPTANCE							
DESIRE TO CO-LOCATE							
RESULTS							
NOTES:							

TABLE 4-4 CAPITAL, O&M & LIFE CYCLE COSTS			
COST COMPONENT	UNITS	FINAL SITE SELECTED	
		10 mgd	25 mgd
INPUT DATA			
Source Water			
Source Type			
Quantity **(1)**	mgd		
Quality	ppm TDS		
Temperature	^{o}F		
Distance to Source	lineal feet		
Land Cost for Intake Pipeline	$ per acre		
Finished Water			
Quantity	mgd		
Quality	ppm TDS		
Distance to Point of Use	Miles		
Land Cost for Transmission	$ per acre		
Electric Power			
Cost of Energy	cents/kWh		
Concentrate Discharge			
Method			
Injection Wells Required			
Quantity **(1)**	mgd		
Distance to Discharge Point	lineal feet		
Land Cost for Discharge Pipeline	$ per acre		
Land for Plant Site			
Acquisition Method			
Cost of Plant Site Land	$ per acre		
Financial			
Type of Ownership			
Subsidies			
Rate of Growth			
Nominal Interest Rate			
Inflation Rate			
Sales Tax			
Contingency			
(1) Calculated value based on projected system yield			
OUTPUT DATA			
CAPITAL COSTS			
Intake System			
Surface Water Pump Station			
Raw Water Structure			
Intake Pipeline			

TABLE 4-4 CAPITAL, O&M & LIFE CYCLE COSTS			
COST COMPONENT	UNITS	FINAL SITE SELECTED	
		10 mgd	25 mgd
Supply Well System			
Pretreatment			
Process Equipment			
R.O. Process			
Membrane System			
Pumps			
Energy Recovery System			
Post-treatment			
Process Equipment			
Concentrate Discharge			
Pump Station			
Pipeline			
Deep Wells			
Infrastructure			
Building			
Site Work			
Land			
Plant Site			
Intake Pipeline			
Discharge Pipeline			
Transmission Pipeline			
Transmission			
Pump Station			
Ground Storage Tanks			
Transmission Pipeline			
Professional Services			
Engineering			
Permitting			
Legal			
Capital Cost Totals			
Subtotal			
Contingency			
Sales Tax			
Subsidies			
Net Total			
Capitalized Interest			
Cost of Financing			
Construction Insurance			
Grand Total			
OPERATION AND MAINTENANCE COSTS	**dollars/year**		
Pretreatment			

TABLE 4-4 CAPITAL, O&M & LIFE CYCLE COSTS			
COST COMPONENT	**UNITS**	**FINAL SITE SELECTED**	
		10 mgd	**25 mgd**
Chemicals			
Post-treatment			
Chemicals			
R.O. Process			
Replacement Membranes (Annualized Over 20 Years)			
Replacement Membranes (Annualized Over 50 Years)			
Water Quality Monitoring			
Monitoring of Concentrate and Product Water			
Energy Consumption			
Power			
Operation and Maintenance			
Replacement Parts			
Plant Site Lease			
Labor			
Operating Insurance			
O&M Cost Totals			
Annualized O&M (Based on 20-Year Life Cycle)			
Annualized O&M (Based on 50-Year Life Cycle)			
LIFE CYCLE PROJECT COSTS			
Based on 20-Year Life Cycle			
Total Capital Cost			
Annualized O&M Cost	dollars/ year		
20-Year Life Cycle Cost	per 1000 gal.		
Based on 50-Year Life Cycle			
Total Capital Cost			
Annualized O&M Cost	dollars/ year		
50-Year Life Cycle Cost	per 1000 gal.		
Public Ownership(2)			
LIFE CYCLE PROJECT COSTS			
Based on 20-Year Life Cycle			
Total Capital Cost			
Annualized O&M Cost	dollars/ year		
20-Year Life Cycle Cost	per 1000 gal.		
Based on 50-Year Life Cycle			
Total Capital Cost			
Annualized O&M Cost	dollars/ year		
50-Year Life Cycle Cost	per 1000 gal.		
(2) Public ownership deletes sales tax and reduces financing interest rate by 0.50%			

Master Data Input Sheet

PROJECT NAME	EXAMPLE FACILITY	

SOURCE WATER

Source	Groundwater	
Quality	5,000 - 10,999	mg/L TDS
Avg. Temperature	77.0 - 85.9	° Fahrenheit
Distance to Source Water	600	lineal feet
Cost of Easement or Purchase	$0	$ per acre

FINISHED WATER

Quantity	10	MGD
Quality	250	mg/L Chlorides
Distance to Point of Use	8.50	miles
Cost of Easement or Purchase	$10,000	$ per acre

ELECTRIC POWER

Cost of Energy	4.25	¢/kwh

CONCENTRATE DISPOSAL

Method	Deep Well Injection	
Distance to Disposal Point	600	lineal feet
Cost of Easement or Purchase	$0	$ per acre

LAND FOR CONSTRUCTION OF PLANT

Acquisition Method	Purchase	
Cost of Land (Plant Site)	$25,000	$ per acre

FINANCIAL

Type of Ownership	Private	
Subsidies	$0	
Rate of Growth	2.50	%
Nominal Interest Rate	5.50	%
Inflation Rate	2.54	%
State Sales Tax	6.50	%
Local Sales Tax	0.00	%

ADVANCED INPUTS

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Advanced Inputs			EXAMPLE FACILITY

This sheet allows you to customize the percentages used in calculating the following cost outputs. To customize percentages select "Customize" from the dropdown menu and enter the new values in the "Custom" column.

Return to Master Data Input Sheet

Default

COST OUTPUTS	DEFAULT	CUSTOM	DESCRIPTION OF COST COMPONENT	
1. Engineering Services	8.00 %	%	Listed as a capital cost under professional services, engineering service costs are associated with project engineering, design, procurement and construction management. The default is set to 8% of the capital cost subtotal excluding professional services	0.08
2. Permitting	2.00 %	%	Listed as a capital cost under professional services, permitting costs are associated with preparing necessary permit applications including all scientific modeling, testing and analysis to meet regulatory requirements. The default is set to 2% of the capital cost subtotal excluding professional services	0.02
3. Legal Services	1.00 %	%	Listed as a capital cost under professional services, legal services are associated with legal support to address all contractual, administrative and regulatory requirements. The default is set to 1% of the capital cost subtotal excluding professional services	0.01
4. Contingency	25.00 %	%	An assumed default is set at 25 percent of the capital cost subtotal including professional services. It does not include any provision for risk and uncertainty differences between project alternatives.	0.25
5. Cost of Financing	3.00 %	%	Cost associated with issuing debt. It is generally estimated at about 3 percent of the amount to be financed, including the net total capital cost and capitalized interest.	0.03
6. Construction Insurance	4.00 %	%	Cost of purchasing insurance to protect the owner against construction problems and failures. A default is set at 4% of the capital cost including the , contingency, sales tax and any subsidies.	0.04
7. Water Quality Monitoring	0.25 %	%	Listed as an O&M cost under concentrate disposal, monitoring costs are associated with monitoring of process discharges and finished water quality as required by local, state and federal permits. The default is set at 0.25% of the capital cost subtotal excluding professional services.	0.0025
8. Operating Insurance	1.00 %	%	Listed as an O&M cost under concentrate disposal, operating insurance costs are associated with purchasing insurance to protect the owner against operation problems and failures. The default is set at 1% of the sum of all first year O&M costs before insurance.	0.01

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Capital Cost Outputs	EXAMPLE FACILITY	
INTAKE SYSTEM		
Surface Water Pump Station	$0	A
Raw Water Structure	$0	B
Pipeline	$110,688	C
Supply Well System	$6,600,000	D
TOTAL	$6,710,688	E
PRETREATMENT		
Process Equipment	$0	F
TOTAL	$0	G
R.O. PROCESS		
Membrane System	$1,944,444	H
Pumps	$604,215	I
Energy Recovery System	$253,775	J
TOTAL	$2,802,434	K
POST TREATMENT		
Process Equipment	$75,000	L
TOTAL	$75,000	M
CONCENTRATE DISPOSAL		
Pump Station	$647,517	N
Pipeline	$36,000	O
Deep Wells	$4,000,000	P
TOTAL	$4,683,517	Q
INFRASTRUCTURE		
Building	$900,000	R
Site Work	$576,000	S
TOTAL	$1,476,000	T
LAND		
Plant Site (Purchase Price)	$125,000	U
Source Water Intake Pipeline	$0	V
Concentrate Disposal Pipeline	$0	W
Transmission Pipeline	$309,091	X
TOTAL	$434,091	Y
TRANSMISSION		
Pump Station	$1,225,497	Z
Ground Storage Tanks	$1,650,000	AA
Transmission Pipeline	$6,283,200	AB
TOTAL	$9,158,697	AC
PROFESSIONAL SERVICES		
Engineering	$2,027,234	AD

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Permitting	$506,809	AE		
Legal	$253,404	AF		
TOTAL	$2,787,447	AG		
CAPITAL COST TOTALS				
Subtotal	$28,127,874	AH	=	E+G+K+M+Q+T+Y+AC+AG
Contingency	$7,031,968	AJ	=	AH * 25%
Sales Tax	$1,647,128	AK		
Subsidies	$0	AL		
Net Total	$36,806,970	AM	=	AH+AJ+AK-AL
Capitalized Interest	$1,012,192	AN		
Cost of Financing	$1,134,575	AO		
Construction Insurance	$1,472,279	AP		
GRAND TOTAL	$40,426,015	AQ		

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

O&M Cost Outputs	EXAMPLE FACILITY
PRETREATMENT	
Chemicals	$0 per year
R.O. PROCESS	
Replacement Membranes (Based on 20-Year Life Cycle)	$175,565 per year
Replacement Membranes (Based on 50-Year Life Cycle)	$257,541 per year
POST TREATMENT	
Chemicals	$111,956 per year
WATER QUALITY MONITORING	
Water Quality Monitoring of Concentrate and Product	$63,351 per year
ENERGY CONSUMPTION	
Power	$803,250 per year
OPERATION & MAINTENANCE	
Replacement Parts	$475,300 per year
Plant Site Lease	$0 per year
Labor	$420,000 per year
Operating Insurance	$368,070 per year
ANNUALIZED O&M COST (Based on a 20-year life cycle)	$2,996,092
ANNUALIZED O&M COST (Based on a 50-year life cycle)	$3,738,997

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

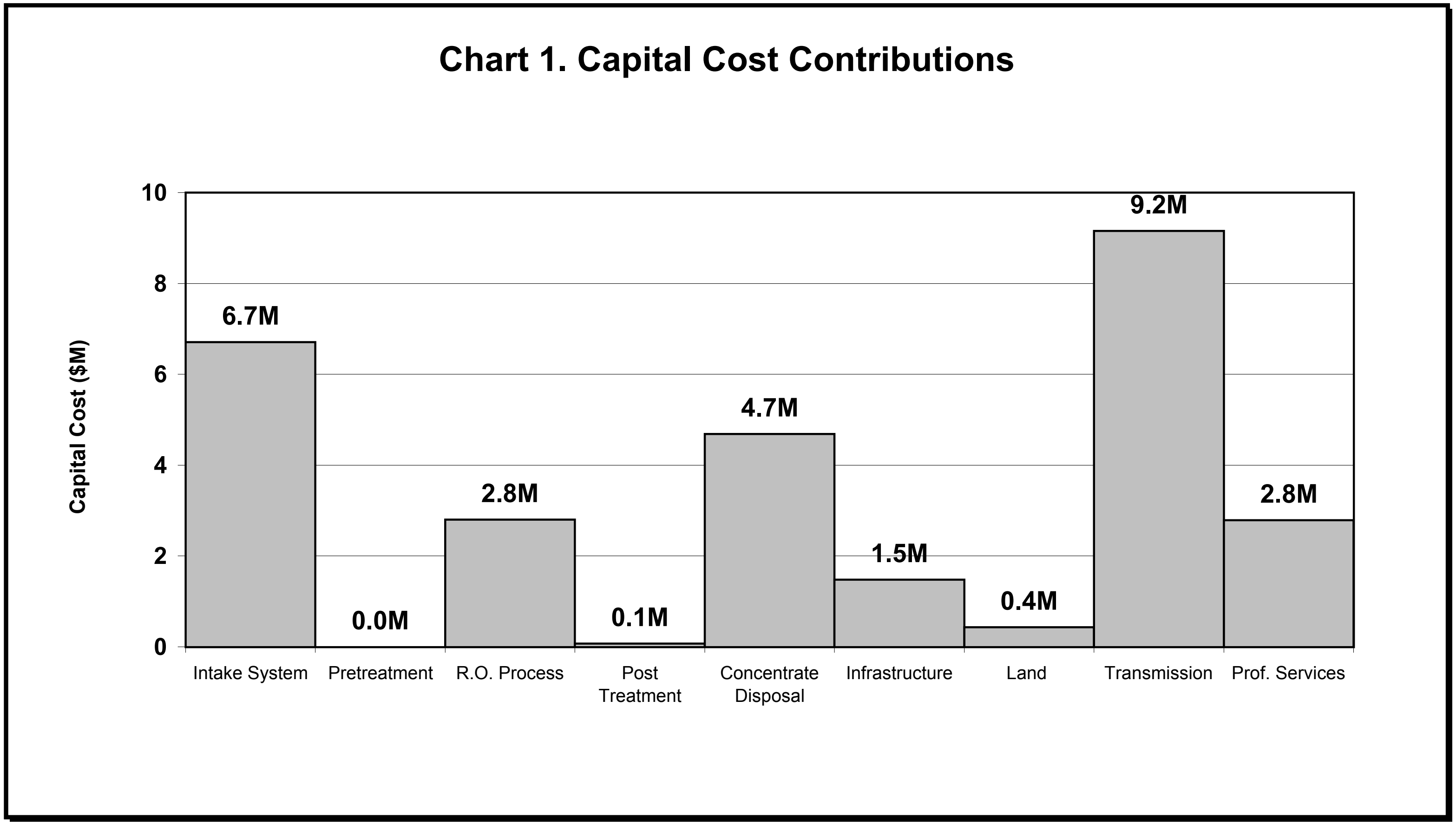
Project Summary	EXAMPLE FACILITY	
SOURCE WATER		
Source	Groundwater	
Avg. Temperature	77.0 - 85.9	° Fahrenheit
Quality	5,000 - 10,999	mg/l TDS
Quantity	14.30	MGD
Pipe Diameter	36	inches
Unit Cost	$184	per lineal foot
Pipe Length	600	lineal ft
CONCENTRATE DISPOSAL		
Disposal Method	Injection Well	
Injection Wells Required	1	
Quantity	4.30	MGD
Pipe Diameter	10	inches
Unit Cost	$60	per lineal foot
Pipe Length	600	lineal ft
PRODUCT WATER		
Quality	250	mg/l TDS
Quantity	10.00	MGD
Pipe Diameter	30	inches
Unit Cost	$140	per lineal foot
Pipe Length	8.50	miles
LAND REQUIREMENTS		
Plant Site	5.00	acres
Source Water Intake Pipeline	0.48	acres
Concentrate Disposal Pipeline	0.28	acres
Transmission Pipeline	30.91	acres
FINANCIAL		
Subsidies	$0.00	
Nominal Interest Rate	5.5%	
Escalation Rate	2.5%	
Period of Construction	12	months
PROJECT COST (Based on 20-year life cycle)		
Total Capital Cost	$40,426,015	
Annualized 20-Year O&M	$2,996,092	per year
20-Year Life Cycle Cost	$1.75	per 1,000 gallons supplied
PROJECT COST (Based on 50-year life cycle)		
Total Capital Cost	$40,426,015	
Annualized 50-Year O&M	$3,738,997	per year
50-Year life Cycle Cost	$1.68	per 1,000 gallons supplied

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Cost Summary Charts - Black and White **EXAMPLE FACILITY**

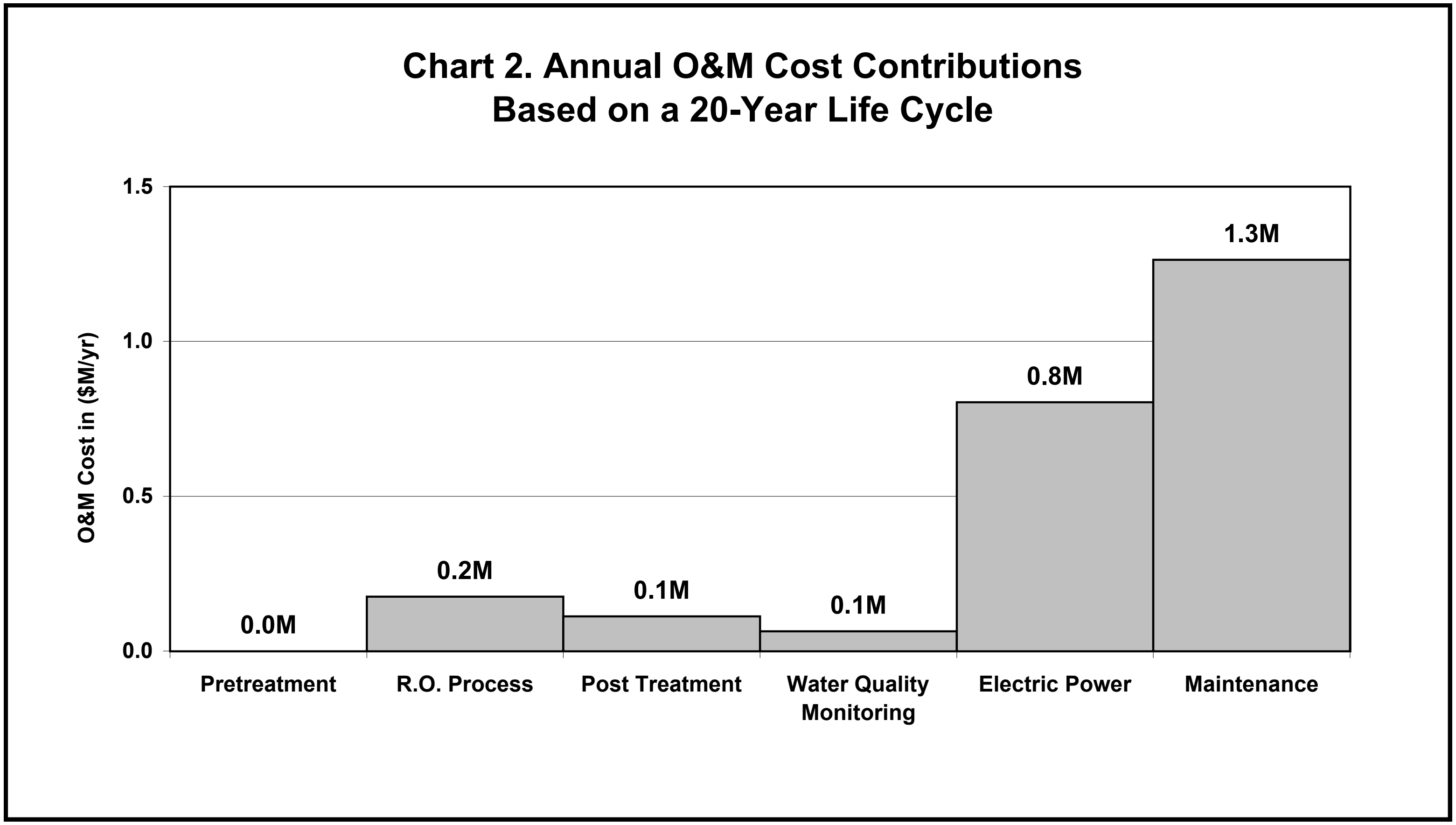
Click on any chart to jump to its location on this sheet or scroll down to browse all charts

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL



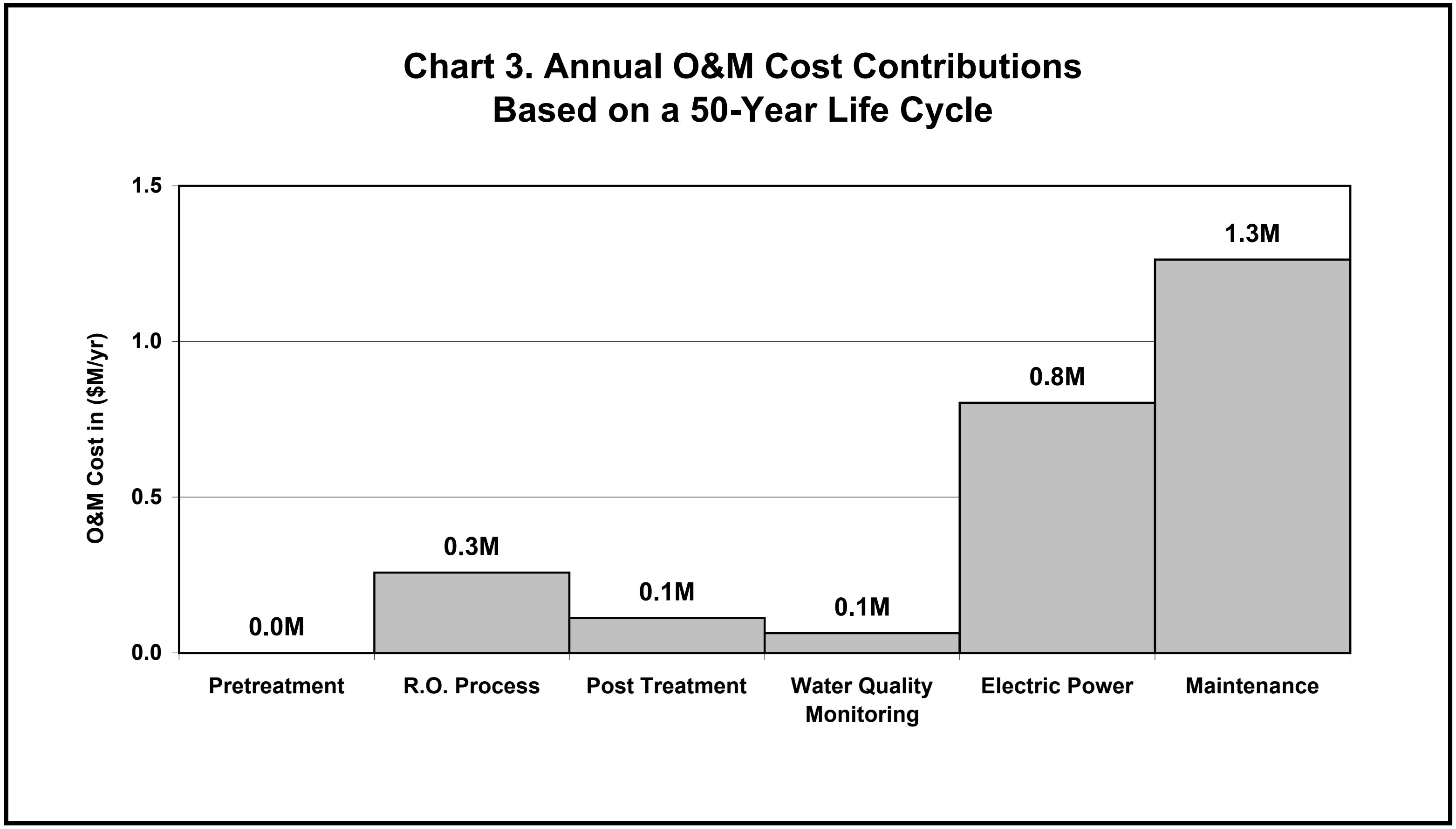
RETURN TO TOP

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL



RETURN TO TOP

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL



RETURN TO TOP

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

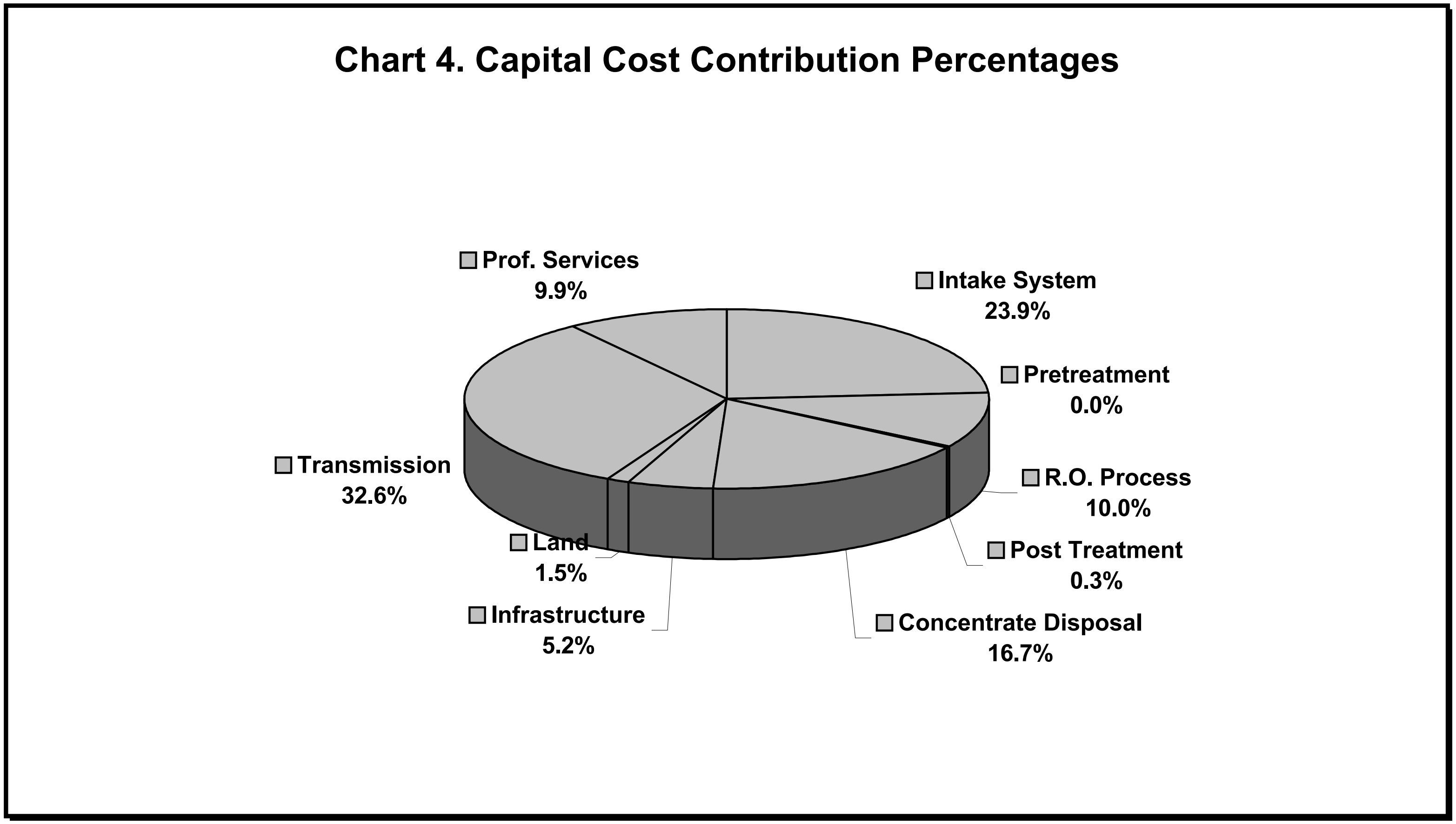


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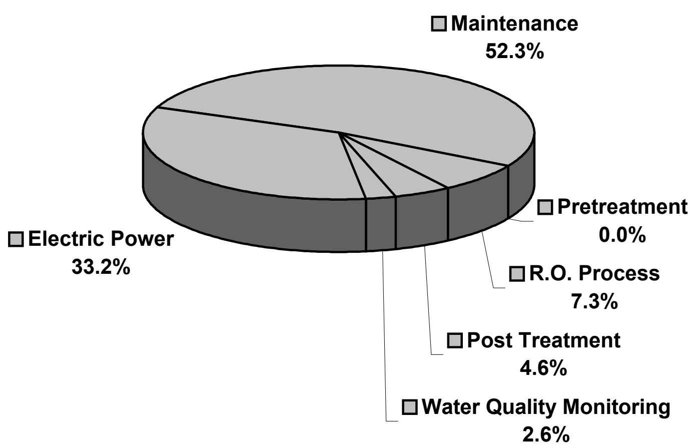
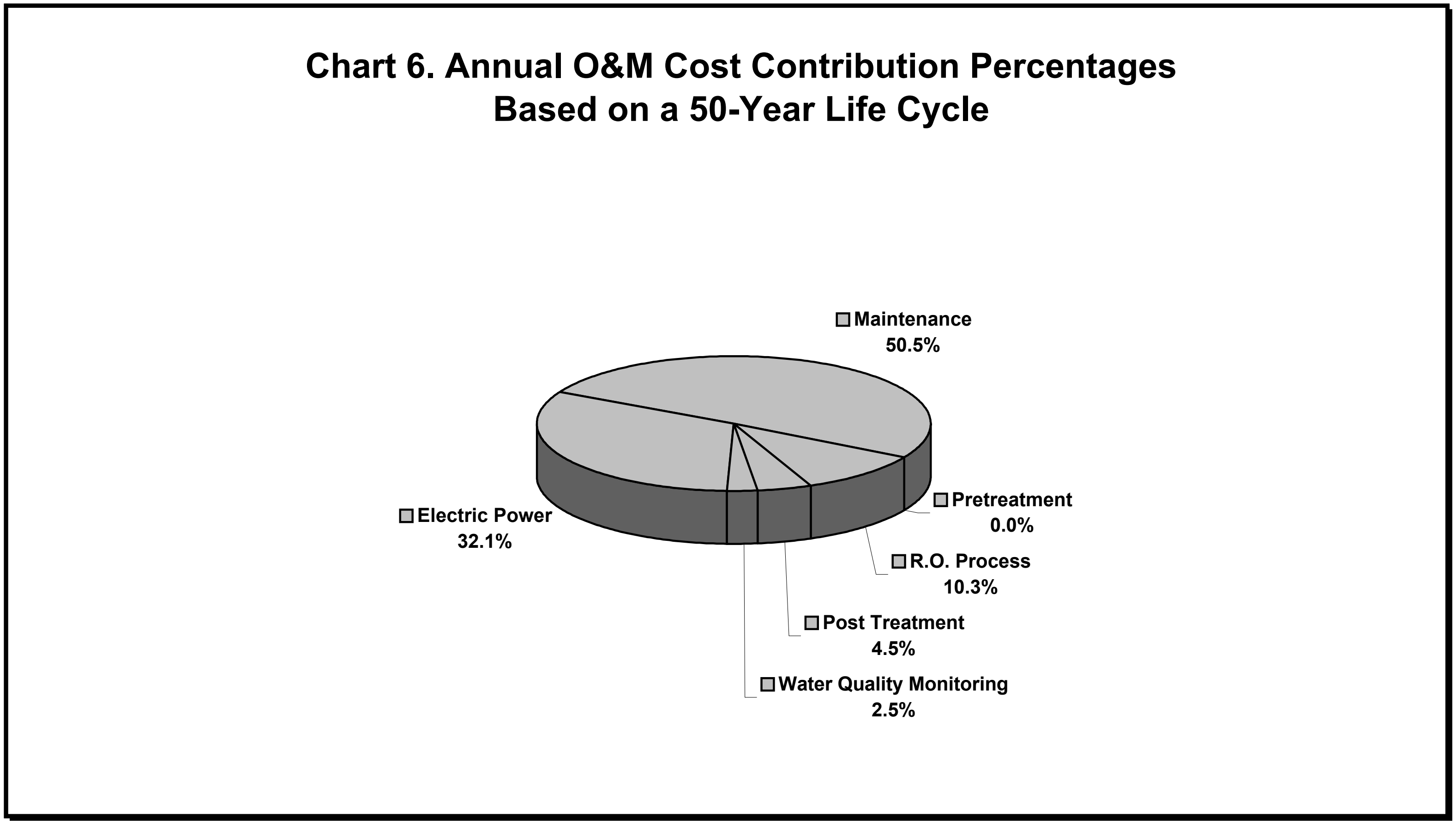
Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Chart 5. Annual O&M Cost Contribution Percentages Based on a 20-Year Life Cycle



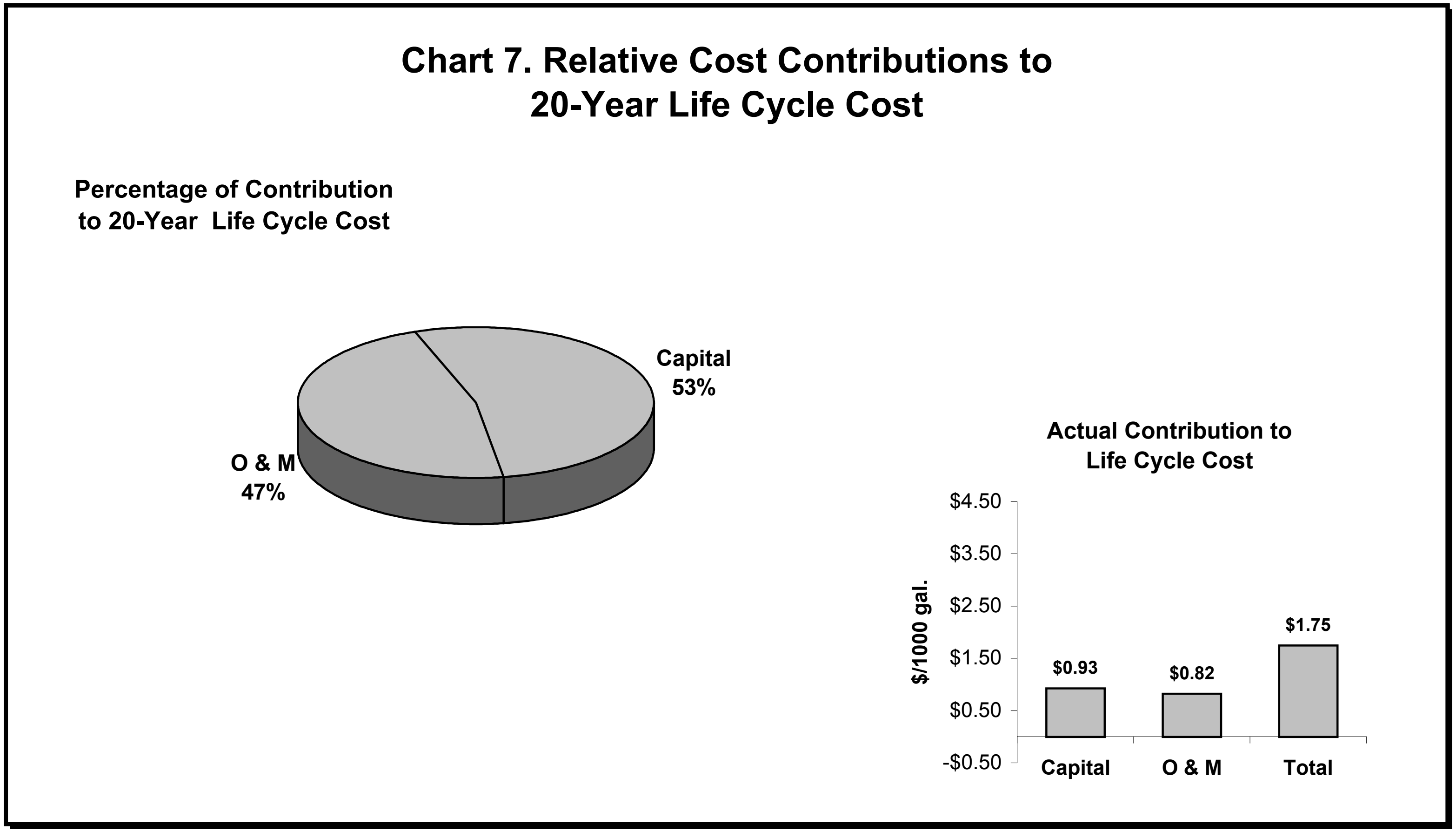
RETURN TO TOP

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL



RETURN TO TOP

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL



RETURN TO TOP

Figure 4-1: EXAMPLE FEASIBILTIY COST PLANNING MODEL

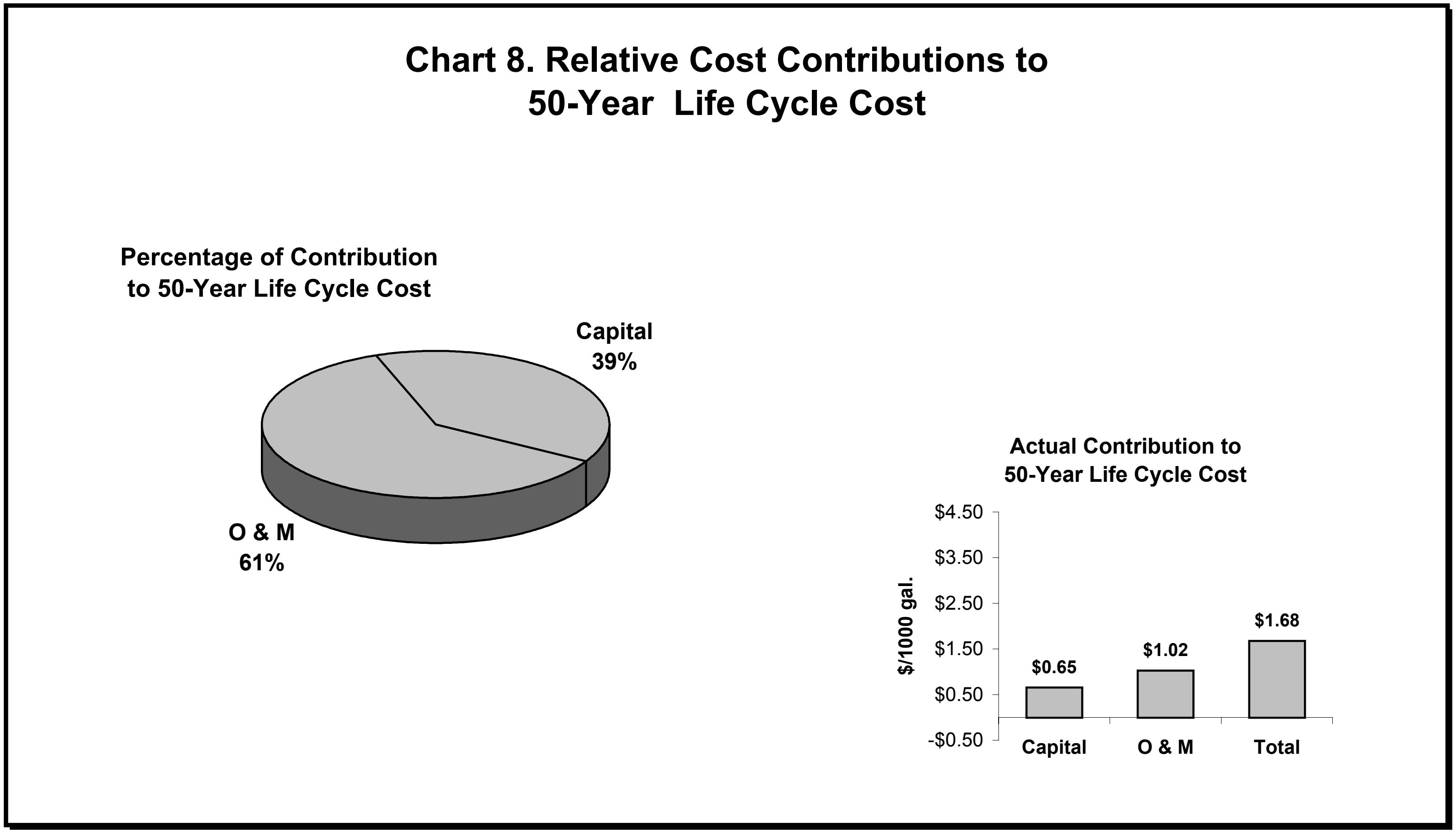


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Figure 4-1: EXAMPLE FEASIBILTIY COST PLANNING MODEL

Click on any sheet title to jump to its definitions.

Click on any term to return back to its place in the model.

MASTER DATA INPUTS

Source Water — Water supply source that will provide feed water to desalination plant to produce finished potable water

Source — Location of source water withdrawal; can come from a surface water source such as an ocean, bay or river, or a groundwater source such as deepwells or shallow beach wells.

Quality — Quality of the source water which will feed the desalination plant. Water quality for desalination plant design is measured in Total Dissolved Solids (TDS), a measure of salinity. Brackish water is typically defined as TDS less than 12,000 mg/l and seawater above 19,000 mg/l TDS. Pure open ocean seawater is typically 33,000 - 35,000 TDS.

Temperature — Source water temperature measured in degrees Fahrenheit or Celsius. Power plant cooling water is typically found in the high 86-95 F range, while stream flows or less arid regions of the world are found in the lower temperature range 68-76.9 F . Most other source waters are found in the 77-85.6 F range.

Distance to Source — Actual distance (in feet) to run pipe between the source water intake and plant site.

Cost of Easement or Purchase — Cost of land to be aquired for intake pipeline

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Finished Water	Finished potable water produced by the desalination plant
Quantity	Quantity of finished potable water to be produced by the plant. This value is measured in million gallons per day (MGD) This quantity will be a constant and uniform production value throughout the period of operation.
Quality	Finished potable water quality expected from this plant. Finished water quality is measured in mg/l chlorides. This value is generally 250 mg/l chlorides but can be higher or lower if blended with another potable supply.
Distance to Use	Actual distance (in miles) to run finished potable water transmission pipe between the plant site and distribution system. The distribution system may be defined as the point of blending with other potable sources or the point at which the main transmission line is connected to smaller distribution lines.
Cost of Easement or Purchase	Cost of land to be aquired for transmission pipeline
Electric Power	Electricity to power the desalination process including all intake and discharge pump systems.
Cost of Energy	Unit cost of electricity to power the desalination facilities. Generally expressed in cents/ kilowatt-hour. Rates can vary from region to region in the U.S. but 3-6 cents/kwh is typical. Lower rates are available if the plant will accept interruptible or off-peak rates.
Concentrate Disposal	Concentrate is the high salinity reject effluent from the desalination process, sometimes referred to as brine. Concentrate must be disposed in an environmentally acceptable manner permitted by state and/or federal regulatory agencies.
Method	Concentrate disposal can be managed in many ways dependant upon the volume and quality of the discharge. Typically, concentrate is disposed of by underground injection wells, direct surface discharge with a regulatory mixing zone or co-located with a lower salinity discharge such as domestic wastewater or power plant cooling water. Each method has advantages and disadvantages with regard to cost , environmental impacts and permitting.

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Distance to Disposal	Actual distance (in feet) to run concentrate disposal pipe between the plant site and point of discharge. This point of discharge may be defined as the location where the concentrate is injected underground, discharged directly to a surface waterbody or blended with another discharge.
Cost of Easement or Purchase	Cost of land to be aquired for disposal pipeline
Land	Land is required to site the desalination plant and required infrastructure including storage facilities and pipelines.
Type of Land	Classification of the setting where the plant will be constructed to identify land easement costs for the transmission line piping. Higher values will be assigned for urban settings, moderate for suburban and lowest for rural.
Acquisition Method	The land control method for the area where the plant will be constructed. This is typically accomplished by purchasing the land or leasing on a long term basis.
Cost of Land (Plant Site)	Cost of land if purchased or leased; cost is expressed in dollars per acre.
Financial	Project costs are funded and financed in a number of ways which can affect the overall finished water unit cost.
Type of Ownership	Ownership options are private or public, which affects primarily the applicable tax structure. For public-private partnerships the selection would be public because they usually take advantage of the benefits of a public ownership in terms of taxes, financial requirements and interest rates
Amortization Period	Period of time over which the project will be financed.
Subsidies	Funds received from grants or in-kind contributions to decrease the cost of the project, usually capital cost.
Nominal Interest Rate	Actual interest rate paid; which is usually considered to be the sum of the real interest rate and the rate of inflation.
Inflation Rate	Annual rate of inflation.
State Sales Tax	Tax paid to the State of Florida on materials and some services purchased to develop a project.

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Local Sales Tax	Tax paid to a local municipality on top of the state sales tax on the same materials and services to which the state sales tax applies.

CAPITAL COST SUMMARY

Intake System	Source water intake system including pipes, pumps and wells, depending on method selected.
Surface Water Pump Station	The source water supply pumping station, where the source is a surface water such as a river, stream or ocean.
Raw Water Structure	A surface water intake structure consisting of a concrete intake structure, box culvert, screens, backwash water retention, electrical building and related appurtenances
Pipeline	The transmission main conveying water from the source to the treatment plant
Supply Well System	A ground water well system. Either deep brackish or shallow beach wells used to supply water to the treatment plant.
Pretreatment	Pretreatment of source water to preserve RO membranes and increase system efficiency.
Process Equipment	The pre-treatment system is assumed only for systems using surface water as the source water, regardless of salinity. Pre-treatment equipment typically includes filtration devices in conjunction with a ferric salt coagulant. Alternatively, membrane filtration can be used
R.O. Process	Reverse Osmosis (RO) desalination process equipment including membranes, pumps and energy recovery systems.
Membrane System	The membrane system includes RO membranes, side entry FRP pressure vessels, support structures, instrumentation and controls, interconnecting piping and valves, and electrical equipment.
Pumps	High efficiency feed pumps used to pump the pretreated source water through the RO membrane system.
Energy Recovery System	Turbines driven by the concentrate flow exiting the RO membranes after separation from the source water. Energy produced by the turbines is used to load the pumps feeding the source water into the RO membrane system.

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Post Treatment	Post treatment chemical feed equipment necessary to meet required finished water requirements
Process Equipment	The post treatment chemical systems consist of bulk storage tankage, sized for 15-30 days storage, depending on plant capacity; day tanks; chemical metering pumps; piping and valves; controls and electrical equipment. Chemicals used for post-treatment include sodium hypochlorite for disinfection, CO_2 and lime for stabilization, a phosphatic corrosion inhibitor and fluoride.
Concentrate Disposal	Concentrate is the high salinity reject effluent from the desalination process, sometimes referred to as brine. Concentrate must be disposed in an environmentally acceptable manner permitted by state and/or federal regulatory agencies.
Pump Station	A high service pump station that pumps the concentrate from the treatment process to the disposal site
Pipeline	The transmission main conveying concentrate from treatment plant to the concentrate disposal site
Deep Wells	Deep injection wells used to dispose of the concentrate.
Infrastructure	Facilities associated with the non-process portion of the plant operation including the plant housing, entrance roads, fencing, storage area, etc.
Building	Building used to house reverse osmosis units for the treatment process.
Site Work	Site development including clearing and grubbing, fill, grading, storm sewers, water and sanitary piping, entrance road, parking area, and perimeter fencing.
Land	Land is required to site the desalination plant and required infrastructure including storage facilities and pipelines.
Plant Site	Land required for the desalination water treatment plant; acreage varies from 3 to 15 acres depending on the plant capacity; land may be leased or purchased.
Source Water Intake Pipeline (Land)	Land area in square feet per linear foot (SF/LF) required for construction of the source water transmission main; trench width varies based on pipe diameter; land can be either urban, suburban, or rural
Concentrate Disposal Pipeline (Land)	Land area in square feet per linear foot (SF/LF) required for construction of the concentrate disposal transmission main; trench width varies based on pipe diameter; land can be either urban, suburban, or rural

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Transmission Pipeline (Land)	Land area in square feet per linear foot (SF/LF) required for construction of the finished water transmission main; trench width varies based on pipe diameter; land can be either urban, suburban, or rural
Transmission	Equipment required to transport finished potable water to the end user.
Pump Station	High service pump station, which pumps finished water from the treatment plant site to the transmission system
Ground Storage Tanks	Finished water storage tank constructed at land surface; stores finished water prior to delivery to customers
Transmission Pipeline	Transmission main that conveys finished water from the treatment plant to the distribution system. The distribution system may be defined as the point of blending with other potable sources or the point at which the main transmission line is connected to smaller distribution lines.
Professional Services	Professional services required to address technical, legal and scientific aspects of constructing and operating a desalination facility project
Engineering	Costs associated with project engineering, design, procurement and construction management.
Permitting	Costs associated with preparing necessary permit applications including all scientific modeling, testing and analysis to meet regulatory requirements.
Legal	Costs associated with legal support to address all contractual, administrative and regulatory requirements
Capital Cost Totals	
Subtotal	Sum of all equipment costs, including land and professional services, before contingency, taxes, and subsidies.
Contingency	Assumed to be 25 percent of all capital costs, it does not include any provision for risk and uncertainty differences between project alternatives.
Sales Tax	Sum of state and local sales taxes.
Subsidies	Sum of all individual subsidies.
Net Total	Total after the contingency and sales tax has been added to, and all subsidies have been subtracted from the subtotal.

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Capitalized Interest	Cost of borrowing funds used for project development incurred before plant construction is complete and operation begins.
Cost of Financing	Cost associated with issuing debt. It is generally estimated at about 3 percent of the amount to be financed (net total), including capitalized interest.
Construction Insurance	Cost of purchasing insurance to protect the owner against construction problems and failures.

O&M COST SUMMARY

Pretreatment

Chemicals	Assumed only for systems using surface water as the source water, regardless of salinity. The pre-treatment equipment assumes membrane filtration with the addition of a ferric salt coagulant and scale inhibitor for source water quality equal to or greater than 19,000 TDS. For source water quality below 19,000 TDS only Sulphuric acid and a scale inhibitor are used for pretreatment.

R.O. Process

Replacement Membranes (20-yr)	R.O. membranes that typically must be replaced every five years. The five-year replacement costs are annualized over a 20 year life cycle.
Replacement Membranes (50-yr)	R.O. membranes that typically must be replaced every five over a 50 year life cycle.

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Post Treatment

Chemicals	The post treatment chemical systems consist of bulk storage tankage, sized for 15-30 days storage, depending on plant capacity; day tanks; chemical metering pumps; piping and valves; controls and electrical equipment. Chemicals used for post-treatment include sodium hypochlorite for disinfection, CO_2 and lime for stabilization, a phosphatic corrosion inhibitor and fluoride.
Water Quality Monitoring	Listed as an O&M cost under concentrate disposal, monitoring costs are associated with monitoring of process discharges and product water quality as required by local, state and federal permits. The default is set at 0.25% of the capital cost subtotal excluding professional services.

Energy Consumption

Power	Electricity to power the desalination process including all intake and discharge pump systems.

Operation & Maintenance

Replacement Parts	Cost associated with the replacement of major components prior to the end of the project's useful life. The cost of replacement parts is a fraction of the sum of the capital costs for the source water intake pump, source water structure, supply well system, pretreatment equipment, R.O. pumps, post-treatment equipment, distribution pump station and deep injection wells.
Plant Site Lease	Cost of leasing the property that the plant is built on.
Labor	Sum of salaries for plant superintendent, operators, mechanics and laborers.
Operating Insurance	Cost of purchasing insurance to protect the owner against operation problems and failures. Cost calculated while taking into account annualized membrane replacement cost.

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

O&M Cost Totals

Annualized O&M (20-Year Life Cycle)	Sum of all individual annual O&M costs. The individual annual O&M costs are assumed to remain uniform over the life cycle of the plant. However, after the first year the total annual O&M cost is increased each year by an escalation rate set by the user.
Annualized O&M (50-Year Life Cycle)	Sum of all individual annual O&M costs. The individual annual O&M costs are assumed to remain uniform over the life cycle of the plant. However, after the first year the total annual O&M cost is increased each year by an escalation rate set by the user.

PROJECT SUMMARY

Source Water	Water supply which will provide feed water to the desalination plant to produce finished potable water.
Source	Location of source water withdrawal; can come from a surface water source such as an ocean, bay or river, or a groundwater source such as deepwells or shallow beach wells.
Temperature	Source water temperature measured in degrees Fahrenheit or Celsius. Power plant cooling water is typically found in the high 86-95 F range, while stream flows or less arid regions of the world are found in the lower temperature range 68-76.9 F . Most other source waters are found in the 77-85.6 F range.
Quality	Quality of the source water which will feed the desalination plant. Water quality for desalination plant design is measured in Total Dissolved Solids (TDS), a measure of salinity. Brackish water is typically defined as TDS less than 12,000 mg/l and seawater above 19,000 mg/l TDS. Pure open ocean seawater is typically 33,000 - 35,000 TDS
Quantity	The amount of source water required to meet the expected finished water production quantity. This amount of water will be approximately the sum flows of the finished water and the concentrate discharge.
Pipe Diameter	Diameter in inches of the source water intake pipeline.
Unit Cost	Unit cost of the source water intake pipeline per lineal foot based on the diameter.
Pipe Length	Length in feet of the source water intake pipeline. Equal to the distance to source indicated by the user.

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Concentrate Disposal	Concentrate is the high salinity reject effluent from the desalination process, sometimes referred to as brine.
Disposal Method	Concentrate disposal can be managed in many ways dependant upon the volume and quality of the discharge. Typically, concentrate is disposed of by underground injection wells, direct surface discharge with a regulatory mixing zone or blended with a lower salinity discharge such as domestic wastewater or power plant cooling water. Each method has advantages and disadvantages with regard to cost , environmental impacts and permitting.
Injection Wells Required	Number of deep injection wells required based on the calculated concentrate flow. Injection wells are only required if the user selects "Deep Well Injection" as the disposal method.
Quantity	The quantity of desalination process concentrate that will be produced daily.
Pipe Diameter	Diameter in inches of the concentrate disposal pipeline.
Unit Cost	Unit cost of the concentrate disposal pipeline per lineal foot based on the diameter.
Pipe Length	Length in feet of the concentrate disposal pipeline. Equal to the distance to disposal indicated by the user.
Product Water	
Quality	Finished potable water quality expected from this plant. Finished water quality is measured in mg/l chlorides. This value is generally 250 mg/l chlorides but can be higher or lower if blended with another potable supply.
Quantity	Quantity of finished potable water to be produced by this plant. This value is measured in million gallons per day (MGD) This quantity will be a constant and uniform production value throughout the period of operation.
Pipe Diameter	Diameter in inches of the product water transmission pipeline.
Unit Cost	Unit cost of the product water transmission pipeline per lineal foot based on the diameter.
Pipe Length	Length in miles of the product water transmission1 pipeline. Equal to the distance to the point of use indicated by the user.

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Land Requirements

Site Area	Land area in acres required for the desalination water treatment plant; acreage varies from 3 to 15 acres depending on the plant capacity; land may be leased or purchased.
Source Water Intake Pipeline	Land area in acres required for the source water intake pipeline; acreage varies depending on the length and diameter of the pipe.
Concentrate Disposal Pipeline	Land area in acres required for the concentrate disposal pipeline; acreage varies depending on the length and diameter of the pipe.
Product Water Transmission Pipeline	Land area in acres required for the product water transmission pipeline; acreage varies depending on the length and diameter of the pipe.

Financial

Subsidies	Sum of all individual subsidies.
Nominal Interest Rate	Actual interest rate paid, usually considered to be the sum of the real interest rate and the rate of inflation.
Escalation Rate	Annual rate of inflation indicated by user
Period of Construction	Time it will take from the beginning of construction to the start of operation.

Project Cost (Based on a 20-Year Life Cycle)

Total Capital Cost	Sum of all costs of all equipment, infrastructure, land and professional services needed to bring the project to operating status. Total capital cost is independent of life cycle.
Annualized O&M (20-Year Life Cycle)	Annualized cost of O&M based on the the total 1st year O&M cost escalated over a 20 year life cycle period.
20-Yr Life Cycle Cost ($/1000gal)	20-year life cycle cost calculated by present worthing all project costs including the total capital cost and the escalated annual O&M costs over **20 years** to the date of project startup. The life cycle cost is then divided by the life cycle water production in 1000 gallons to give the 20-year life cycle cost in $/1000 gal.

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

Project Cost (Based on a 50-Year Life Cycle)

Total Capital Cost	Sum of all costs of all equipment, infrastructure, land and professional services needed to bring the project to operating status. Total capital cost is independent of life cycle.
Annualized O&M (50-Year Life Cycle)	Annualized cost of O&M based on the the total 1st year O&M cost escalated over a 50 year life cycle period.
50-Yr Life Cycle Cost ($/1000gal)	20-year life cycle cost calculated by present worthing all project costs including the total capital cost and the escalated annual O&M costs over 50 years to the date of project startup. The life cycle cost is then divided by the life cycle water production in 1000 gallons to give the 20-year life cycle cost in $/1000 gal.

RETURN TO TOP

Figure 4-1: EXAMPLE FEASIBILITY COST PLANNING MODEL

SITE EVALUATION
FIRST TIER
SCREENING ANALYSIS

5.0 SITE EVALUATION

A total of twenty-four (24) power plant sites were reviewed to identify representative candidate sites for the co-location of a desalination facility. Power plant sites within the boundaries of the SFWMD were reviewed to select the most suitable sites that included thirteen (13) existing plants and eleven (11) proposed plants. Section 5.1 lists these existing sites. Refer to Figure 5-1 for general location of sites.

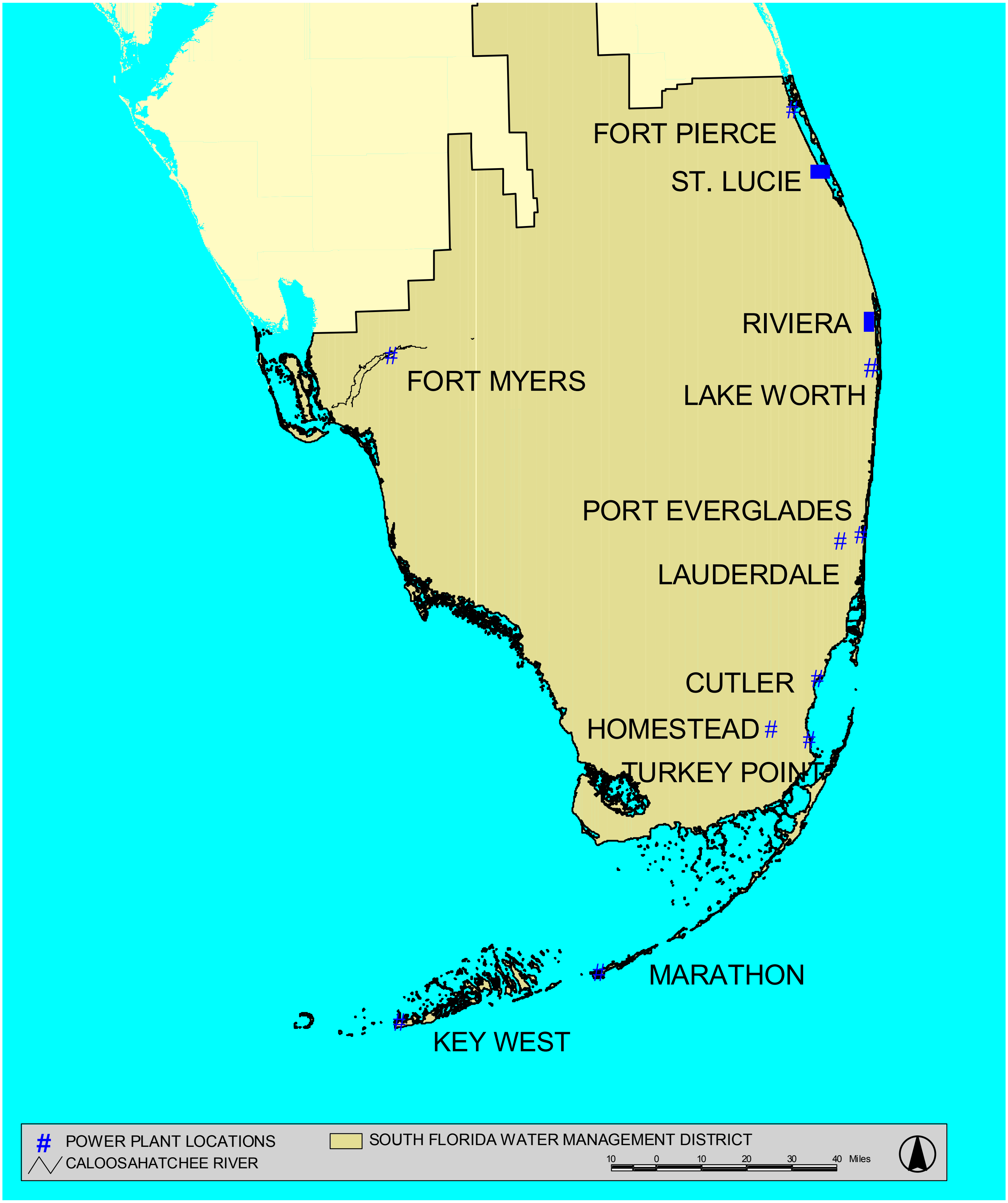
5.1 FIRST TIER SCREENING ANALYSIS

The first tier analysis (also referred to as "Fatal Flaw Analysis") was used to screen the potential sites referenced in the Scope of Work. All of the facilities subject to evaluation, with the exception of the cities of Key West, Homestead, Lake Worth, and Ft. Pierce Utilities sites, are owned and operated by FPL. The Fatal Flaw Analysis initially eliminated those sites that should not be subjected to further, more detailed analysis. The existing power plant sites include:

- **Cutler**
- **Ft. Myers**
- **Ft. Pierce Utilities**
- **Homestead Utilities**
- **Key West Utilities**
- **Lake Worth Utilities**
- **Lauderdale**
- **Marathon/FKEC**
- **Port Everglades**
- **Riviera**
- **St. Lucie**
- **Turkey Point, Nuclear**
- **Turkey Point, Oil/Gas**

THE PROPOSED POWER PLANT SITES INCLUDE:

- **AES Coral/ Lake Worth**
- **Competitive Power Ventures/St. Lucie**
- **Decker / St. Lucie**
- **Duke / Ft. Pierce**
- **El Paso / Broward Energy Center**
- **Enron / Deerfield Beach**
- **Enron / Miami**
- **Enron / Midway**
- **Enron / Pompano Beach**
- **FPL/Midway**
- **Marathon/FKEC**



WRA	**Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants**	
	Figure 5-1: GENERAL LOCATION MAP OF EXISTING POWER PLANTS	**Prepared for:** **South Florida Water Management District** **Florida Power & Light Company**

5.1.1 DESCRIPTION OF EVALUATION CRITERIA

- **Cooling Source Water:** The scope of this project is limited to the evaluation of brackish and seawater sources. If the source of cooling water is not seawater or brackish water, the site will be excluded from further analysis because it does not meet the minimum objectives of the study stated by the SFWMD.
- **Cooling System Type:** Power plant cooling water systems would have to be "once-through" systems to generate sufficient quantities of water for the dilution of concentrate resulting from the desalination process.
- **Fuel Type:** If the fuel source used in the power plant is uranium (nuclear), the site will be dropped from further consideration because of both the expected public aversion towards potable water produced even in association with a nuclear plant and the additional regulatory issues of dealing with the Nuclear Regulatory Commission (NRC).
- **Plant Life Span**: If a plant is scheduled for retirement during the planning horizon of this study (year 2020), that site could not provide a reliable long-term potable water source and it would not justify the cost of construction. Repowering at that site may allow the site to remain feasible, depending on the technology chosen.
- **Regulatory Issues:** Some sites may have regulatory or permitting issues that could cause that site to be unbuildable, regardless of other criteria that appeared to be favorable for the construction of a desalination plant at that site.
- **Threatened And Endangered Species**: The existence of threatened and endangered species (T&E), or plant discharges to an area that contains habitat important to the breeding, foraging, roosting, nesting or wintering of T&E species, could halt, delay or complicate the construction of a desalination plant in that area.
- **Archeological And Historical Resources:** The existence of historical or archeological resources, or both, could delay the construction of a desalination plant.

5.1.2 CANDIDATE SITE EVALUATION

EXISTING POWER PLANTS

The scope of work for this project required that the study identify and review existing and proposed power plant sites for the co-location of desalination facilities. These facilities had to be located on or near seawater or brackish water cooling sources. The sites reviewed in this study are summarized in Table 5-1. This table included several existing and proposed power plant sites that were found not to be located on seawater or brackish water. Each of the power plants sites identified in the initial screening is briefly described below. Those sites that passed the first tier screening (Fatal Flaw Analysis) are more fully described in Section 5.2 (Second Tier Screening).

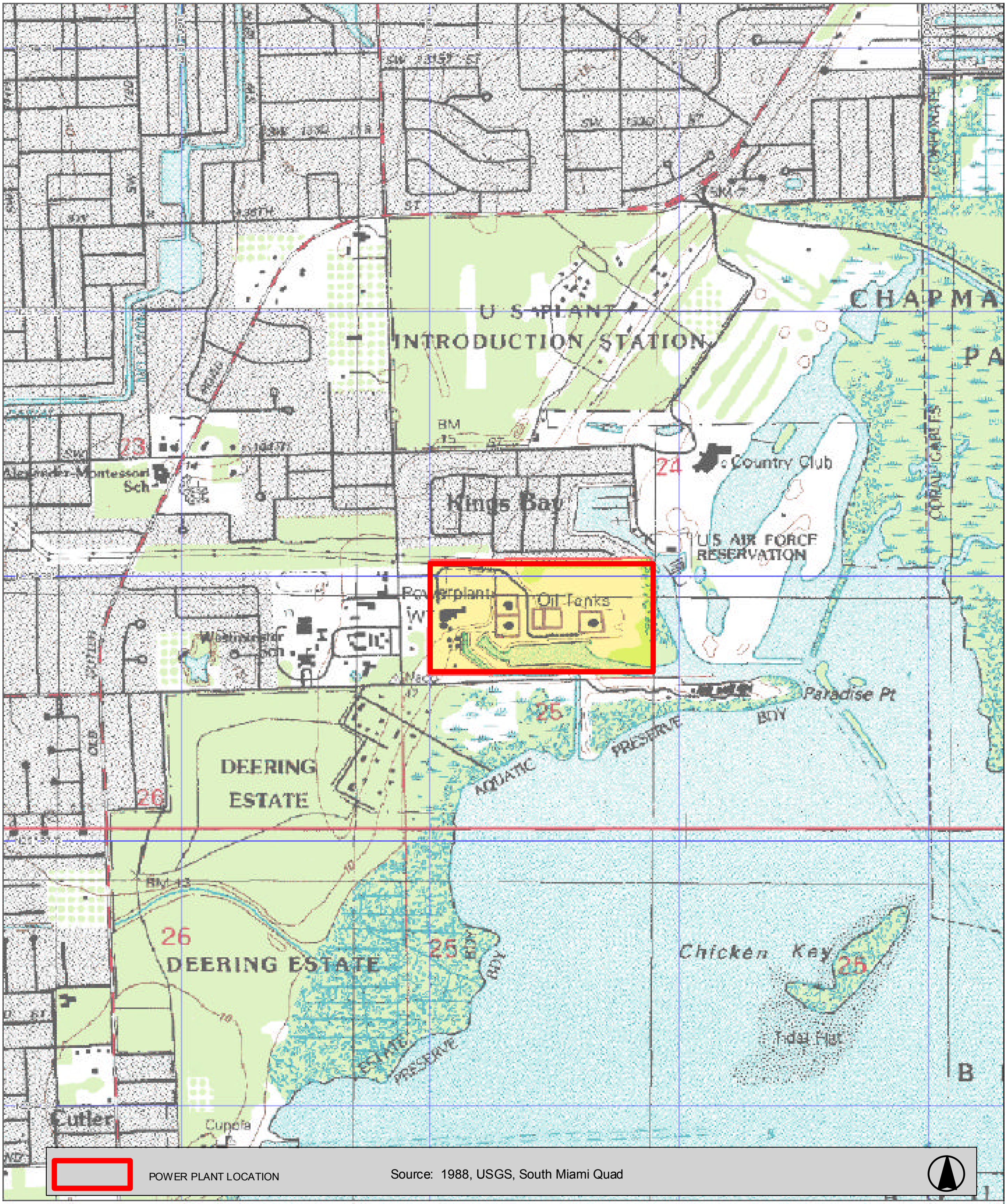
TABLE 5-1 FIRST TIER CRITERIA – FATAL FLAW SCREENING PROCESS								
SCREENING CRITERIA	**COOLING WATER SOURCE**	**COOLING SYSTEM TYPE**	**FUEL TYPE**	**PLANT LIFE SPAN**	**REGULATORY ISSUES**	**THREATENED & ENDANGERED SPECIES**	**ARCHEOLOGICAL AND HISTORICAL RESOURCES**	**FATAL FLAW RESULTS (PASS OR FAIL)**
PLANT LOCATION								
CUTLER	BISCAYNE BAY	ONCE THRU	GAS	UNKNOWN	MFLs (PENDING)	MANATEE	UNKNOWN	PASS
FT. MYERS	CALOOSAHATCHEE RIVER	ONCE THRU	OIL/GAS	20+	MFLs (PENDING)	MANATEE	NONE	PASS
FT. PIERCE UTILITIES	IRL/ATLANTIC	ONCE THRU	GAS/OIL	UNKNOWN	MFLs (PENDING)	MANATEE	NONE	PASS
HOMESTEAD UTILITIES	FRESH	CLOSED/AIR	DIESEL OIL/GAS	UNKNOWN	NONE	UNKNOWN	UNKNOWN	FAIL
KEY WEST UTILITIES	FRESH	CLOSED/AIR	DIESEL/GAS	UNKNOWN	NONE	UNKNOWN	UNKNOWN	FAIL
LAKE WORTH UTILITIES	CITY SYSTEM	COOLING TOWER	GAS/OIL	UNKNOWN	NONE	UNKOWN	UNKNOWN	FAIL
LAUDERDALE	DANIA CUTOFF	ONCE THRU	GAS/OIL	20+	NONE	MANATEE	NONE	PASS
MARATHON / FKEC	FRESH	CLOSED/AIR	DIESEL OIL	UNKNOWN	NONE	UNKNOWN	UNKNOWN	FAIL
PORT EVERGLADES	ICW/ATLANTIC OCEAN	ONCE THRU	OIL/GAS	UNKNOWN	NONE	MANATEE	NONE	PASS
RIVIERA	ICW/LAKE WORTH	ONCE THRU	OIL/GAS	UNKNOWN	NONE	MANATEE	NONE	PASS
ST. LUCIE	ATLANTIC OCEAN	ONCE THRU	NUCLEAR	UNKNOWN	NRC	MANATEE SEA TURTLE	NONE	FAIL
TURKEY POINT, NUCLEAR	BISCAYNE BAY	ONCE THRU	NUCLEAR	UNKNOWN	NRC	MANATEE	NONE	FAIL
TURKEY POINT, OIL & GAS	BISCAYNE BAY	ONCE THRU	OIL/GAS	UNKNOWN	NONE	MANATEE	NONE	PASS
SITES PROPOSED FOR DEVELOPMENT								
AES CORAL/LAKE WORTH	FRESH	COOLING TOWER	GAS	40 +	UNKNOWN	UNKNOWN	UNKNOWN	FAIL
COMPETITIVE POWER	GRAY WATER	COOLING TOWER	GAS/OIL	40 +	UNKNOWN	UNKNOWN	UNKNOWN	FAIL
DECKER / ST. LUCIE	NONE	CLOSED/AIR	GAS/OIL	40 +	UNKNOWN	UNKNOWN	UNKNOWN	FAIL
DUKE / FORT PIERCE	NONE	CLOSED/AIR	GAS/OIL	40 +	UNKNOWN	UNKNOWN	UNKNOWN	FAIL
EL PASO / DEERFIELD	RECLAIMED WATER	CLOSED/AIR	GAS	40 +	UNKNOWN	UNKNOWN	UNKNOWN	FAIL
ENRON / DEERFIELD BEACH	NONE	CLOSED/AIR	GAS/OIL	40 +	UNKNOWN	UNKNOWN	UNKNOWN	FAIL
ENRON / MIAMI	NONE	CLOSED/AIR	GAS/OIL	40 +	UNKNOWN	UNKNOWN	UNKNOWN	FAIL
ENRON / MIDWAY	NONE	CLOSED/AIR	GAS/OIL	40 +	UNKNOWN	UNKNOWN	UNKNOWN	FAIL
ENRON / POMPANO BEACH	NONE	CLOSED/AIR	OIL	40 +	PROJECT CANCELLED	UNKNOWN	UNKNOWN	FAIL
FPL / MIDWAY	G.W. OR GRAYWATER	COOLING TOWER	GAS/OIL	40+	UNKNOWN	UNKNOWN	UNKNOWN	FAIL
MARATHON / FKEC	FRESH	CLOSED/AIR	DIESEL	40+	UNKNOWN	UNKNOWN	UNKNOWN	FAIL

PLANT SITE: CUTLER

The Cutler power plant is an older facility sited in southern Dade County to the west of Biscayne Bay (Figures 5-2, 5-3). The Cutler Power Plant has the capacity to produce a total of 215 MW, using Biscayne Bay as a once-through cooling water source. There are no proposed expansions for this plant. This site did not exhibit a co-location feasibility fatal flaw and passed the initial screening criteria. The criteria and results are summarized below:

COOLING WATER SOURCE:	**BISCAYNE BAY**
COOLING SYSTEM TYPE:	**ONCE THROUGH**
FUEL TYPE:	**GAS**
PLANT LIFE SPAN:	**UNKNOWN**
REGULATORY ISSUES:	**MFLs (pending)**
THREATENED AND ENDANGERED SPECIES:	**MANATEES**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULT: PASS



Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-2:

CUTLER POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-3:

CUTLER POWER PLANT LOCATION

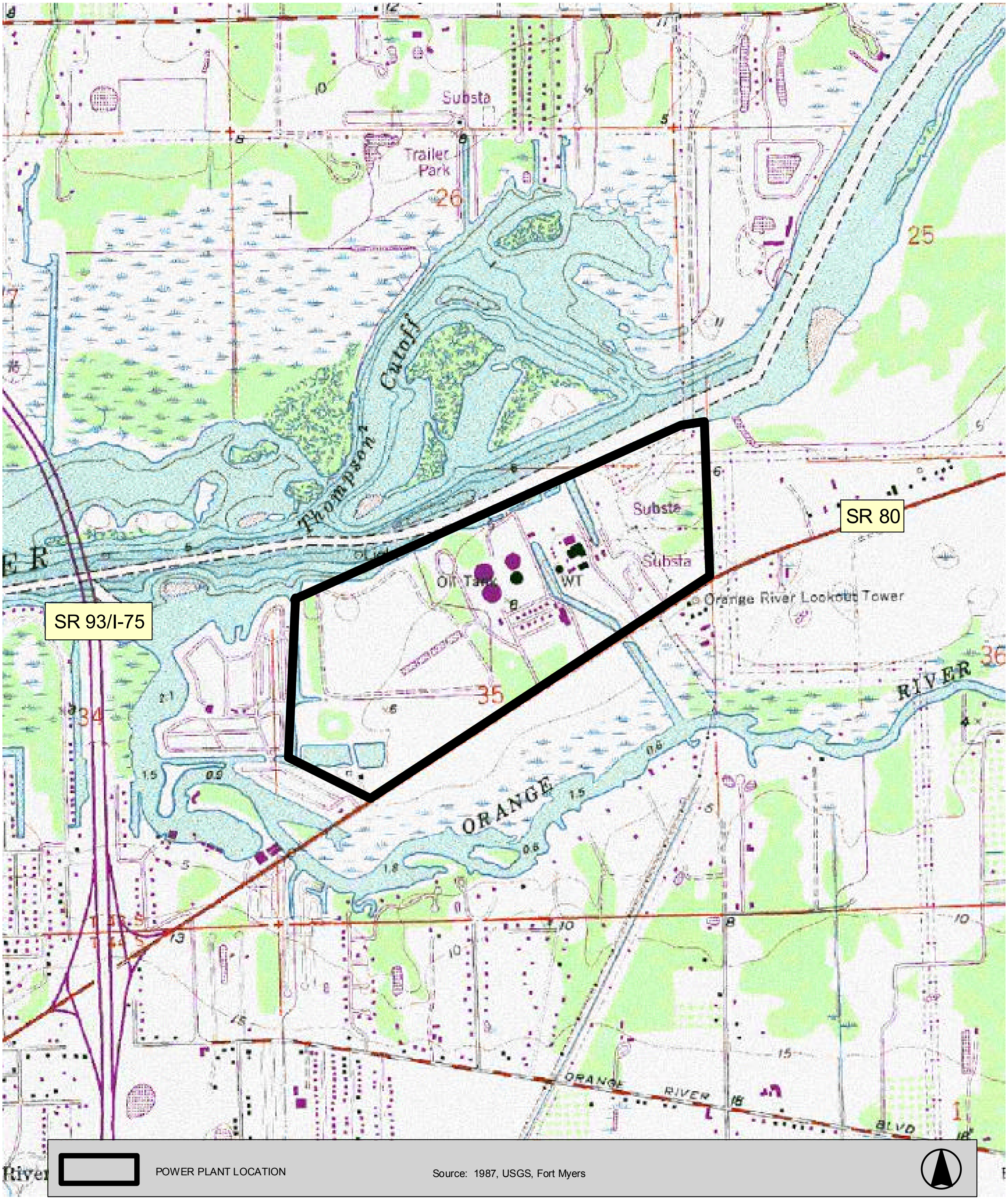
Prepared for:
South Florida Water Management District
Florida Power & Light Company

PLANT SITE: FT. MYERS

This power plant is located on the south bank of the Caloosahatchee River, upstream of Interstate 75 in Lee County, in the Lower West Coast Planning Area of the SFWMD (Figures 5-4, 5-5). This is one of the older power plants operated by FPL, although it is presently being repowered to gas-fired combined cycle units. It uses the Caloosahatchee River as a cooling water source for once-through cooling and then discharges to the Orange River. This site did not exhibit a co-location feasibility fatal flaw and passed the initial screening criteria. The criteria and results are summarized below:

COOLING WATER SOURCE:	**CALOOSAHATCHEE RIVER**
COOLING SYSTEM TYPE:	**ONCE THROUGH**
FUEL TYPE:	**GAS/OIL**
PLANT LIFE SPAN:	**20 YEARS +**
REGULATORY ISSUES:	**MFLs (pending)**
THREATENED AND ENDANGERED SPECIES:	**MANATEES**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**NONE REPORTED**

RESULT: PASS



Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-4:

FORT MYERS POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-5:

FORT MYERS POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

PLANT SITE: FT. PIERCE

The Ft. Pierce Utilities Authority's H.D. King Power Plant is located on the west side of the Atlantic Intracoastal Waterway (Indian River), across from Ft. Pierce Inlet (Figures 5-6, 5-7). The site is surrounded by other industrial, commercial and public land uses. The plant consists of a 23.4 MW combined cycle unit, a 16.5 MW gas/oil-fired boiler unit, a 33 MW gas/oil-fired boiler unit, a 56.1 MW gas/oil-fired boiler unit, and two 2.75 MW diesel generators. This power plant site uses the Indian River Lagoon (OFW) as a source for once-through cooling water supplies. This site did not exhibit a co-location feasibility fatal flaw and passed the initial screening criteria. The criteria and results are summarized below:

COOLING WATER SOURCE:	**INDIAN RIVER LAGOON**
COOLING SYSTEM TYPE:	**ONCE THROUGH**
FUEL TYPE:	**GAS/OIL**
PLANT LIFE SPAN:	**UNKNOWN**
REGULATORY ISSUES:	**MFLs (pending)**
THREATENED AND ENDANGERED SPECIES:	**MANATEES**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**NONE REPORTED**

RESULT: PASS

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-6:

FORT PIERCE POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-7:

FORT PIERCE POWER PLANT LOCATION

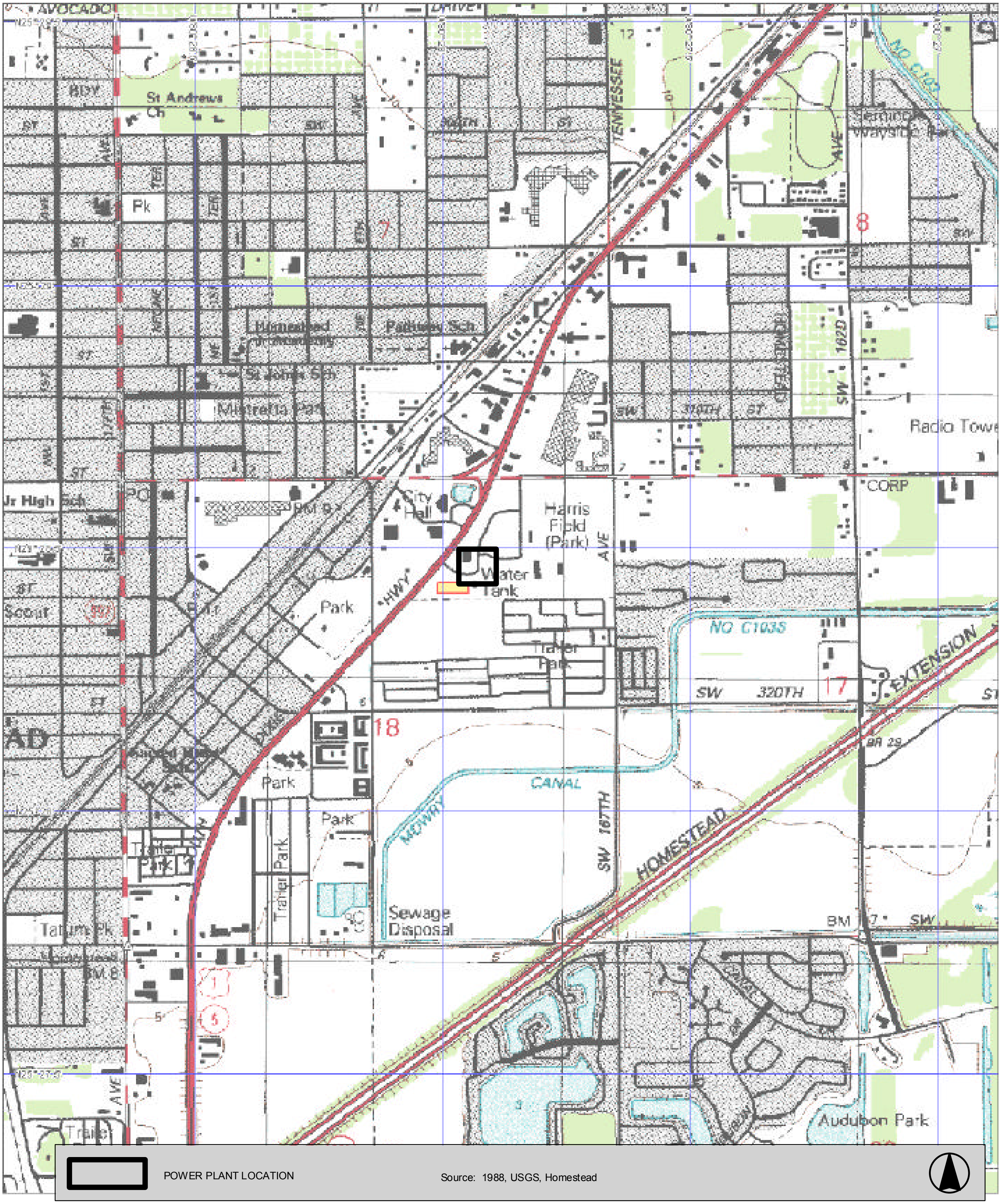
Prepared for:
South Florida Water Management District
Florida Power & Light Company

PLANT SITE: CITY OF HOMESTEAD

The City of Homestead's G.W. Ivey Power Plant is located in southern Dade County (Figures 5-8, 5-9). The plant contains sixteen diesel generators, ranging from 2 MW to 8.8 MW. A diesel-powered plant uses minimal (<10 gpd) quantities of water for cooling purposes. Due to the fact the plant does not use seawater or brackish water and has a closed system; it did not pass the Fatal Flaw Analysis and was removed from further consideration. The criteria and results are summarized below:

COOLING WATER SOURCE:	**FRESH**
COOLING SYSTEM TYPE:	**CLOSED/AIR**
FUEL TYPE:	**DIESEL OIL/GAS**
PLANT LIFE SPAN:	**UNKNOWN**
REGULATORY ISSUES:	**NONE**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULT: FAIL



Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-8:

HOMESTEAD POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-9:

HOMESTEAD POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

PLANT SITE: KEY WEST

The Stock Island Power Plant is located on Stock Island near the City of Key West (Figures 5-10, 5-11). The plant consists of two 8.8 MW diesel generators, a 23.5 MW oil-fired gas turbine, and two 20 MW oil-fired gas turbines. A diesel/oil-fired plant uses minimal (<10 gpd) quantities of water for cooling purposes. Due to the fact the plant does not use seawater or brackish water and has a closed system; it did not pass the Fatal Flaw Analysis and was dropped from further consideration. The criteria and results are summarized below:

COOLING WATER SOURCE:	**FRESH**
COOLING SYSTEM TYPE:	**CLOSED/AIR**
FUEL TYPE:	**DIESEL OIL/GAS**
PLANT LIFE SPAN:	**UNKNOWN**
REGULATORY ISSUES:	**NONE**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULT: FAIL

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-10:

KEY WEST POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

WRA

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-11:

KEY WEST POWER PLANT LOCATION

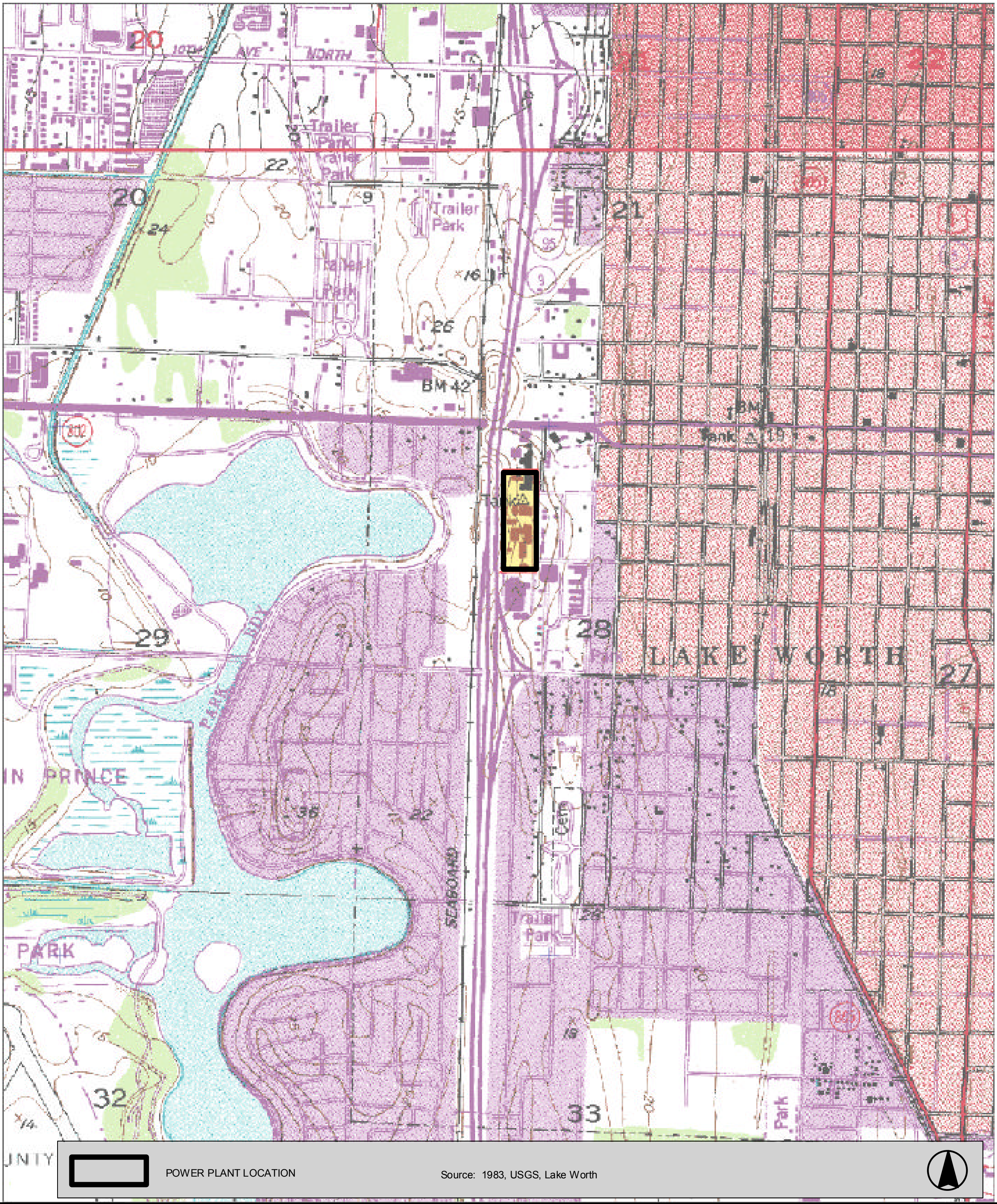
Prepared for:
South Florida Water Management District
Florida Power & Light Company

PLANT SITE: LAKE WORTH UTILITIES

The City of Lake Worth Utilities' Tom G. Smith Power Plant is located inland adjacent to Interstate 95 in the City of Lake Worth (Figures 5-12, 5-13). This facility has five 2 MW diesel engine generators, along with three gas/oil-fired steam generating units rated at 7.5 MW, 26.5 MW, and 33 MW respectively, a 30 MW oil-fired gas turbine, and a 29.5 MW oil/gas-fired combined cycle unit. The plant uses water from the City of Lake Worth's potable water system and discharges that water to the city's wastewater system. Due to the fact the plant does not use seawater or brackish water and has a closed system; it did not pass the Fatal Flaw Analysis and was dropped from further consideration. The criteria and results are summarized below:

COOLING WATER SOURCE:	**POTABLE PUBLIC SUPPLY**
COOLING SYSTEM TYPE:	**COOLING TOWER**
FUEL TYPE:	**GAS/OIL**
PLANT LIFE SPAN:	**UNKNOWN**
REGULATORY ISSUES:	**NONE**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL



Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-12:

LAKE WORTH POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

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Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-13:

LAKE WORTH POWER PLANT LOCATION

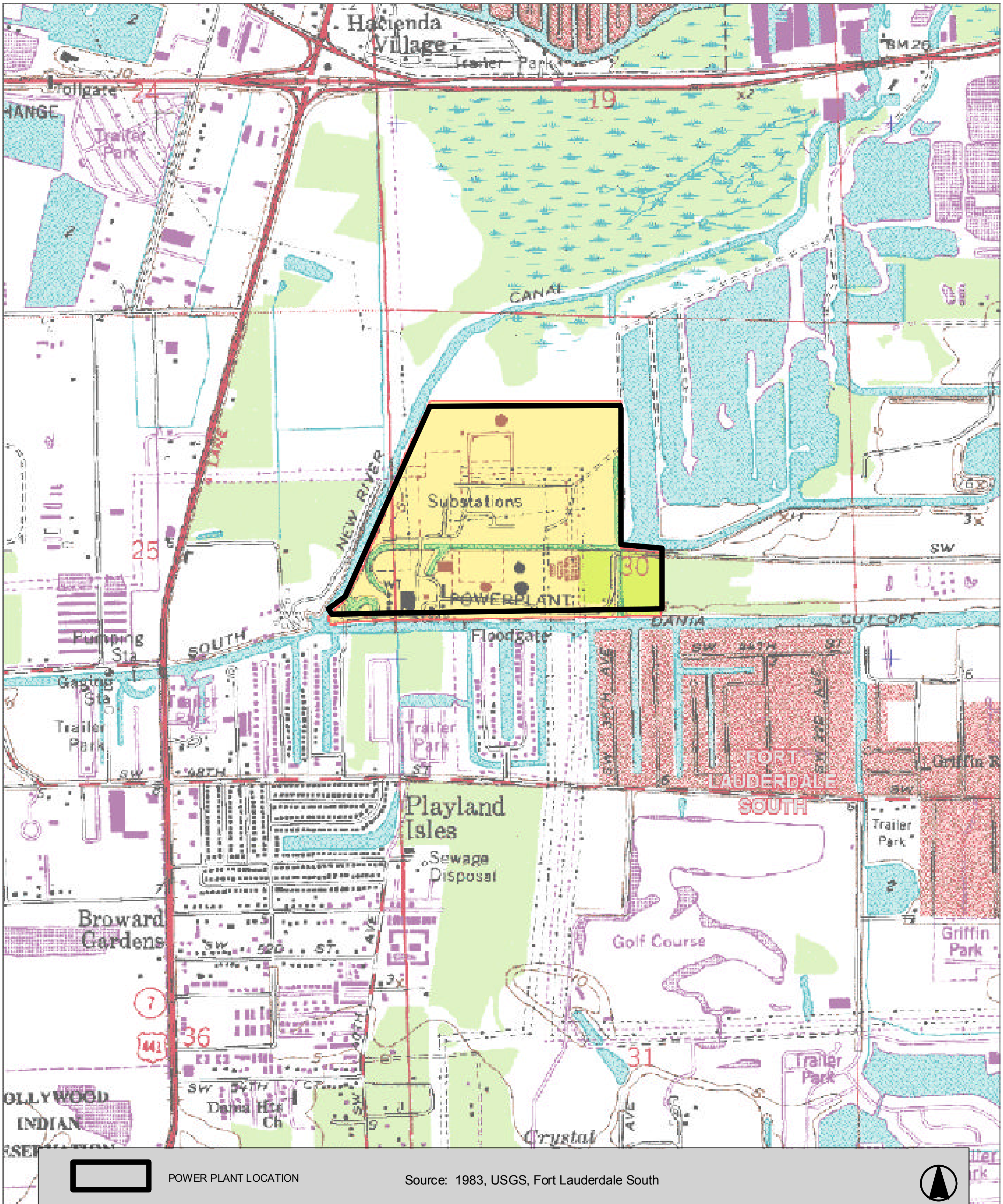
Prepared for:
South Florida Water Management District
Florida Power & Light Company

PLANT SITE: LAUDERDALE

The Lauderdale power plant is situated on approximately 390 acres on the north side of the New River in Ft. Lauderdale (Figures 5-14, 5-15). This power plant site, which was repowered in 1991, contains four gas-fired combined cycle units, along with twenty-four older oil-fired simple cycle gas turbines. The plant uses the Dania Cutoff as a once-through cooling water source. This site did not exhibit a co-location feasibility fatal flaw and passed the initial screening criteria. The criteria and results are summarized below:

COOLING WATER SOURCE:	**DANIA CUTOFF**
COOLING SYSTEM TYPE:	**ONCE THROUGH**
FUEL TYPE:	**GAS/OIL**
PLANT LIFE SPAN:	**20 YEARS +**
REGULATORY ISSUES:	**NONE REPORTED**
THREATENED AND ENDANGERED SPECIES:	**MANATEES**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**NONE REPORTED**

RESULT: PASS



WRA

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Figure 5-14:

LAUDERDALE POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

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Figure 5-15:

LAUDERDALE POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

PLANT SITE: MARATHON/FKEC

The Florida Keys Electric Cooperative's Marathon Generation Plant is located in Marathon in the middle Florida Keys (Figures 5-16, 5-17). The plant contains eight diesel generators, ranging from 2 MW to 3.58 MW. A diesel plant uses minimal (<10 gpd) quantities of water for cooling purposes Due to the fact the plant does not use seawater or brackish water and has a closed system, it did not pass the Fatal Flaw Analysis and was dropped from further consideration. The criteria and results are summarized below:

COOLING WATER SOURCE:	**FRESH**
COOLING SYSTEM TYPE:	**CLOSED/AIR**
FUEL TYPE:	**DIESEL OIL**
PLANT LIFE SPAN:	**UNKNOWN**
REGULATORY ISSUES:	**NONE**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-16:

MARATHON POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

WRA

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-17:

MARATHON POWER PLANT LOCATION

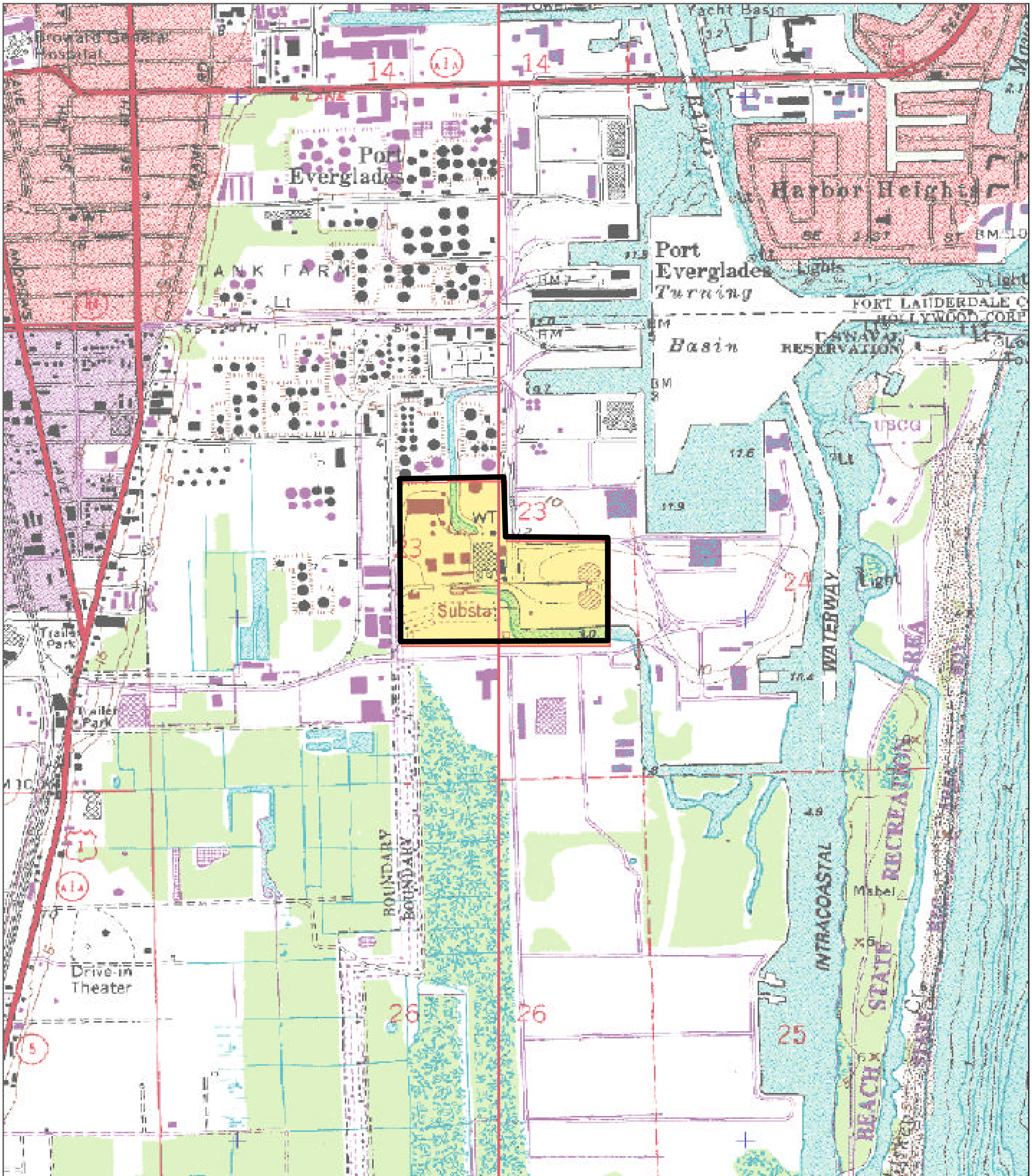
Prepared for:
South Florida Water Management District
Florida Power & Light Company

PLANT SITE: PORT EVERGLADES

The Port Everglades Plant is located in Port Everglades, across from Ft. Lauderdale Inlet (Figures 5-18, 5-19). The Port Everglades Plant has the capacity to produce a total of 1242 MW. The 94-acre site is surrounded by industrial lands. This site uses the Atlantic Intracoastal Waterway for once-through cooling. This site did not exhibit a co-location feasibility fatal flaw and passed the initial screening criteria. The criteria and results are summarized below:

COOLING WATER SOURCE:	**ICW/ATLANTIC OCEAN**
COOLING SYSTEM TYPE:	**ONCE THROUGH**
FUEL TYPE:	**OIL/GAS**
PLANT LIFE SPAN:	**UNKNOWN**
REGULATORY ISSUES:	**NONE REPORTED**
THREATENED AND ENDANGERED SPECIES:	**MANATEES**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**NONE REPORTED**

RESULTS: PASS



POWER PLANT LOCATION

Source: 1983, USGS, Port Everglades, Fort Lauderdale South

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-18:

PORT EVERGLADES POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-19:

PORT EVERGLADES POWER PLANT LOCATION

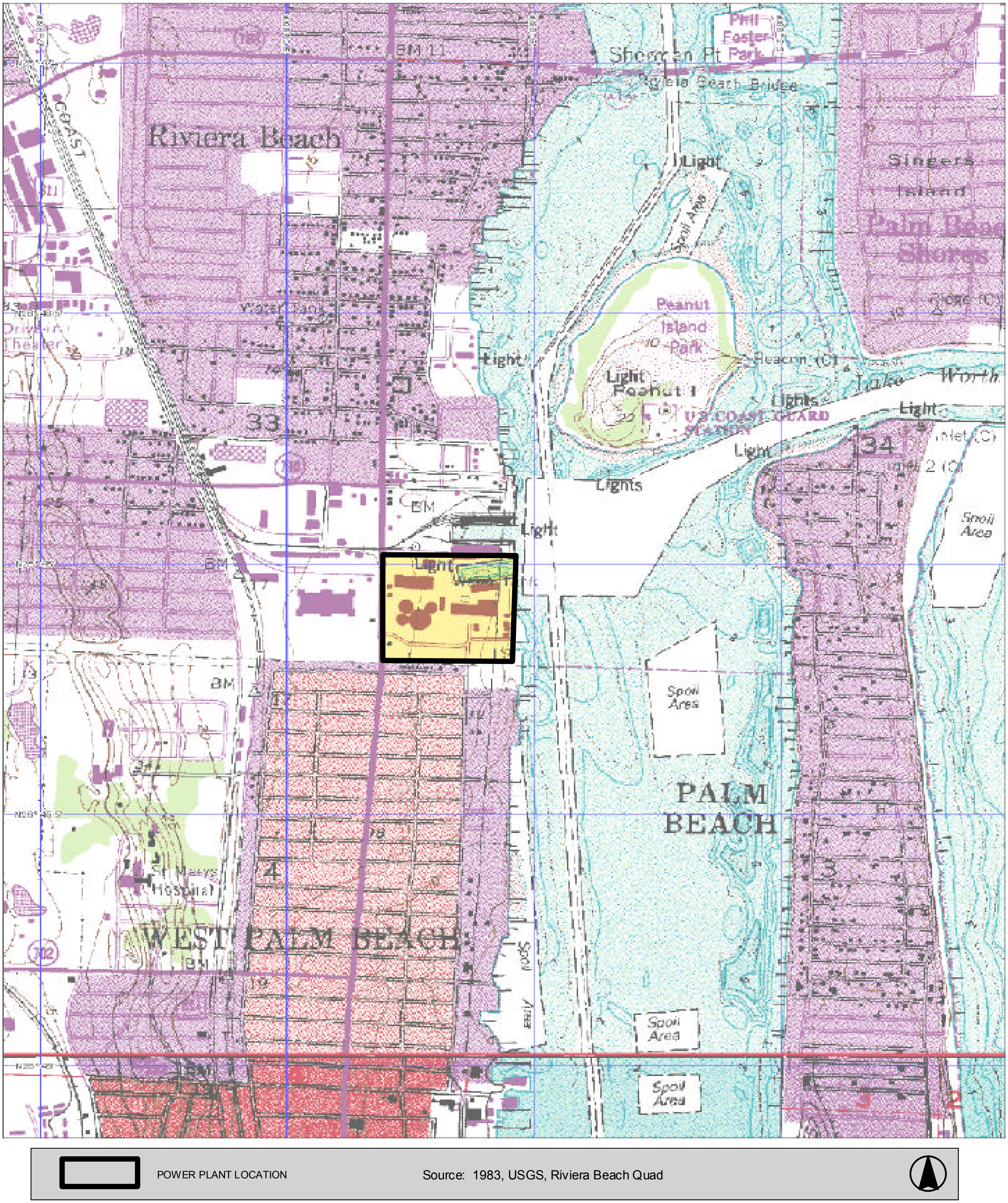
Prepared for:
South Florida Water Management District
Florida Power & Light Company

PLANT SITE: RIVIERA

The Riviera Plant is located in the Town of Riviera Beach on the west side of the Atlantic Intracoastal Waterway, to the southwest of Lake Worth Inlet (Figures 5-20, 5-21). The Riviera Plant has the capacity to produce a total of 563 MW. The 34-acre site is surrounded by other industrial and port-related land uses. This power plant site, originally opened in 1962, uses Lake Worth as a source for once-through cooling water supplies. This site did not exhibit a co-location feasibility fatal flaw and passed the initial screening criteria. The criteria and results are summarized below:

COOLING WATER SOURCE:	**ICW/LAKE WORTH**
COOLING SYSTEM TYPE:	**ONCE THROUGH**
FUEL TYPE:	**OIL/GAS**
PLANT LIFE SPAN:	**UNKNOWN**
REGULATORY ISSUES:	**NONE REPORTED**
THREATENED AND ENDANGERED SPECIES:	**MANATEES**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**NONE REPORTED**

RESULTS: PASS



Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-20:

RIVIERA POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-21:

RIVIERA POWER PLANT LOCATION

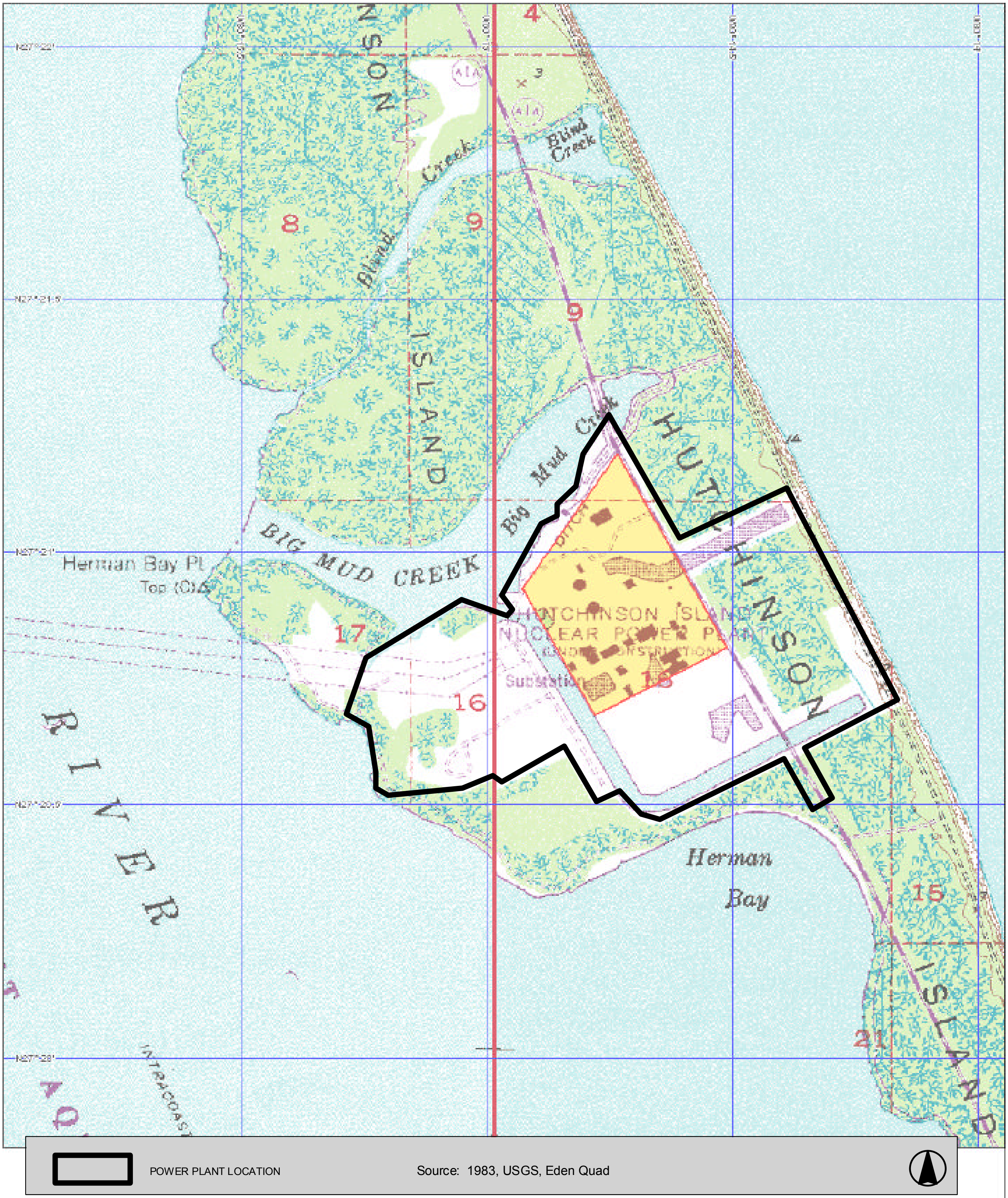
Prepared for:
South Florida Water Management District
Florida Power & Light Company

PLANT SITE: ST. LUCIE

The St. Lucie Plant is located on a large tract of land on Hutchinson Island in St. Lucie County, in the Upper East Coast Planning Area of the SFWMD (Figures 5-22, 5-23). The two nuclear units at this site, rated 839 MW and 714 MW respectively, use the Atlantic Ocean for cooling water supplies. Due to the fact the plant is nuclear-fueled it did not pass the Fatal Flaw Analysis and was dropped from further consideration. The criteria and results are summarized below:

COOLING WATER SOURCE:	**ATLANTIC OCEAN**
COOLING SYSTEM TYPE:	**ONCE THROUGH**
FUEL TYPE:	**NUCLEAR**
PLANT LIFE SPAN:	**UNKNOWN**
REGULATORY ISSUES:	**NRC**
THREATENED AND ENDANGERED SPECIES:	**MANATEES & SEA TURTLES**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**NONE**

RESULTS: FAIL



Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-22:

ST. LUCIE POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

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Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-23:

ST. LUCIE POWER PLANT LOCATION

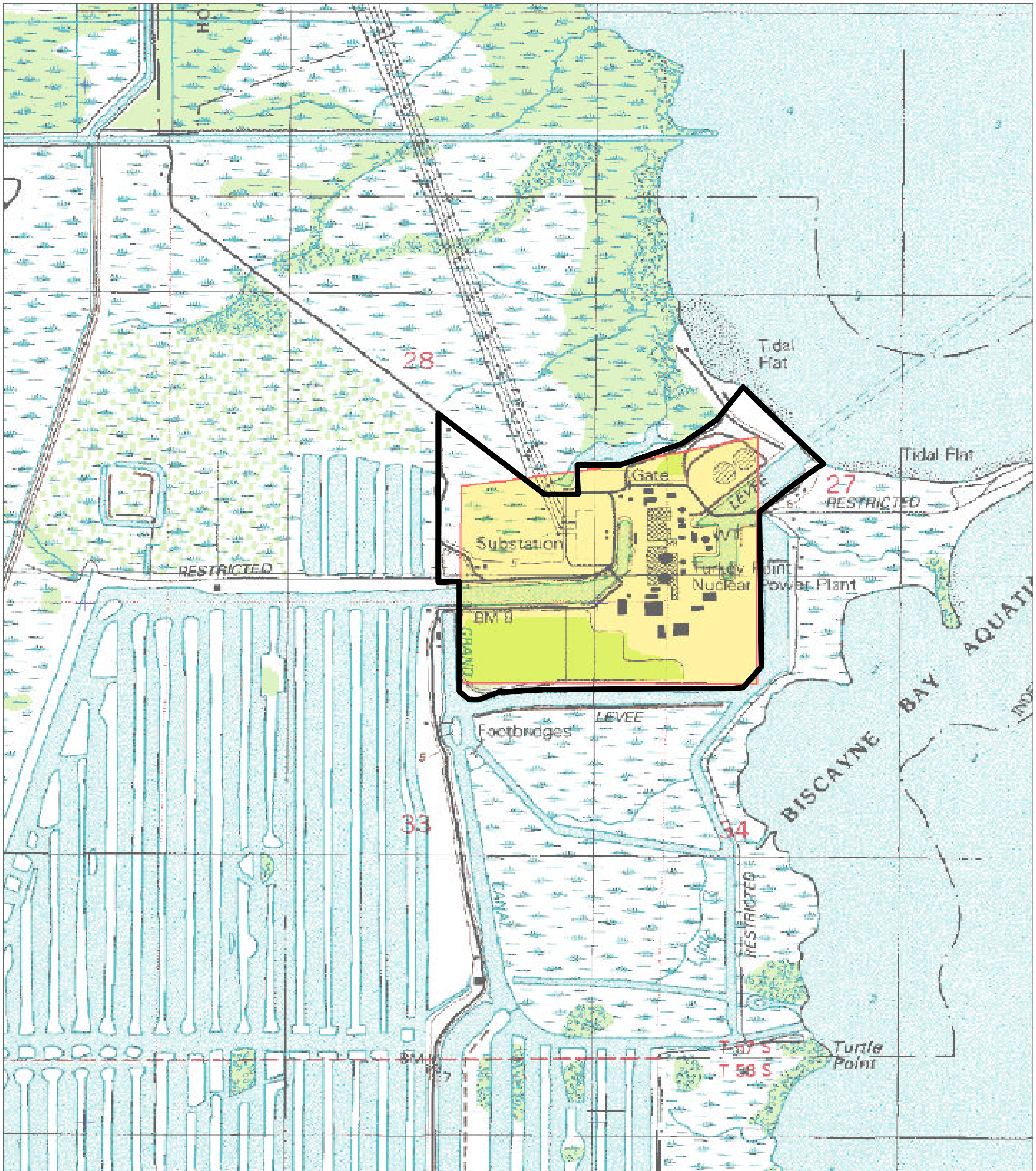
Prepared for:
South Florida Water Management District
Florida Power & Light Company

TURKEY POINT NUCLEAR AND OIL-FIRED

These power plant sites are located adjacent to one another on a large site in southern Dade County adjacent to Biscayne Bay (Figures 5-24, 5-25). The plants contains two 400 MW oil/gas-fired boiler units and two 693 MW nuclear units. Seawater, for cooling purposes, is withdrawn from Biscayne Bay and circulated through a series of cooling canals. There are no proposed expansions or replacements listed for the Turkey Point site. While the nuclear plant failed the initial screening criteria, the oil-fired plant site did not exhibit a co-location feasibility fatal flaw and passed the initial screening criteria. The criteria and results are summarized below:

COOLING WATER SOURCE:	**BISCAYNE BAY**
COOLING SYSTEM TYPE:	**ONCE THROUGH**
FUEL TYPE:	**NUCLEAR AND GAS/OIL**
PLANT LIFE SPAN:	**UNKNOWN**
REGULATORY ISSUES:	**NRC**
THREATENED AND ENDANGERED SPECIES:	**MANATEES**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**NONE REPORTED**

RESULTS: PASS



POWER PLANT LOCATION

Source: 1988, USGS, Arsenicker Keys

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-24:

TURKEY POINT POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-25:

TURKEY POINT POWER PLANT LOCATION

Prepared for:
South Florida Water Management District
Florida Power & Light Company

PROPOSED POWER PLANTS

There are a number of new power plants and existing plant expansions and modifications proposed for the State of Florida. Many of these sites are located with the boundaries of the SFWMD. Many of the new plants (at new sites) are independent power plants owned by private companies that sell bulk power on a wholesale basis to the state's regulated utilities. Florida law does not allow for true "merchant plants" to be built in the state, unless the plant has less than 75 MW of steam turbine capacity, or if the plant has a long-term contract to sell its capacity to a regulated utility that sells on a retail basis, i.e. to FPL. However, developers are allowed to build gas-fired simple cycle gas turbines to be used for selling peaking power to regulated utilities. These plants are typically gas-fired gas turbine plants that do not require water for cooling. Therefore, these plants are not suitable for the co-location of desalination facilities. However, they are evaluated below.

AES CORAL/LAKE WORTH

AES Coral recently purchased a project that was being developed by Thermo Eco-tek at the City of Lake Worth's Tom G. Smith Power Plant. AES is installing a new gas-fired combined cycle unit that will provide steam to the City's new and existing steam turbine units. This inland plant will utilize the on-site cooling tower/cooling water system. Because it does not use seawater or brackish water, it did not pass the Fatal Flaw Analysis. The criteria and results are summarized below:

COOLING WATER SOURCE:	**FRESH**
COOLING SYSTEM TYPE:	**COOLING TOWER**
FUEL TYPE:	**GAS**
PLANT LIFE SPAN:	**40 YEARS +**
REGULATORY ISSUES:	**UNKNOWN**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL

COMPETITIVE POWER VENTURES/ST. LUCIE

This plant would use a gas/oil-fired combined cycle unit to generate and sell electrical power primarily during peak demand periods. The plant will have a cooling water system that includes a 5-cell cooling tower. Since the site is inland, the cooling water source will not be seawater or brackish water. Therefore, it did not pass the Fatal Flaw Analysis. The criteria and results are summarized below:

COOLING WATER SOURCE:	**GRAYWATER**
COOLING SYSTEM TYPE:	**COOLING TOWER**
FUEL TYPE:	**GAS/OIL**
PLANT LIFE SPAN:	**40 YEARS +**
REGULATORY ISSUES:	**UNKNOWN**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL

DECKER/ST. LUCIE

This plant would use gas/oil-fired gas turbines to generate and sell electrical power primarily during peak demand periods. Decker has not gone forward with further development of this plant. It would not require water for cooling purposes. Because it would not use seawater or brackish water, it did not pass the Fatal Flaw Analysis. The criteria and results are summarized below:

COOLING WATER SOURCE:	**NONE**
COOLING SYSTEM TYPE:	**CLOSED/AIR**
FUEL TYPE:	**GAS/OIL**
PLANT LIFE SPAN:	**40 YEARS +**
REGULATORY ISSUES:	**UNKNOWN**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL

DUKE ENERGY/FT. PIERCE

This plant would use eight gas/oil-fired gas turbines to generate and sell electrical power primarily during peak demand periods. It would not require water for cooling purposes. Because it does not use seawater or brackish water, it did not pass the Fatal Flaw Analysis. The criteria and results are summarized below:

COOLING WATER SOURCE:	**NONE**
COOLING SYSTEM TYPE:	**CLOSED/AIR**
FUEL TYPE:	**GAS/OIL**
PLANT LIFE SPAN:	**40 YEARS +**
REGULATORY ISSUES:	**UNKNOWN**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL

EL PASO MERCHANT ENERGY/BROWARD ENERGY CENTER

This plant, proposed to be located in Deerfield, would use gas-fired simple cycle and combined cycle units to generate and sell electrical power primarily during peak demand periods. El Paso plans to utilize cooling towers with reclaimed water for cooling purposes. Because it does not use seawater or brackish water, it did not pass the Fatal Flaw Analysis. The criteria and results are summarized below:

COOLING WATER SOURCE:	**RECLAIMED WATER**
COOLING SYSTEM TYPE:	**CLOSED/AIR**
FUEL TYPE:	**GAS**
PLANT LIFE SPAN:	**40 YEARS +**
REGULATORY ISSUES:	**UNKNOWN**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL

ENRON/DEERFIELD BEACH

This plant would use three gas/oil-fired gas turbines to generate and sell electrical power primarily during peak demand periods. It would not require water for cooling purposes. Because it does not use seawater or brackish water, it did not pass the Fatal Flaw Analysis. The criteria and results are summarized below:

COOLING WATER SOURCE:	**NONE**
COOLING SYSTEM TYPE:	**CLOSED/AIR**
FUEL TYPE:	**GAS/OIL**
PLANT LIFE SPAN:	**40 YEARS +**
REGULATORY ISSUES:	**UNKNOWN**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL

ENRON/MIAMI

This plant would use three gas/oil-fired gas turbines to generate and sell electrical power primarily during peak demand periods. It would not require water for cooling purposes. Because it would not use seawater or brackish water, it did not pass the Fatal Flaw Analysis. In addition, Enron recently cancelled this plant. The criteria and results are summarized below:

COOLING WATER SOURCE:	**NONE**
COOLING SYSTEM TYPE:	**CLOSED/AIR**
FUEL TYPE:	**GAS/OIL**
PLANT LIFE SPAN:	**40 YEARS +**
REGULATORY ISSUES:	**UNKNOWN**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL

ENRON/MIDWAY

This plant, proposed to be located near Port St. Lucie, would use three gas/oil-fired gas turbines to generate and sell electrical power primarily during peak demand periods. It would not require water for cooling purposes. Because it would not use seawater or brackish water, it did not pass the Fatal Flaw Analysis. The criteria and results are summarized below:

COOLING WATER SOURCE:	**NONE**
COOLING SYSTEM TYPE:	**CLOSED/AIR**
FUEL TYPE:	**GAS/OIL**
PLANT LIFE SPAN:	**40 YEARS +**
REGULATORY ISSUES:	**UNKNOWN**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL

ENRON/POMPANO BEACH

This plant would use three gas/oil-fired gas turbines to generate and sell electrical power primarily during peak demand periods. It would not require water for cooling purposes. Because it would not use seawater or brackish water, it did not pass the Fatal Flaw Analysis. In addition, Enron recently cancelled this plant. The criteria and results are summarized below:

COOLING WATER SOURCE:	**NONE**
COOLING SYSTEM TYPE:	**CLOSED/AIR**
FUEL TYPE:	**GAS/OIL**
PLANT LIFE SPAN:	**40 YEARS +**
REGULATORY ISSUES:	**PROJECT CANCELLED**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL

FPL/MIDWAY

FPL has planned a gas-fired combined cycle plant for its new Midway site, with initial operation planned for June 2005. Since this is an inland site, FPL would need to find groundwater or other alternative sources for cooling purposes. Because it would not use seawater or brackish water, it did not pass the Fatal Flaw Analysis. The criteria and results are summarized below:

COOLING WATER SOURCE:	**G.W. OR GRAYWATER**
COOLING SYSTEM TYPE:	**COOLING TOWER**
FUEL TYPE:	**GAS/OIL**
PLANT LIFE SPAN:	**40 YEARS +**
REGULATORY ISSUES:	**UNKNOWN**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL

MARATHON/FKEC

FKEC has recently added a 3.58 MW diesel generator (Unit 9) to its power plant. Since a diesel generator does not use seawater or brackish water for cooling, it did not pass the Fatal Flaw Analysis. The criteria and results are summarized below:

COOLING WATER SOURCE:	**FRESH**
COOLING SYSTEM TYPE:	**CLOSED/AIR**
FUEL TYPE:	**DIESEL**
PLANT LIFE SPAN:	**40 YEARS +**
REGULATORY ISSUES:	**UNKNOWN**
THREATENED AND ENDANGERED SPECIES:	**UNKNOWN**
ARCHEOLOGICAL AND HISTORICAL RESOURCES:	**UNKNOWN**

RESULTS: FAIL

5.1.3 SELECTED SITES FOR FURTHER EVALUATION

The following plants passed the Fatal Flaw Analysis and were subjected to second tier screening criteria. These sites were

- **Cutler**
- **Ft. Myers**
- **Ft. Pierce**
- **Lauderdale**
- **Port Everglades**
- **Riviera**
- **Turkey Point (oil/gas)**

SECOND TIER
SCREENING ANALYSIS

5.2 SECOND TIER SCREENING ANALYSIS

Seven sites passed the Fatal Flaw Analysis. These are:

- Cutler
- Ft. Myers
- Ft. Pierce
- Lauderdale
- Port Everglades
- Riviera
- Turkey Point Oil/Gas

5.2.1 DESCRIPTION OF EVALUATION CRITERIA

PHYSICAL CHARACTERISTICS OF PLANT SITES

- **LOCATION OF AVAILABLE LAND:** The site of the proposed desalination plant site should have enough available land, either on-site or nearby, to accommodate the proposed desalination facility. The power plant site should be located reasonably close to the water-demand area. The site was rated as "Good" if it was within a reasonable distance (5-10 miles) of a major water demand area and point of connection to an area of sufficient demand.

- **AVAILABLE LAND AREA:** The proposed site should contain at least 5 acres (10 acres preferred) required to construct the proposed desalination facility. Land availability could be an important consideration at some of the more compact sites. Sites with 7 to 10 acres available for desalination plant construction were rated as "Good". Sites with about 5 to 7 acres were rated as "Fair" and those with less than about 5 acres were rated as "Poor".

- **LAND FOR FUTURE EXPANSION:** The criteria identified the value of additional land to facilitate future expansion. A proposed site got a high score if it contains additional area that could be used to expand the proposed desalination plant in the future. Sites with a minimum total of 10 acres available were rated as "Good". Sites with 7 to 10 acres were rated as "Fair" and those with less than 5 acres were rated as "Poor".

- **LAND USE AND ZONING:** The land use and zoning of the site should allow for the construction of a desalination facility. Generally, the industrial or public utility land use and zoning classifications required for a power plant should allow for the construction and operation of a desalination facility.

POWER PLANT CHARACTERISTICS

- **PLANT STATUS:** If a plant is shut down, scheduled for retirement or will be repowered using a technology that does not use seawater or brackish water for cooling purposes, that site was dropped from further evaluation.

- **NUMBER OF UNITS:** The higher the number of units at the power plant site, the less likely that the plant would have all of the units shut down for maintenance or other reasons at any one time. This fact would help to ensure that there would be sufficient cooling water flow at all times to meet dilution requirements of a desalination plant. Multiple base load units can provide cooling water flow for dilution at all times.

- **MEGAWATT (MW) RATING:** Generally, the larger the MW rating of an individual generating unit or power plant, the higher the cooling water flow. This would allow for greater volumes of water for cooling purposes and dilution of desalination process concentrate. Power plants that did not use once-through cooling systems would not be suitable for co-location of a desalination plant

- **BASE LOAD FACILITY:** The proposed desalination plant location should be sited with a base load power plant. This will help to ensure that there is a minimum continuous cooling water flow for dilution purposes.

- **CYCLING FACILITY:** Cycling facilities are generating units that are brought on line to run during prescribed periods of the day. If the proposed facility is to be co-located with a cycling facility, it is necessary that such a facility is used very frequently and/or it has continuous cooling water flow to meet the dilution requirements of the desalination plant.

- **PEAKING FACILITY**: A peaking facility is usually dispatched by the utility to generate at "peak" times of customer demand, such as summer afternoons or winter mornings. If the proposed facility is to be co-located with a peaking facility, it may not be suitable due to a lack of continuous cooling water flow.

- **PLANT IN SERVICE DATE:** The date that a power plant began operations can give an indication of its useful life. While most power plants were originally designed for a 30-year life, most have been operated far longer. Utilities are taking advantage of upgrade technologies to continue to operate older, low-cost power plants. If the plant is an older plant, it may be scheduled for retirement, upgrading or repowering. Upgrades and repowering will extend the life of the power plant.

- **PLANNED PLANT EXPANSION (DATE AND MW):** It is necessary to determine the type, approximate schedule and magnitude of proposed plant expansions to determine the alterations in the power plant facility that may affect the development of a co-located desalination plant.

- **PLANNED PLANT EXPANSION (COOLING SYSTEM CHANGES):** Changes to the plant's cooling system, related to repowering or other plant changes, need to be evaluated when considering a power plant site for co-location.

- **PLANNED PLANT REPOWERING OPTIONS:** Some power plants may be scheduled for repowering. The type of repowering technology chosen affects the ability of the facility to support co-location of a desalination plant. If the older boilers are replaced with simple cycle gas-fired gas turbines, which do not use cooling water, the dilution source will not be available. Repowering with gas-fired combined cycle units (which incorporate gas turbines and steam turbines) will still require cooling water, but the flow, source, or other factors (addition of a cooling tower) may change the cooling water flow rate and duration.

- **PLANNED PLANT EXPANSION FOR CO-GENERATION:** If a proposed site is also the site of a proposed co-generation facility, this may make it easier and less costly to co-locate a desalination plant. Instead of using electric-driven forwarding pumps in the desalination plant, steam from the power plant may be available for driving them (instead of using electric driven pumps), lowering overall operation costs.

- **NATURAL GAS FUEL SOURCE:** Natural gas has been noted by the SFWMD as a desirable fuel source for a power plant co-located with a desalination plant. This is largely because of the common perception that a natural gas plant is a cleaner burning plant, and therefore, may not be subjected to as much public pressure to close down or to restrict plant expansion in the future.

INTAKE AND DISCHARGE OPTIONS

- **INTAKE SOURCE:** The source of the intake feed water for the desalination plant was an important consideration. Generally, brackish waters associated with estuarine areas may be more difficult to permit because of potential impacts to marine nursery areas.

- **DISCHARGE LOCATION:** The location of the cooling water discharge was an important factor in the selection of a potential site for a desalination facility. Whether the discharge is to seawater or brackish water may impact the permittability of a proposed facility. Recent discussions with FDEP staff indicate that obtaining a permit for a new discharge that would cause degradation beyond ambient conditions would be extremely difficult.

- **WATER QUALITY CLASSIFICATION:** The classification of the receiving water bodies will determine the likelihood of success of permitting a proposed facility. Permitting a desalination plant discharging within an Outstanding Florida Water (OFW) could be very difficult. (Refer to Figure 5-26). For OFWs, an applicant would be required to show that the new discharge would not have any adverse water quality effects on the receiving water compared to ambient conditions. However, if the discharge was located upstream of an OFW (e.g., in a tidal creek or stream) and it could be shown that the effluent would cause no adverse effects, it is possible that a discharge could be permitted. Due to the unlikelihood of obtaining a wastewater permit for a new Reverse Osmosis concentrate discharge into an OFW, locations of potential desalination plants may be restricted to non-OFW designated water bodies. If a desalination plant were to be sited in such a location, deep well injection may be required for concentrate disposal.

- **FLOW RATE PER UNIT AND TOTAL:** Discharge rates from the individual generating units and from the discharge canal need to be sufficient to support the dilution requirements of the desalination facility. The higher the cooling water discharge rates, the lower the increase in total dissolved solids and other constituents by dilution of the process concentrate. It is important to determine the cooling water discharge flow rate by unit, and for the total plant, based upon the minimum number of units in operation at any given time.
- **DESALINATION SOURCE WATER:** The source of water for the desalination process is an important aspect of plant design and of the quality of water that may be expected from a given plant. Feed waters with a lower total dissolved solids concentration can yield a higher quality of water at a lower unit cost. Waters that fluctuate widely in quality, such as brackish water that may vary between high flow and low flow seasons and incoming or outgoing tides, may require additional process considerations.
- **DESALINATION DISCHARGE METHOD:** The method of concentrate disposal has an impact upon the permittability of a plant site. Those areas where concentrate from the desalination process is an issue, such as brackish water estuaries, could be more difficult to permit. Conversely, those sites situated on open water bodies, such as the Atlantic Ocean or the Gulf of Mexico may not be perceived to have as great a concentrate disposal issue. Some plant locations may require that the concentrate be disposed in deep injection wells. This also creates substantial permitting issues, as well as adding costs to the desalination plant process.
- **COMPATIBILITY OF REJECT WATER:** Water quality impacts resulting from the production of desalinated water is primarily due to the changes in concentrations of ions, which existed in the original source water (seawater). Seawater contains a number of constituents including metals, salts, and organic compounds. As seawater passes through a reverse osmosis membrane, many of these chemicals are removed, leaving a fresh, purified water product. The removed constituents, termed concentrate, are now at a greater concentration than the source water. This condition can result in changes in salinity in the receiving water when the concentrate is discharged. Increased salinity may result in physiological stress or toxicity for a number of different aquatic organisms. Co-location of a desalination plant with a power plant takes advantage of the large (hundreds of millions of gallons per day) cooling water flow associated with base loaded power plants to dilute the concentrate.

WATER DEMAND AND TRANSMISSION

- **POTENTIAL USERS:** Identification of potential users of the product water located near the proposed reverse osmosis facility and order-of-magnitude estimates of the cost to deliver water to the potential users. Sites located near potential users were rated as “High”. Sites located at moderate distances from a water-demand area were rated as “Fair”, while those that were not near such locations were rated as “Poor”

- **YEAR 2010 DEMANDS:** Any proposed facility should be “on line” to meet anticipated future demands. The need to meet future water demands should be made in concert with other proposed water development plans.

- **YEAR 2020 DEMANDS:** The same considerations as the above criteria should apply to the year 2020 demands. In this instance, additional opportunities for co-location, co-generation, or facility expansions should have presented themselves.

- **PROXIMITY TO DEMAND:** Only sites within a reasonable distance of existing or projected water demand were evaluated. Most of the potable water demand and the existing and projected supply deficits are located near the coastal portion of the study area. It is also necessary to locate the plants close to the demand centers in order to reduce transmission costs. Sites that were located in close proximity to existing and projected future water-supply/demand deficit areas were rated as “Good”. Those sites located at a distance from potential users or in an area of low existing and future water demand were rated “Fair”, while those remote sites that were located a great distance from a water-demand area, or in an area of low existing and projected water demand were rated as “Poor”.

- **PROXIMITY TO TRANSMISSION LINES AND POINTS OF CONNECTION:** The proposed facilities should be close to existing water transmission lines or points of connection (water treatment or storage facilities) to reduce pumping costs and to provide potable-water blending opportunities. Sites located near adequately sized transmission lines were rated as “Good”. Sites located at moderate distances or near marginally-sized water mains were rated as “Fair”, while those sites located at great distances or near substantially undersized transmission mains, were rated as “Poor”.

- **OTHER WATER SUPPLY OPTIONS:** Desalination facilities may be given additional consideration in areas where no or few other water supply options are available. On the contrary, less consideration was given to locations where the cost of desalinated seawater would not be competitive with other less costly options.

ENVIRONMENTAL CONSIDERATIONS

- **REGULATORY STATUS:** There are a number of permits that would be required to construct and operate a seawater desalination plant in Florida. Concerns about existing or proposed conditions at a power plant site, including requirements for thermal discharge studies could impact that site. Similarly, any proposal or regulatory requirement for conversion to off-stream cooling systems (cooling tower or reservoir) or other power plant regulatory-compliance issues could affect the viability of a site.

- **PERMITTABILITY:** Any desalination facility must have the potential to be permittable to be considered as a representative candidate. The two most important permit issues would be discharge of the concentrate and wetland impacts associated with the construction of the plant and transmission lines. The FDEP issues an Industrial Wastewater Facility (IWWF) permit to address the concentrate discharge criteria. The discharge of the concentrate is the most difficult permit to obtain due to the FDEP Antidegradation Policy. The basis of the Policy is that new or increase discharges pass the public interest test in addition to meeting all other FDEP rules. The discharge is not allowed to degrade the quality of the receiving waters below the state standards. This policy would make is very difficult to permit a discharge in an Outstanding Florida Water (OFW) water body. Wetland impacts would be permitted through the Environmental Resource Permit process. In this process, the applicant must demonstrate avoidance and minimization of impacts to wetland systems. Those wetlands, which cannot be avoided, are then required to be mitigated at ratios specified by the SFWMD or FDEP dependent on a host of ecological factors. Air emission permits would also be required. Additionally, port authority and other permits from local and regional agencies would be required.

- **ENVIRONMENTAL IMPACTS:** The primary environmental considerations for the siting of any proposed desalination plant are:

  - Impacts to water quality (particularly salinity) within the source or receiving waters.
  - Impacts to aquatic flora and fauna in the source or receiving waters.
  - Impacts to inland habitats disturbed or destroyed by the physical construction (dredge and fill) of the desalination facility, associated intake and discharge structures, and transmission lines.
  - Potential impacts to threatened and endangered species

OTHER

- **PUBLIC ACCEPTANCE:** Public acceptance will be extremely important in identifying viable desalination sites. Otherwise, potential sites could fail if the public strongly opposes that site. Consideration will be given to serious demonstrated opposition to proposed alternative water-supply options.

- **DESIRE TO CO-LOCATE:** There may be situations where an electric utility would like to co-locate with a desalination plant. There may be other situations where a privately owned or municipally owned electric utility would desire to expand their services to include water supply. Conversely, a utility may not want to have a desalination or other industrial facility co-located on its property, due to operational or liability issues. With recent changes in utility industry regulation, generating units and entire power plants may be sold to other companies. Having a desalination plant co-located with the power plant may be seen as a disadvantage by potential buyers, particularly if they are interested in repowering the plant or changing the method of unit dispatch.

TABLE 5-2 SECOND TIER ANALYSIS							
	PLANT LOCATION						
Note: Scored: high, medium, low or good, fair, poor	**CUTLER**	**FT MYERS**	**FT PIERCE**	**LAUDERDALE**	**PORT EVERGLADES**	**RIVIERA**	**TURKEY POINT**
PHYSICAL CHARACTERISTICS OF PLANT SITES							
LOCATION OF AVAILABLE LAND	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD
AVAILABLE LAND AREA	FAIR	GOOD	POOR	FAIR	GOOD	POOR	GOOD
LAND FOR FUTURE EXPANSION	FAIR	GOOD	FAIR	GOOD	FAIR	FAIR	GOOD
LAND USE AND ZONING	INDUSTRIAL	INDUSTRIAL	UTILITY / PUBLIC	UTILITY	INDUSTRIAL	INDUSTRIAL	COMPATIBLE
POWER PLANT CHARACTERISTICS							
PLANT STATUS	ACTIVE	ACTIVE	ACTIVE	ACTIVE	ACTIVE	ACTIVE	ACTIVE
NUMBER OF UNITS	2-ST	6 NEW CT, 2-ST, 12-GT	3-ST, 1-CC, 2-DIESEL	2-CC, 24GT	4-ST	2-ST	2-ST
MEGAWATT (MW) RATING	215	1500,600	16.5, 33, 56.1, 31.6, 5.5	1428	1242	563	400, 400
BASE LOAD FACILITY	NO	YES (AFTER REPOWERING COMPLETE 2003)	YES	YES (CC)	YES (UNITS 3 AND 4)	NO	YES
PEAKING FACILITY	YES	YES (OLDER GTS)	YES (DIESEL)	YES (GT)	NO	NO	NO
CYCLING FACILITY	YES	YES (NEW CTS, BUT WILL BECOME BASE LOAD)	NO	NO	YES (UNITS 1 AND 2)	YES	NO
PLANT IN SERVICE DATE	1954, 1955	2000-CT, 1958-ST, 1969-ST, 1974-GT	UNKNOWN	1991-CC, 1957-ST, 1958-ST, 1970-GT, 1972-GT	1960, 1961, 1964, 1965, 1971	1962, 1963	1967, 1968
PLANNED PLANT EXPANSION (DATE AND MW)	NONE	3 CTS, THEN CC BY 2005	UNKNOWN	NONE	POTENTIAL SITE	POTENTIAL SITE	NONE
PLANNED PLANT EXPANSION (COOLING SYSTEM CHANGES)	NONE	NONE	UNKNOWN	N/A	N/A	NONE	NONE
PLANNED PLANT REPOWERING OPTIONS	NONE	IN PROGRESS THROUGH 2003 +540MW	UNKNOWN	RECENTLY COMPLETED	UNKNOWN	NONE	NONE
PLANNED PLANT EXPANSION FOR CO-GENERATION	NONE	NONE	NONE	N/A	NONE	NONE	NONE
NATURAL GAS FUEL SOURCE	YES	CT-YES	YES (BOILERS AND CT)	YES-CT	YES (UNITS 1-4)	YES (UNITS 3 AND 4)	YES/OIL
INTAKE AND DISCHARGE OPTIONS							
INTAKE SOURCE	BISCAYNE BAY	CALOOSAHATCHEE RIVER	ICW/ATLANTIC OCEAN	DANIA CUTOFF	ICW/ATLANTIC OCEAN	ICW/LAKE WORTH LAGOON	BISCAYNE BAY
DISCHARGE LOCATION	BISCAYNE BAY	ORANGE RIVER	ICW/ATLANTIC OCEAN	DANIA CUTOFF	ICW/ATLANTIC OCEAN	ICW/LAKE WORTH LAGOON	COOLING POND
WATER QUALITY CLASSIFICATION	CLASS III, OFW (BISCAYNE BAY AQUATIC PRESERVE)	CLASS III	CLASS III	CLASS III	CLASS III	CLASS III	CLASS III

TABLE 5-2 SECOND TIER ANALYSIS							
	PLANT LOCATION						
Note: Scored: high, medium, low or good, fair, poor	**CUTLER**	**FT MYERS**	**FT PIERCE**	**LAUDERDALE**	**PORT EVERGLADES**	**RIVIERA**	**TURKEY POINT**
TOTAL FLOW RATE, PER UNIT (MGD)	UNKNOWN	644	UNKNOWN	UNKNOWN	1164	576	UNKNOWN
DESALINATION SOURCE WATER	BISCAYNE BAY	CALOOSAHATCHEE RIVER	ICW/ATLANTIC OCEAN	DANIA CUTOFF	ICW/ATLANTIC OCEAN	ICW/LAKE WORTH LAGOON	BISCAYNE BAY
DESALINATION DISCHARGE METHOD	SURFACE	SURFACE/GROUND	SURFACE	SURFACE	SURFACE	SURFACE	SURFACE
COMPATIBILITY OF REJECT WATER	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD
WATER DEMAND AND TRANSMISSION							
POTENTIAL USERS	GOOD	GOOD	FAIR	GOOD	GOOD	FAIR	GOOD
YEAR 2010 DEMANDS (mgd)	237	64	9	166	166	95	237
YEAR 2020 DEMANDS (mgd)	282	75	14	185	185	118	282
PROXIMITY TO DEMAND	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	POOR
PROXIMITY TO TRANSMISSION LINES AND POINTS OF CONNECTION	FAIR	GOOD	FAIR	GOOD	GOOD	GOOD	POOR
OTHER WATER SUPPLY OPTIONS	LIMITED	LIMITED	LIMITED	NUMEROUS	NUMEROUS	LIMITED	NUMEROUS
ENVIRONMENTAL CONSIDERATIONS							
REGULATORY STATUS	MFLS	MFLS	OFW	IN COMPLIANCE	IN COMPLIANCE	IN COMPLIANCE	IN COMPLIANCE
PERMITTABILITY	DIFFICULT	HIGH	DIFFICULT	MEDIUM	HIGH	HIGH	FAIR
ENVIRONMENTAL IMPACTS	LOW	MEDIUM	MEDIUM	LOW	LOW	LOW	MEDIUM
OTHER							
PUBLIC ACCEPTANCE	MEDIUM	HIGH	HIGH	HIGH	HIGH	HIGH	LOW
DESIRE TO CO-LOCATE	NONE	MEDIUM	UNKNOWN	MEDIUM	MEDIUM	HIGH	NONE
RESULTS	REPRESENTATIVE	HIGHLY DESIRABLE	REPRESENTATIVE	DESIRABLE	HIGHLY DESIRABLE	DESIRABLE	UNDESIRABLE
NOTES:	NOT BASE LOADED	REPOWERING: SEE TYSP CT'S ARE AIR COOLED EXTRACTED FROM TEN YEAR SITE PLAN		SIMILAR TO PORT EVERGLADES	HIGH POTENTIAL	SMALL SITE NOT BASE LOADED POOR INTAKE LOCATION	ASSOCIATED WITH NUCLEAR FACILITY POOR PUBLIC PERCEPTION

5.2.2 CANDIDATE SITE EVALUATION

CUTLER

This facility is located at 14925 SW 67 Avenue in Miami, Dade County. It consists of two natural gas-fired conventional steam electric generating units, designated as Units #5 and #6. It began commercial operation in November 1954. It began commercial operation in July 1955.

The approximately 70-acre site contains two gas-fired boiler units using Biscayne Bay as a once-through cooling water source. Having passed the first tier screening criteria, this site was subjected to the second tier screening criteria. The intake and discharge cooling canals are Class III Waters, while Biscayne Bay is classified as an OFW. There are no stated plans for expansion, retirement or repowering at this site. There is need for additional water supplies to meet current and projected demands in this area.

Major issues with this site include its small size, age of the plant and proximity to the Biscayne Bay OFW. The site is used primarily as a peaking facility, and therefore does not have a continuous flow of cooling water that could be used for dilution of the concentrate from the desalination process. Environmental permitting may be more difficult for this site than for sites not located in close proximity to an OFW. This site was ranked as a “Representative” site, meaning that detailed information and analysis developed for other sites would have transfer value for this site.

PHYSICAL PLANT SITE

- **LOCATION:** **GOOD**
- **AVAILABLE LAND AREA:** **FAIR**
- **LAND FOR FUTURE EXPANSION:** **FAIR**
- **LAND USE AND ZONING:** **COMPATIBLE**

POWER PLANT CHARACTERISTICS

- **PLANT STATUS:** **ACTIVE**
- **NUMBER OF UNITS:** **2 STEAM TURBINES**
- **MEGAWATT (MW) RATING:** **215**
- **BASE LOAD FACILITY:** **NO**
- **PEAKING FACILITY:** **YES**
- **CYCLING FACILITY:** **YES**
- **PLANT IN SERVICE DATE:** **1954/5**

- **PLANNED PLANT EXPANSION (DATE AND MW):** **NONE**
- **PLANNED PLANT EXPANSION (COOLING CHANGES):** **NONE**
- **PLANNED PLANT REPOWERING OPTIONS:** **NONE**
- **PLANNED PLANT EXPANSION FOR CO-GENERATION:** **NONE**
- **NATURAL GAS FUEL SOURCE:** **YES**

INTAKE AND DISCHARGE OPTIONS

- **INTAKE SOURCE:** **BISCAYNE BAY**
- **DISCHARGE LOCATION:** **BISCAYNE BAY**
- **WATER QUALITY CLASSIFICATION:** **CLASS III**
- **FLOW RATE PER UNIT AND TOTAL:** **UNKNOWN**
- **DESALINATION SOURCE WATER:** **BISCAYNE BAY**
- **DESALINATION DISCHARGE METHOD:** **SURFACE**
- **COMPATIBILITY OF REJECT WATER:** **GOOD**

WATER DEMAND AND TRANSMISSION

- **POTENTIAL USERS:** **GOOD**
- **YEAR 2010 DEMANDS:** **237 MGD**
- **YEAR 2020 DEMANDS:** **282 MGD**
- **PROXIMITY TO DEMAND:** **GOOD**
- **PROXIMITY TO TRANSMISSION LINES:** **FAIR**
- **OTHER WATER SUPPLY OPTIONS:** **LIMITED**

ENVIRONMENTAL CONSIDERATIONS

- **REGULATORY STATUS:** **MFLS**
- **PERMITTABILITY:** **DIFFICULT**
- **ENVIRONMENTAL IMPACTS**: **LOW (Table 5-3)**

OTHER

- **PUBLIC ACCEPTANCE:** **MEDIUM**
- **DESIRE TO CO-LOCATE:** **NONE**

RESULT: REPRESENTATIVE

FT. MYERS

The Ft. Myers plant is located at 10650 State Road 80, Ft. Myers, in Lee County. This facility previously consisted of two fuel/oil-fired conventional steam electric generating units, designated as Units 1 and 2, and 12 older simple-cycle gas turbines, designated as Units 3 through 14. Units 1 and 2 have been shut down as part of an ongoing repowering project, and the steam turbine-generators will be re-used. The condensers on the original units will continue to be used, maintaining the dilution flow for co-location of a desalination plant.

Units 3 through 14, which operate in peaking service, have a rated gross capacity of 50 MW each. The repowered combined cycle units will be dispatched as base load units. The older gas turbines are typically operated in peaking service. Two more gas turbines will be added in 2003 and later converted to combined cycle operation. This new combined cycle unit will use cooling water and discharge the warm water into the discharge canal.

The plant draws cooling water from the Caloosahatchee River and discharges into a man-made cooling canal, which then flows into the Orange River. The plant also utilizes a new cooling tower, which was added as part of the repowering project. The cooling tower draws from the cooling canal, provides evaporative cooling, and then discharges the cooled water back into the discharge canal.

This 480-acre site, located on the south bank of the Caloosahatchee River in the Lower West Coast Planning Area, offers great potential as a water-supply site. The site is somewhat remote from the current water-demand areas, but is in close proximity to several potable water transmission lines.

Several locations on the site would be suitable for the location of a desalination facility. An area approximately seven acres in size, located immediately to the west of the cooling water discharge canal and north of S.R. 80 could be used for a desalination plant site. A smaller area to the east of the cooling-water discharge canal (between the new gas turbine generator building, transformer pads and transmission lines) offers some possibilities.

The Caloosahatchee River and the Orange River (the discharge site) are both classified as Class III Waters, suitable for recreation and fish and wildlife procreation. The National Wildlife Refuge across the river from the plant site is an OFW (Outstanding Florida Water), and as such, has anti-degradation criteria associated with it. There are no known regulatory or permitting or environmental issues associated with this site.

This site has been determined to be "Highly Desirable".

PHYSICAL PLANT SITE

▪ **LOCATION:**	**GOOD**
▪ **AVAILABLE LAND AREA:**	**GOOD**
▪ **LAND FOR FUTURE EXPANSION:**	**GOOD**
▪ **LAND USE AND ZONING:**	**COMPATIBLE**

POWER PLANT CHARACTERISTICS

▪ **PLANT STATUS:**	**ACTIVE**
▪ **NUMBER OF UNITS:**	**6-NEW GAS TURBINES IN COMBINED CYCLE WITH 2-STEAM TURBINES, 12-OLDER GAS TURBINES**
▪ **MEGAWATT (MW) RATING:**	**1500, 600**
▪ **BASE LOAD FACILITY:**	**YES (WHEN COMBINED CYCLE REPOWERING IS COMPLETE IN 2003)**
▪ **PEAKING FACILITY:**	**YES (FOR OLDER GAS TURBINES)**
▪ **CYCLING FACILITY:**	**YES (FOR NEW GAS TURBINES WHICH WILL BECOME BASE LOAD WITH COMPLETION OF REPOWERING IN 2003)**
▪ **PLANT IN SERVICE DATE:**	**1958 TO 2000**
▪ **PLANNED PLANT EXPANSION (DATE AND MW):**	**2001-2005**
▪ **PLANNED PLANT EXPANSION (COOLING CHANGES):**	**TOWERS ADDED MAY 2001**
▪ **PLANNED PLANT REPOWERING OPTIONS:**	**IN PROGRESS**
▪ **PLANNED PLANT EXPANSION FOR CO-GENERATION:**	**NONE**
▪ **NATURAL GAS FUEL SOURCE:**	**YES**

INTAKE AND DISCHARGE OPTIONS

▪ INTAKE SOURCE:	CALOOSAHATCHEE RIVER
▪ DISCHARGE LOCATION:	ORANGE RIVER
▪ WATER QUALITY CLASSIFICATION:	CLASS III
▪ FLOW RATE ANNUAL AVERAGE:	644 MGD
▪ DESALINATION SOURCE WATER:	CALOOSAHATCHEE RIVER
▪ DESALINATION DISCHARGE METHOD:	SURFACE/GROUND
▪ COMPATIBILITY OF REJECT WATER:	GOOD

WATER DEMAND AND TRANSMISSION

▪ POTENTIAL USERS:	GOOD
▪ YEAR 2010 DEMANDS:	64MGD
▪ YEAR 2020 DEMANDS:	75 MGD
▪ PROXIMITY TO DEMAND:	GOOD
▪ PROXIMITY TO TRANSMISSION LINES:	GOOD
▪ OTHER WATER SUPPLY OPTIONS:	SW, GW, RES.

ENVIRONMENTAL CONSIDERATIONS

▪ REGULATORY STATUS:	MFL'S
▪ PERMITTABILITY:	HIGH
▪ ENVIRONMENTAL IMPACTS:	MEDIUM (Table 5-3)

OTHER

▪ PUBLIC ACCEPTANCE:	HIGH
▪ DESIRE TO CO-LOCATE:	MEDIUM

RESULT: HIGHLY DESIRABLE

FT. PIERCE

The H.D. King Power Plant is located at 311 North Indian River Drive, Ft. Pierce, in St. Lucie County. It consists of one 16.5 MW fossil fuel fired steam generator, one 33 MW fossil fuel fired steam generator, one 56.1 MW fossil fuel fired steam generator, one 23.4 MW combined cycle gas turbine with an 8.2 MW heat recovery steam generator, and two 2.75 MW diesel generators.

The Ft. Pierce Site is located in the City of Ft. Pierce on the west side of the Atlantic Intracoastal Waterway (Indian River), across from Ft. Pierce Inlet. The small site is surrounded by other industrial, commercial and public land uses. This power plant site uses the Indian River Lagoon (OFW) as a source for once-through cooling water supplies. This site is located near existing and future water demands and transmission and storage locations. Permittability, due to potential environmental impacts to the OFW, may be more difficult at this site. The Ft. Pierce power plant, operated by the City, does offer some potential for water-supply development. However, the small size of the plant and the lack of available land in the area, limits the potential of this site. This site has been determined to be "Representative". Data from other similar sites (Port Everglades) have applicability to this site.

PHYSICAL PLANT SITE

- **LOCATION:** **GOOD**
- **AVAILABLE LAND AREA:** **POOR**
- **LAND FOR FUTURE EXPANSION:** **FAIR**
- **LAND USE AND ZONING:** **COMPATIBLE**

POWER PLANT CHARACTERISTICS

- **PLANT STATUS:** **ACTIVE**
- **NUMBER OF UNITS:** **3 STEAM TURBINES, 1 COMBINED CYCLE, 2 DIESEL**
- **MEGAWATT (MW) RATING:** **16.5, 33, 56.1, 23 & 8, 5.5**
- **BASE LOAD FACILITY:** **YES**
- **PEAKING FACILITY:** **YES**
- **CYCLING FACILITY:** **NO**
- **PLANT IN SERVICE DATE:** **UNKNOWN**
- **PLANNED PLANT EXPANSION (DATE AND MW):** **UNKNOWN**

▪ PLANNED PLANT EXPANSION (COOLING CHANGES):	UNKNOWN
▪ PLANNED PLANT REPOWERING OPTIONS:	UNKNOWN
▪ PLANNED PLANT EXPANSION FOR CO-GENERATION:	NONE
▪ NATURAL GAS FUEL SOURCE:	YES

INTAKE AND DISCHARGE OPTIONS

▪ INTAKE SOURCE:	ICW/ATLANTIC
▪ DISCHARGE LOCATION:	ICW/ATLANTIC
▪ WATER QUALITY CLASSIFICATION:	CLASS III
▪ FLOW RATE PER UNIT AND TOTAL:	UNKNOWN
▪ DESALINATION SOURCE WATER:	ICW/ATLANTIC
▪ DESALINATION DISCHARGE METHOD:	SURFACE
▪ COMPATIBILITY OF REJECT WATER:	GOOD

WATER DEMAND AND TRANSMISSION

▪ POTENTIAL USERS:	FAIR
▪ YEAR 2010 DEMANDS:	9 MGD
▪ YEAR 2020 DEMANDS:	14 MGD
▪ PROXIMITY TO DEMAND:	GOOD
▪ PROXIMITY TO TRANSMISSION LINES:	FAIR
▪ OTHER WATER SUPPLY OPTIONS:	LIMITED

ENVIRONMENTAL CONSIDERATIONS

▪ REGULATORY STATUS:	OFW
▪ PERMITTABILITY:	DIFFICULT
▪ ENVIRONMENTAL IMPACTS:	MEDIUM (Table 5-3)

OTHER

▪ PUBLIC ACCEPTANCE:	HIGH
▪ DESIRE TO CO-LOCATE:	UNKNOWN

RESULT: REPRESENTATIVE

LAUDERDALE

This facility is located at 4300 Southwest 42nd Avenue, Ft. Lauderdale, in Broward County. It consists of four new gas turbines arranged in a combined-cycle configuration with two steam turbines, and two banks of twelve older simple-cycle gas turbines. Each combined-cycle unit consists of two gas turbines, each with a net summer continuous capability of 430 MW. Each bank of simple-cycle gas turbines has a net capability of 504 MW.

The four combined-cycle gas turbines are identical in configuration. Each gas turbine is connected to an electrical generator, and each gas turbine generates heat, which produces steam in a heat recovery steam generator (HRSG). The steam from two HRSGs is then sent to a steam turbine generator for additional electrical power.

The Lauderdale site is situated on approximately 390 acres on the north side of the New River in Ft. Lauderdale. This base load power plant uses the Dania Cutoff (Class III Waters) as a once-through cooling water source. The large land area appears to be suitable for the co-location and construction of a desalination plant. The proximity to current and projected water demands is good. Environmental impacts appear to be low and permittability appears to be good. This site was ranked as "Desirable". Much of the data from the analysis of the Port Everglades site would appear to generally be pertinent at this location.

PHYSICAL PLANT SITE

▪ **LOCATION:**	**GOOD**
▪ **AVAILABLE LAND AREA:**	**FAIR**
▪ **LAND FOR FUTURE EXPANSION:**	**GOOD**
▪ **LAND USE AND ZONING:**	**COMPATIBLE**

POWER PLANT CHARACTERISTICS

▪ **PLANT STATUS:**	**ACTIVE**
▪ **NUMBER OF UNITS:**	**2-NEW COMBINED CYCLE and 24-OLDER GAS TURBINES**
▪ **MEGAWATT (MW) RATING:**	**1428**
▪ **BASE LOAD FACILITY:**	**YES (NEW COMBINED CYCLE)**
▪ **PEAKING FACILITY:**	**YES (OLDER GAS TURBINES)**
▪ **CYCLING FACILITY:**	**NO**
▪ **PLANT IN SERVICE DATE:**	**1957-72 (ORIGINAL UNITS)**

- **PLANNED PLANT EXPANSION (DATE AND MW):** **NONE**
- **PLANNED PLANT EXPANSION (COOLING CHANGES):** **N/A**
- **PLANNED PLANT REPOWERING OPTIONS:** **COMPLETED**
- **PLANNED PLANT EXPANSION FOR CO-GENERATION:** **N/A**
- **NATURAL GAS FUEL SOURCE:** **YES**

INTAKE AND DISCHARGE OPTIONS

- **INTAKE SOURCE:** **DANIA CUTOFF**
- **DISCHARGE LOCATION:** **DANIA CUTOFF**
- **WATER QUALITY CLASSIFICATION:** **CLASS III**
- **FLOW RATE PER UNIT AND TOTAL:** **UNKOWN**
- **DESALINATION SOURCE WATER:** **DANIA CUTOFF**
- **DESALINATION DISCHARGE METHOD:** **SURFACE**
- **COMPATIBILITY OF REJECT WATER:** **GOOD**

WATER DEMAND AND TRANSMISSION

- **POTENTIAL USERS:** **GOOD**
- **YEAR 2010 DEMANDS:** **166 MGD**
- **YEAR 2020 DEMANDS:** **185 MGD**
- **PROXIMITY TO DEMAND:** **GOOD**
- **PROXIMITY TO TRANSMISSION LINES:** **GOOD**
- **OTHER WATER SUPPLY OPTIONS:** **NUMEROUS**

ENVIRONMENTAL CONSIDERATIONS

- **REGULATORY STATUS:** **IN COMPLIANCE**
- **PERMITTABILITY:** **MEDIUM**
- **ENVIRONMENTAL IMPACTS**: **LOW (Table 5-3)**

OTHER

- **PUBLIC ACCEPTANCE:** **HIGH**
- **DESIRE TO CO-LOCATE:** **MEDIUM**

RESULT: DESIRABLE

PORT EVERGLADES

This facility is located at 8100 Eisenhower Boulevard, Ft. Lauderdale, Broward County. This facility has the capacity to produce a total of 1242 MW. The smaller Units 1 and 2 are dispatched in cycling service, and Units 3 and 4 are typically dispatched as base load units. Units are often kept in “hot standby” during the winter, for as many as 3 days at a time.

The 94-acre FP&L Port Everglades site is located to the southwest of Ft. Lauderdale Inlet and uses the Atlantic Intracoastal Waterway (Class III Waters) for once-through cooling. The plant has an intake located in a man-made canal drawing water from slip number 3 of Port Everglades. The intake is free from normally expected chemical contamination sources such as fuel spills. The intake canal is located in an industrialized area and may be subject to periodic light oil and grease contamination requiring a skimmer.

The facility has eight discharge structures located along a man-made canal within the site. The discharge travels through the canal to discharge into the Intracoastal Waterway. The facility operates with a Manatee Protection Plan, but does not have an observation area established for manatee viewing. However, manatees can come all the way into the discharge canal during the winter months.

The site is surrounded by port-related and other industrial land uses numerous parcels near the existing power plant site appear to be suitable for the co-location of a desalination plant. The most ideal of these parcels is located to northeast of the cooling water discharge canal. This site is approximately four-acres in size. Additional land (approximately 5 acres) to the immediate east could possibly be used once the unused fuel storage tanks are removed. This site has been listed as a “potential” site for future plant expansions/repowering, although there are no present plans to do so. Major water transmission lines and elevated storage are located near the proposed site. Environmental impacts are estimated to be low and permittability to be high. This site was ranked as “Highly Desirable”.

PHYSICAL PLANT SITE

▪ LOCATION:	GOOD
▪ AVAILABLE LAND AREA:	GOOD
▪ LAND FOR FUTURE EXPANSION:	FAIR
▪ LAND USE AND ZONING:	COMPATIBLE

POWER PLANT CHARACTERISTICS

▪ PLANT STATUS:	ACTIVE
▪ NUMBER OF UNITS:	4 STEAM TURBINES
▪ MEGAWATT (MW) RATING:	1242
▪ BASE LOAD FACILITY:	YES (LARGER UNITS)
▪ PEAKING FACILITY:	NO
▪ CYCLING FACILITY:	YES (SMALLER UNITS)
▪ PLANT IN SERVICE DATE:	1960-1971
▪ PLANNED PLANT EXPANSION (DATE AND MW):	POTENTIAL SITE
▪ PLANNED PLANT EXPANSION (COOLING CHANGES):	N/A
▪ PLANNED PLANT REPOWERING OPTIONS:	UNKNOWN
▪ PLANNED PLANT EXPANSION FOR CO-GENERATION:	NONE
▪ NATURAL GAS FUEL SOURCE:	YES

INTAKE AND DISCHARGE OPTIONS

▪ INTAKE SOURCE:	ICW/ATLANTIC
▪ DISCHARGE LOCATION:	ICW/ATLANTIC
▪ WATER QUALITY CLASSIFICATION:	CLASS III
▪ FLOW RATE ANNUAL AVERAGE:	1164 MGD
▪ DESALINATION SOURCE WATER:	ICW/ATLANTIC
▪ DESALINATION DISCHARGE METHOD:	SURFACE
▪ COMPATIBILITY OF REJECT WATER:	GOOD

WATER DEMAND AND TRANSMISSION

▪ POTENTIAL USERS:	GOOD
▪ YEAR 2010 DEMANDS:	166 MGD
▪ YEAR 2020 DEMANDS:	185 MGD
▪ PROXIMITY TO DEMAND:	GOOD

- **PROXIMITY TO TRANSMISSION LINES:** **GOOD**
- **OTHER WATER SUPPLY OPTIONS:** **NUMEROUS**

ENVIRONMENTAL CONSIDERATIONS

- **REGULATORY STATUS:** **IN COMPLIANCE**
- **PERMITTABILITY:** **HIGH**
- **ENVIRONMENTAL IMPACTS:** **LOW (Table 5-3)**

OTHER

- **PUBLIC ACCEPTANCE:** **HIGH**
- **DESIRE TO CO-LOCATE:** **MEDIUM**

RESULT: **HIGHLY DESIRABLE**

RIVIERA

The Riviera Plant is located at 200-300 Broadway, Riviera Beach in Palm Beach County. It is located on the west side of the Atlantic Intracoastal Waterway (Lake Worth), across from Lake Worth Inlet. This small, 34-acre site is surrounded by other industrial land uses. This power plant site uses Lake Worth (Class III Waters) as a source for once-through cooling water. It consists of two fossil fuel-fired boilers, Unit 3 and Unit 4. Unit 3 began commercial operation in 1962, with Unit 4 following in 1963.

During the past year, the plant has been operated at a greater than 50% capacity, but future operating levels are uncertain. The plant will be at minimal loads when insufficient demand is present and run at full capacity when required. According to plant personnel, the plant will likely be dispatched in cycling service in the future, after the Ft. Myers repowering is completed and those units are dispatched for base load. There are no present plans for repowering the Riviera Plant.

Future power plant expansion and desalination plant co-location options are limited because of the small size of this site. This site passed the initial screening criteria. Environmental impacts are estimated to be low, while permittability is high. This site also has a potential problem with the location of the intake structure that is located in a slip at the adjacent port facility. There have been reported incidents of petroleum contamination from the spilling of fuel or pumping of bilges from ships at the port facilities. There are also occasional problems with high turbidity caused by propeller wash from the ships and or tugboats assisting them when entering or exiting the facilities. These two potential issues complicate the operation of a desalination facility. This site was determined to be “Desirable”.

PHYSICAL PLANT SITE

- **LOCATION:** **GOOD**
- **AVAILABLE LAND AREA:** **POOR**
- **LAND FOR FUTURE EXPANSION:** **FAIR**
- **LAND USE AND ZONING:** **COMPATIBLE**

POWER PLANT CHARACTERISTICS

- **PLANT STATUS:** **ACTIVE**
- **NUMBER OF UNITS:** **2**

▪ **MEGAWATT (MW) RATING:**	**563 MW**
▪ **BASE LOAD FACILITY:**	**NO**
▪ **PEAKING FACILITY:**	**NO**
▪ **CYCLING FACILITY:**	**YES**
▪ **PLANT IN SERVICE DATE:**	**1962, 1963**
▪ **PLANNED PLANT EXPANSION (DATE AND MW):**	**POTENTIAL SITE**
▪ **PLANNED PLANT EXPANSION (COOLING CHANGES):**	**NONE**
▪ **PLANNED PLANT REPOWERING OPTIONS:**	**NONE**
▪ **PLANNED PLANT EXPANSION FOR CO-GENERATION:**	**NONE**
▪ **NATURAL GAS FUEL SOURCE:**	**YES**

<u>INTAKE AND DISCHARGE OPTIONS</u>

▪ **INTAKE SOURCE:**	**ICW/LAKE WORTH**
▪ **DISCHARGE LOCATION:**	**ICW/LAKE WORTH**
▪ **WATER QUALITY CLASSIFICATION:**	**CLASS III**
▪ **FLOW RATE PER UNIT AND TOTAL:**	**576 MGD**
▪ **DESALINATION SOURCE WATER:**	**ICW/LAKE WORTH**
▪ **DESALINATION DISCHARGE METHOD:**	**SURFACE**
▪ **COMPATIBILITY OF REJECT WATER:**	**GOOD**

<u>WATER DEMAND AND TRANSMISSION</u>

▪ **POTENTIAL USERS:**	**FAIR**
▪ **YEAR 2010 DEMANDS:**	**95 MGD**
▪ **YEAR 2020 DEMANDS:**	**118 MGD**
▪ **PROXIMITY TO DEMAND:**	**GOOD**
▪ **PROXIMITY TO TRANSMISSION LINES:**	**GOOD**
▪ **OTHER WATER SUPPLY OPTIONS:**	**LIMITED**

<u>ENVIRONMENTAL CONSIDERATIONS</u>

▪ **REGULATORY STATUS:**	**IN COMPLIANCE**
▪ **PERMITTABILITY:**	**HIGH**
▪ **ENVIRONMENTAL IMPACTS**:	**LOW (Table 5-3)**

<u>OTHER</u>

▪ **PUBLIC ACCEPTANCE:**	**HIGH**
▪ **DESIRE TO CO-LOCATE:**	**HIGH**

▪ **RESULT: DESIRABLE**

TURKEY POINT OIL/GAS PLANT

This facility is located at 9.5 miles east of Florida City on SW 344 Street, Florida City in Dade County. The Turkey Point site is composed of two separate co-located power plants: the Fossil Plant and the Nuclear Plant. The Fossil Plant consists of two fossil steam generating units that burn natural gas and fuel oil. These units began commercial operation in 1967 and 1968.

The Turkey Point oil/gas plant passed the Fatal Flaw and Second Tier Analysis. However, due to its location in close proximity and association with the nuclear unit at this site, it was ranked as "Undesirable". It was believed that public perception would be such that the public would not accept potable water from a source near a nuclear facility. This facility will not be subject of further analysis.

PHYSICAL PLANT SITE

- **LOCATION:** **GOOD**
- **AVAILABLE LAND AREA:** **GOOD**
- **LAND FOR FUTURE EXPANSION:** **GOOD**
- **LAND USE AND ZONING:** **COMPATIBLE**

POWER PLANT CHARACTERISTICS

- **PLANT STATUS:** **ACTIVE**
- **NUMBER OF UNITS:** **2**
- **MEGAWATT (MW) RATING:** **400 MW EACH**
- **BASE LOAD FACILITY:** **YES**
- **PEAKING FACILITY:** **NO**
- **CYCLING FACILITY:** **NO**
- **PLANT IN SERVICE DATE:** **1967 & 1968**
- **PLANNED PLANT EXPANSION (DATE AND MW):** **NONE**
- **PLANNED PLANT EXPANSION (COOLING CHANGES):** **NONE**
- **PLANNED PLANT REPOWERING OPTIONS:** **NONE**
- **PLANNED PLANT EXPANSION FOR CO-GENERATION:** **NONE**
- **NATURAL GAS FUEL SOURCE:** **YES/OIL**

INTAKE AND DISCHARGE OPTIONS

- INTAKE SOURCE: BISCAYNE BAY
- DISCHARGE LOCATION: COOLING POND
- WATER QUALITY CLASSIFICATION: CLASS III
- FLOW RATE PER UNIT AND TOTAL: UNKNOWN
- DESALINATION SOURCE WATER: BISCAYNE BAY
- DESALINATION DISCHARGE METHOD: SURFACE
- COMPATIBILITY OF REJECT WATER: GOOD

WATER DEMAND AND TRANSMISSION

- POTENTIAL USERS: GOOD
- YEAR 2010 DEMANDS: 237 MGD
- YEAR 2020 DEMANDS: 282 MGD
- PROXIMITY TO DEMAND: POOR
- PROXIMITY TO TRANSMISSION LINES: POOR
- OTHER WATER SUPPLY OPTIONS: NUMEROUS

ENVIRONMENTAL CONSIDERATIONS

- REGULATORY STATUS: IN COMPLIANCE
- PERMITTABILITY: FAIR
- ENVIRONMENTAL IMPACTS: MEDIUM (Table 5-3)

OTHER

- PUBLIC ACCEPTANCE: LOW
- DESIRE TO CO-LOCATE: NONE

RESULT: UNDESIRABLE

5.2.3 SELECTED SITES FOR FUTURE DETAILED EVALUATION

The two sites that were ranked as “Highly Desirable” were Ft. Myers and Port Everglades. These two sites were selected for further evaluation in the third tier evaluation. The largest component of the third tier evaluation is the application of the Desalination Feasibility Cost Planning Model to determine the unit costs for the finished water that could be produced at the proposed co-located plant sites. The two selected sites are not necessarily the two best sites for co-locating a desalination plant, but rather represent a range of cost and operational options, which can be applied to the other sites if desired in the future.

Specifically, the Ft. Myers site represents a very feasible older site that is having its operational life being extended by repowering. The water quality is lower salinity than seawater ranging from slightly brackish to seawater. The plant location on the Caloosahatchee may require a deep well injection disposal system due to pending MFL rules. Therefore, both a cooling water blended concentrate discharge and deep well injection will be evaluated in tier three. The plant is also located in an area of growing potable water demand with an excellent interconnected potable water distribution system.

In contrast, the Port Everglades site represents another very feasible site that is characterized as older power plant facility in an area of growing water demand. The plant utilizes ambient seawater for cooling water and would be an excellent candidate for a blended concentrate discharge having a substantial cooling water flow.

Table 5-3: Number of Federally (USFWS) and State (FFWCC/FDA) Listed Protected Species Occurrences Within a 1.0 mile Radius of Each Candidate Power Plant Site. (Source: Florida Geographic Data Library and Florida Natural Area Inventory Occurrence Records, 1999; FFWCC Eagle Nest Data Base, 2001)

POWERPLANT SITE	USFWS LISTED SPECIES[1]	FFWCC LISTED SPECIES[1]	FDA LISTED SPECIES[1]	COMMENTS
Cutler	0 (0)	4 (0)	29 (0)	1. Bird rookery (#62007) 2500 ft. NW of site.
Ft. Myers	2 (1)	6 (1)	0 (0)	1. Manatee aggregation site in discharge basin. 2. Bird rookery (#619040) 1500 ft. NE of site.
Ft. Pierce	1 (1)	1 (1)	2 (0)	1. Manatee aggregation site in discharge basin. 2. Presence of Johnson's Seagrass (*Halophila johnsonii*) in vicinity of discharge location.
Homestead	0 (0)	0 (0)	0 (0)	No comment.
Key West	0 (0)	2 (0)	0 (0)	No comment.
Lake Worth	0 (0)	1 (1)	0 (0)	No comment.
Lauderdale	1 (1)	1 (1)	0 (0)	1. Manatee aggregation site in discharge basin.
Pt. Everglades	1 (1)	1 (1)	2 (0)	1. Manatee aggregation site in discharge basin.
Riviera	2 (2)	1 (1)	1 (0)	1. Manatee aggregation site in discharge basin. 2. Presence of Johnson's Seagrass (*Halophila johnsonii*) in vicinity of discharge location.
St. Lucie	6 (6)	7 (7)	2 (1)	1. Sea turtle nesting beach on-site. 2. Presence of Johnson's Seagrass (*Halophila johnsonii*) in vicinity of facility basin. 3. Bird rookery located on-site.
Turkey Point	1 (1)	1 (1)	0 (0)	1. Within critical habitat for the American crocodile (*Crocodylus acutus*).

( ) Indicates number of listed species occurrences recorded on-site or immediately adjacent to the powerplant site, which could be potentially impacted by proposed activities.

[1]Official lists of Florida's endangered species, threatened species, and species of special concern. Florida Game and Fresh Water Fish Commission. August 1997.

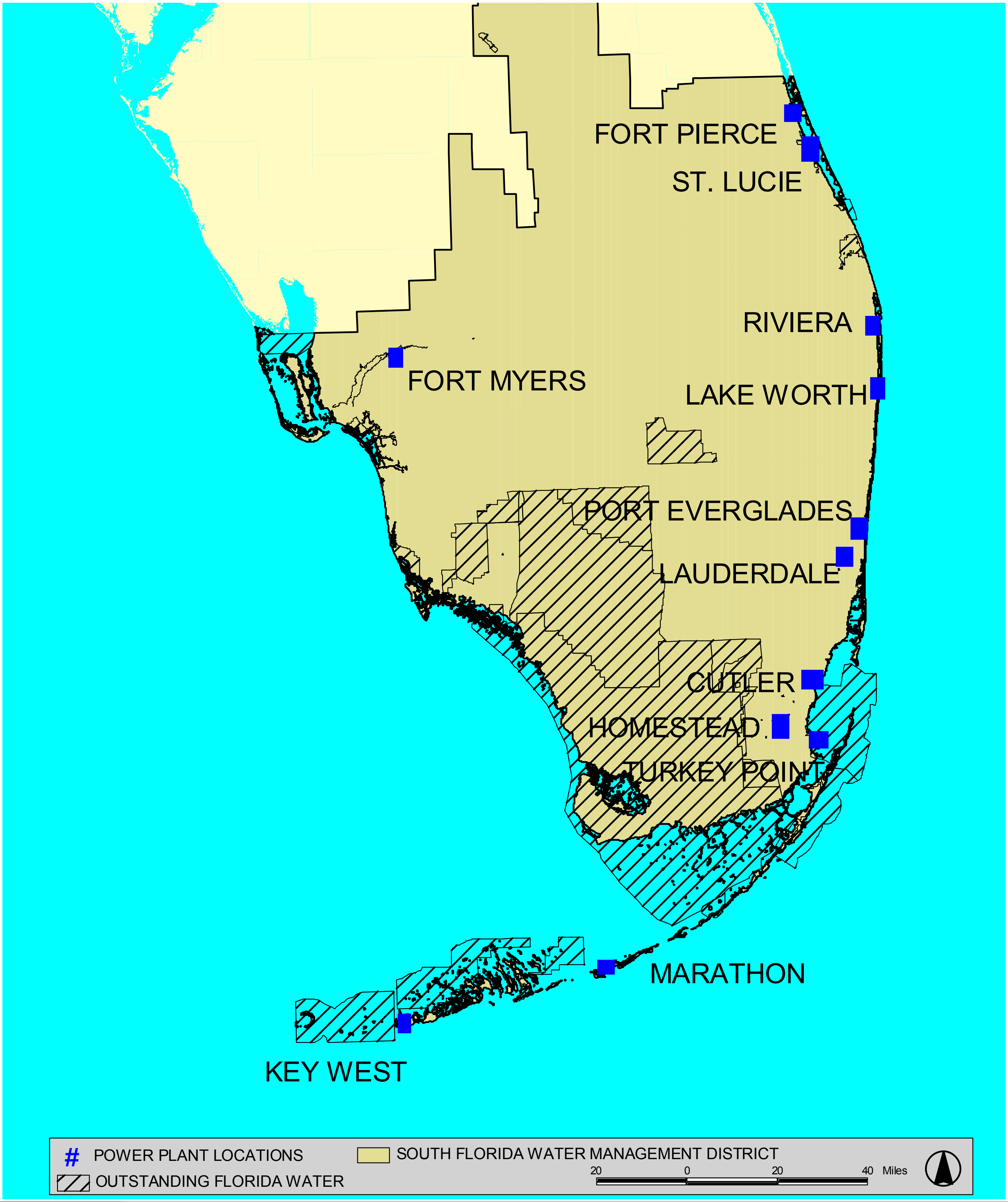


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Figure 5-26:

OUTSTANDING FLORIDA WATERS

Prepared for:
South Florida Water Management District
Florida Power & Light Company

FINAL SITE EVALUATION

5.3. FINAL SITE EVALUATION

5.3.1. DESCRIPTION OF EVALUATION CRITERIA

The final sites selected for feasibility evaluation were evaluated by a series of 14 criteria. Each criterion assesses the information and data specific to these final sites. In addition to information collected by the WRA project team for the first and second tier evaluation, information collected during site visits and provided by FPL was used in assessing these sites.

It is important to recognize that the objective of the third tier evaluation is not to rank the final sites but rather to provide a concise evaluation of the feasibility of co-locating a desalination facility at each selected site to assist in identifying representative sites.

POWER PLANT OPERATIONS DESCRIPTION: Descriptions are provided on plant location and conditions, general operational information including power produced, fuel type and power production technology employed. Information obtained from on-site visits is described. Pertinent permits that would impact the co-location of a desalination facility discharge are described. Finally, future operational plans for the power plants, that may impact the longevity of a co-located desalination facility are identified.

TREATMENT TECHNOLOGY: Based on the source water quality and desired product water quality, various reverse osmosis treatment technologies may be employed. Brackish water and seawater systems involve different treatment components and differing operational requirements such as pump pressures. Product-water quality limits may require additional treatment sequences if higher product water quality (lower TDS) is desired.

DESALINATION PLANT OPERATIONS: Desalination plant operation descriptions have been developed. These will be conceptual plans for operating the desalination facility to produce the desired product water while maximizing the co-location benefits of the power plant operation. Descriptions of source water intake and concentrate discharge are provided, including piping and plant facility locations. Operational elements particular to each power plant operation that would impact the operation of the desalination facility are identified.

SOURCE WATER QUALITY: Co-located facilities will use power-plant cooling water as the source water. Source water quality is an important factor in determining and designing the reverse osmosis process. Power plant cooling water is characterized based on information identified in the Ten-Year Site Plans, Site Certification Applications, operating permits and information provided by FPL. A description of the desalination facility source water, addresses water quality characteristics critical to the desalination process design including temperature, salinity and any additives introduced as a result of the power plant cooling water operation. Additionally, source water quantities required to produce the desired product water are identified based upon the efficiency of the desalination process.

PRETREATMENT REQUIREMENTS: Source-water pretreatment requirements are identified and described. Pretreatment is critical to the reverse osmosis process in order to maintain productivity and membrane life. Pretreatment requirements may vary based upon the water quality conditions at each site.

PRODUCT WATER YIELD AND POST TREATMENT: A description of product water quantity and quality including finished water salinity and other primary drinking water standards are provided for the final sites. Product water yield is quantified based on projected system efficiency.

CONCENTRATE MANAGEMENT: Concentrate disposal is critical to the successful environmental management of a desalination facility. In a water-cooled power plant co-location, the desired method of concentrate disposal is to blend the concentrate with the cooling water discharge from the power plant operation. Required dilution factors to meet State of Florida IWWF discharge standards are described. As an alternative to blending, deep well injection may provide another option.

PERMIT REQUIREMENTS: Permits will be required for all aspects of the desalination operation including the concentrate discharge, plant construction, air emissions, chemical handling system discharges, solid waste disposal and pipeline construction. Power plant operations may require the modification of existing IWWF permits for a decreased discharge. Each permit is described and a preliminary assessment will be made regarding the ability to obtain that permit.

ENVIRONMENTAL ISSUES: Environmental issues may affect the ability to operate a desalination facility. These issues may include items such as impacts to threatened or endangered species, wetland impacts for desalination plant and pipeline construction, and consumptive water use regulatory issues such as Minimum Flows and Levels.

LAND USE COMPATIBILTY: Existing and future land use classifications that could impact the construction or operation of a desalination facility are discussed in the report. An identification and description of adjacent land uses that may be incompatible and impact the construction or operation of a desalination facility is provided.

SERVICE AREAS AND DEMAND: Service areas for product water anticipated by the proposed desalination facility will be identified and described. Service areas would include both public and private water utilities that can be reasonably supplied by the desalination facility. Demand quantities for the desalinated water are assessed using SFWMD Water Supply Plans and SFWMD Water Shortage phased restrictions. An assessment of the ability of potential users to accept the cost of the desalinated water source is provided in general terms.

CAPITAL COST: Major desalination facility capital cost items are identified and cost summaries prepared. These items are more fully described in the Desalination Feasibility Cost Planning Model. Specifically, these items include:

- **Intake System**
- **Pretreatment System**
- **R.O. Process**
- **Post-treatment System**
- **Concentrate Disposal System**
- **Infrastructure**
- **Land**
- **Distribution System**
- **Professional Services**

OPERATION AND MAINTENANCE (O&M) COSTS: Major desalination facility O&M cost items are identified and cost summary prepared. These items are more fully described in the Desalination Feasibility Cost Planning Model. Specifically, these items include:

- **Pretreatment System**
- **Reverse Osmosis Process**
- **Post Treatment System**
- **Concentrate Disposal**
- **Energy Consumption**
- **Other O&M**

LIFE CYCLE COST: A life cycle cost for each proposed desalination facility will be computed using the Desalination Feasibility Cost Planning Model. Life cycle costs are prepared for 20 and 50-year terms. Life cycle costs will be expressed in dollars per 1000 gallons.

5.3.2. FT. MYERS

POWER PLANT OPERATIONS DESCRIPTION

Location

The Ft. Myers Plant is located at 10650 State Road 80, Ft. Myers, in Lee County.

Generating Equipment

This facility consists of two fuel gas/oil-fired conventional steam electric generating units, designated as Units 1 and 2, and 12 older simple-cycle gas turbines, designated as Units 3 through 14. Units 1 and 2 have been shut down as part of the repowering project. The steam turbine-generators will continue to be used as part of the repowering project, but the boilers will be removed. Units 3 through 14, the fuel oil-fired simple cycle fired GE gas turbines, each has a rated gross capacity of 50 MW.

These units have been dispatched in cycling service, although with high capacity factors during 2001. The repowered combined cycle units will be dispatched as base load units. The older gas turbines are typically operated in peaking service from 9 am to 7 pm. No retirement date for these gas turbines is planned.

Cooling Water System

The plant has an intake structure located in a man-made canal that draws cooling water from the Caloosahatchee River. The intake is free from troublesome chemical contamination sources such as fuel spills. Unit 1 has a cooling water flow of 116,000 gpm (two 68,000 gpm pumps) and discharges the warm water through two 54-inch pipes into the discharge canal. Unit 2 has a cooling water flow of 258,000 gpm (two 137,500 gpm pumps), discharging through two 72-inch pipes into the discharge canal. In addition, there is an auxiliary cooling water flow of 21,000 gpm. With both units in full operation, the peak cooling water flow into the discharge canal would be approximately 593 MGD. With only the smaller unit running, the minimum flow would be approximately 177 MGD. No chemicals, chlorination, or biocides are used in the cooling water systems.

The plant's FDEP Industrial Wastewater Facility (IWWF) permit does not have a dissolved oxygen reporting or compliance condition. The plant has four discharge structures along a man-made canal within the site. The discharge flows through the canal (which provides a significant mixing area) and discharges into the Orange River. The Point of Discharge is defined as the point where the discharge canal joins with the Orange River. The Orange River accepts a large amount of runoff from the Lehigh Acres area.

The predicted monthly average of discharge temperatures for the repowered plant, based on prior monthly data, vary from 75.9°F in the winter to 98.6°F in the summer. Based on these predicted monthly discharge temperature averages, the annual average temperature is 87.8°F. The plant will utilize a new 12 cell cooling tower, which was added as part of the repowering project. The cooling tower draws from the cooling canal, provides evaporative cooling with a flow of 170,000 gpm, and then discharges the cooled water back into the discharge canal. No chemical, chlorination or biocides are used in the new cooling tower. The plant is in full compliance with all environmental operating permits. There are no outstanding compliance issues.

As part of the existing manatee protection plan, when the inlet canal temperature falls to 61°F, FPL tries to maintain an outlet canal temperature of at least 68°F. Manatees can enter the top third of the discharge canal. In fact, across the highway from the plant is a county park with a manatee viewing area.

TREATMENT TECHNOLOGY

BRACKISH WATER REVERSE OSMOSIS PROCESS

Based on information provided by FPL and the South Florida Water Management District, the salinity of the feedwater (FPL's Ft. Myers plant cooling water intake from the Caloosahatchee River) for the Ft. Myers Facility would be expected to average about 15,000 mg/L TDS. Although this range is higher than what is typically considered brackish water, the preliminary study for this facility is based on the use of a high concentrate brackish water feedwater source. Based on this information, the Ft. Myers facility would be generally considered a brackish water reverse osmosis facility.
Reverse Osmosis (RO) for the conversion of brackish water to drinking water has been utilized in Florida since the early 1970's. The first significant project was a 0.5 MGD facility constructed in 1972 at Rotunda West, in Charlotte County. Since then, approximately 100 facilities have been built in the state, ranging in capacity from less than 25,000 GPD to the 40 MGD plant now under construction in Boca Raton. Other significant facilities are located in Cape Coral, Jupiter, Hollywood, and in Collier County. The 15 MGD Cape Coral plant supplies all of the municipal drinking water supply for the City, and has been in operation since 1977.

All of the existing brackish water RO plants in Florida utilize ground water as the feedwater source, and in the majority of cases the water, while salty, is physically very clean. This generally means that no special pretreatment is required, and the standard pretreatment consisting of cartridge filtration and chemical addition for scale control is commonplace.

Pretreatment for brackish surface water RO must accomplish two primary objectives; reduce the feed water turbidity and the SDI (Silt Density Index, a fouling test specific to RO), and reduce bio-fouling potential. The standard method of brackish surface water pretreatment includes two-stage media filtration, with a ferric salt used as a coagulant.

After chemical pretreatment, the brackish water passes through cartridge filters, normally fitted with cartridges that have a nominal rating of 5 microns (5/1000th of a millimeter). These filters are present solely for protecting the membranes from a sudden upset in the raw water source. Such an upset can cause high turbidity and suspended solids, which will plug the membranes if they are left unprotected. Typical cartridge filter life in Florida's brackish water systems is 2-6 months. If change outs are required more than once per month, additional pretreatment may be needed.

After passing through the cartridge filters, the water is pressurized and introduced to the RO membranes. Typical pressure ranges are 180 psig to 400 psig in existing Florida plants. The feed pressure required depends on two factors; the quality of the feed water in terms of Total Dissolved Solids (TDS), and the system permeate recovery (60-85% for most Florida plants). These two factors determine the design flux (the rate at which water passes through the RO membrane). Higher flux requires higher pressure and vice versa.

In the membrane system, the feed water is separated into the “feed/brine” stream, and permeate. Permeate is the water that passes through the membrane and is purified to eventually become the finished product water. As the brackish water passes through the system, nearly pure water passes through the membrane, leaving the majority of the salts behind. Most brackish water membranes will reject at least 99% of the sodium chloride in the feedwater. In brackish water plants that operate at a recovery greater than 60%, the RO process will be separated into two stages, primarily for hydraulic reasons. This separation is called “brine-staging” and is required to maintain the feed/brine side fluid velocity as the permeate is being removed through the membrane. As a general rule, the second stage will have half the number of membranes of the first stage. Sometimes the pressure is boosted between the stages, to increase the efficiency of the second stage. This boost can be accomplished by recovering the final concentrate energy or using an electric inter-stage boost pump.

The amount of water that permeates is controlled at the rated capacity of the system, and the remainder, now more concentrated, exits the system as “concentrate”, and is directed to the discharge system for that facility. In the majority of cases, there is sufficient energy remaining in the concentrate that re-pumping is not required for delivery to the discharge point.

The permeate, now essentially salt-free, may require air stripping to remove hydrogen sulfide. Carbon dioxide will also be removed in the air stripper, but pH adjustment will still be required. In most brackish water RO plants, a portion of the raw water bypasses the treatment process to blend with the permeate. This is done to provide the product water with some hardness and alkalinity to stabilize the product water, making it less corrosive. Pure permeate has virtually nothing but sodium chloride left after RO, has a low pH, and is very corrosive. Even after blending, the pH will need adjustment, and a corrosion inhibitor may need to be added to the product water prior to distribution.

DESALINATION PLANT OPERATIONS

The FPL Ft. Myers power plant site is located along the Caloosahatchee River, where it draws water for the plant's condenser cooling water system. This 480-acre site, located on the south bank of the Caloosahatchee River in the Lower West Coast Planning Area, offers great potential as a water-supply site. The large area of the site, combined with an on-going repowering project, makes this a strong candidate site. The site is scheduled for plant repowerings in the 2001 to 2006 period. These expansions could possibly be coordinated with the co-location of a desalination facility.

It appears that the facility has adequate land available (approximately 7 acres) for the construction of a brackish water RO facility. Several locations on the site would be suitable for the location of a desalination facility. As illustrated on Figure 5-27, an area approximately seven acres in size, located immediately to the west of the cooling water discharge canal and north of S.R. 80 could be used for a desalination plant site. A smaller area to the east of the cooling-water discharge canal (between the new gas turbine generator building, transformer pads and transmission lines) offers some possibilities. Other areas on or adjacent to the site could be used as well. However, these two locations offer the greatest potential because of their proximity to the cooling water discharge canal.

The power plant has an intake structure located in a man-made canal, which draws water from the Caloosahatchee River. Upon site inspection, the intake appears to be free from chemical contamination sources such as fuel spills, oil and grease.

As illustrated on Figure 5-28, the desalination process would begin with the extraction of the heated brackish water from the discharge side of the power plant's condenser cooling water system. A chlorination system would be incorporated into the feedwater pumping station for intermittent shock chlorination of the pretreatment system. This system would be used to control bio-fouling in the feedwater system up to the inlet to the RO system. Since RO membranes cannot tolerate chlorine, a dechlorination system would be needed. The raw water volume pumped would be greater than the feedwater volume required (either 14.25 MGD or 35.7 MGD) by the volume needed for backwashing the pretreatment filtration system, and is usually about 2-5% of the filter capacity.

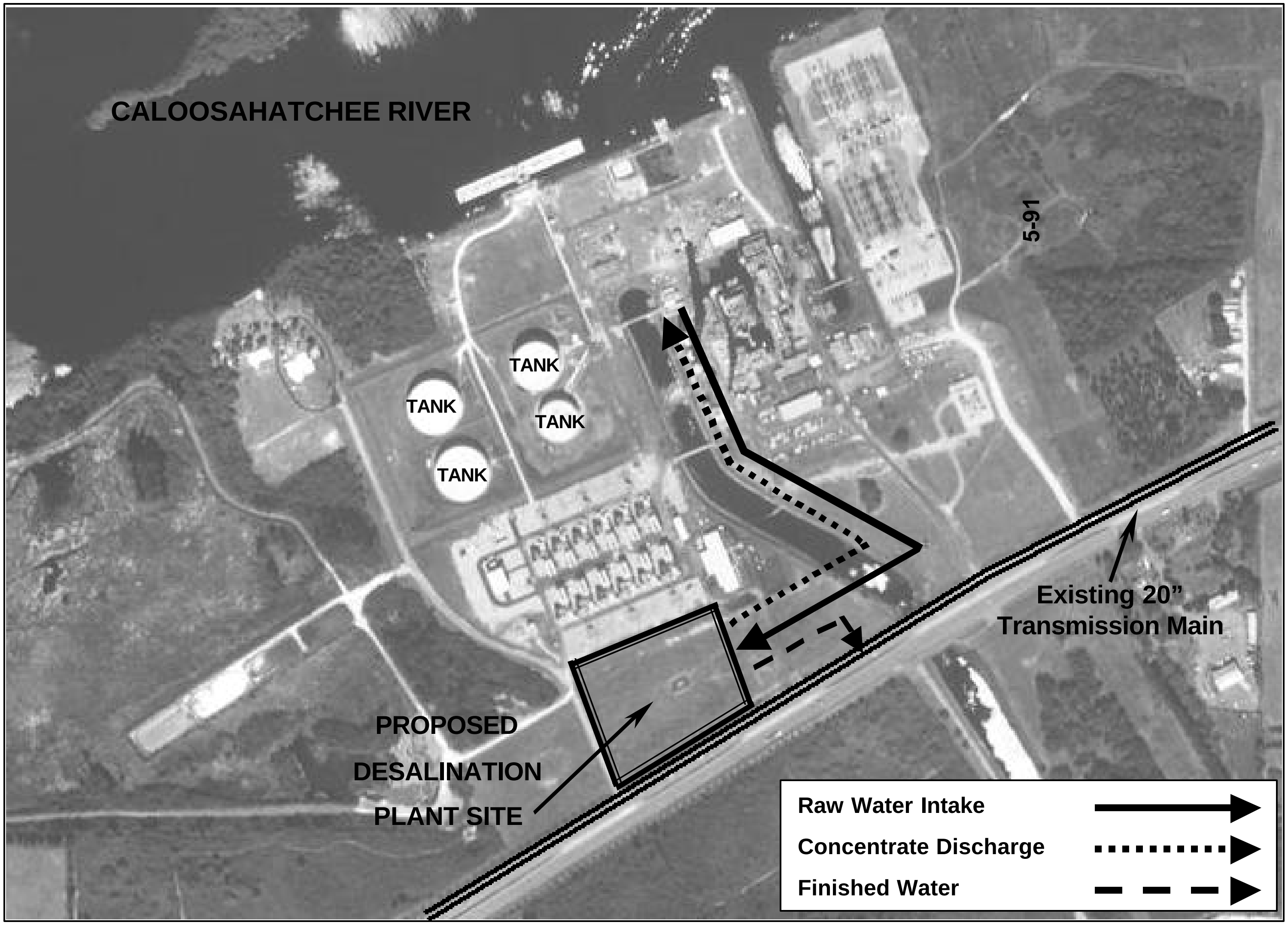

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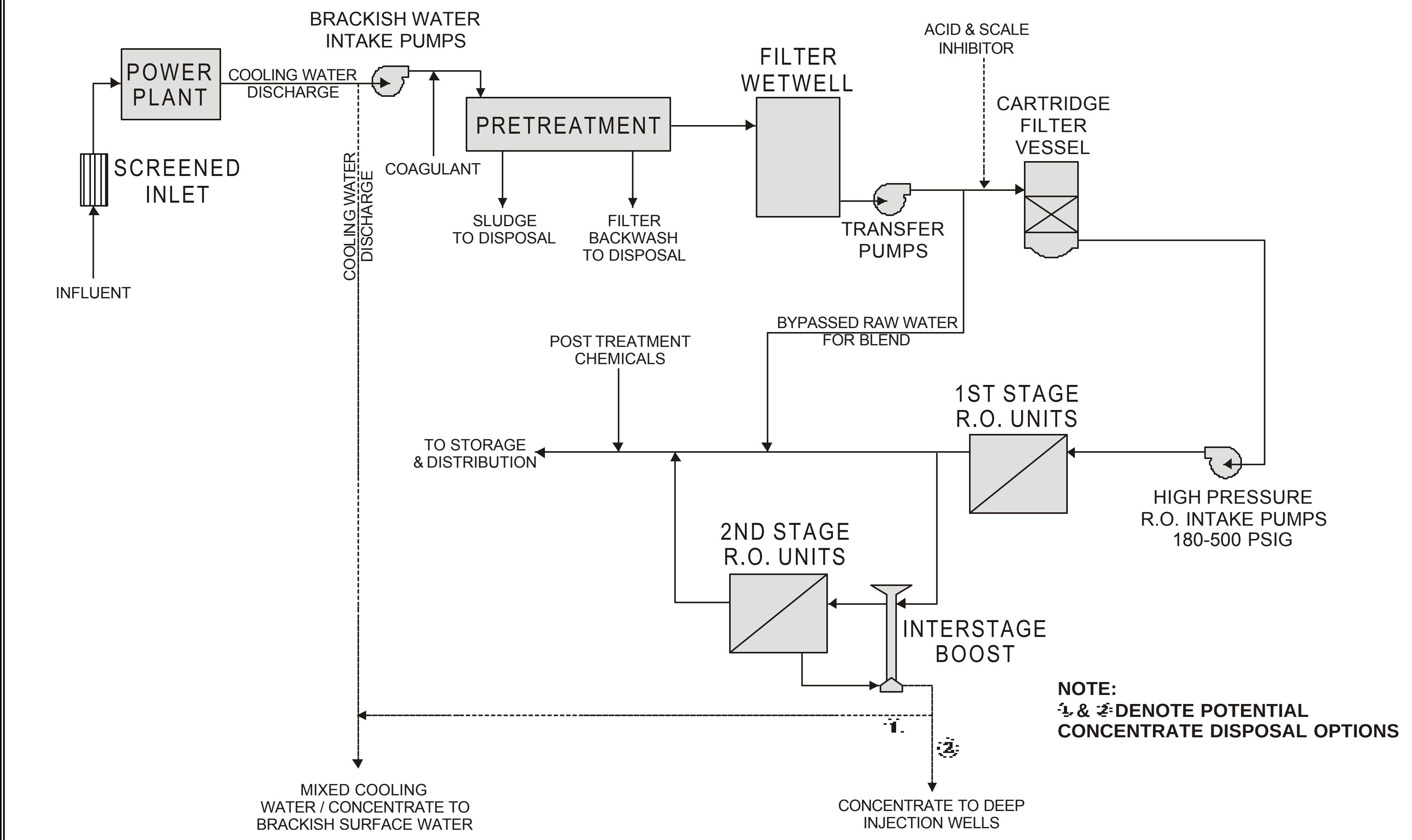
Figure 5-27:
CONCEPTUAL DESALINATION PLANT CONFIGURATION, FT. MYERS SITE

Prepared For:
South Florida Water Management District
Florida Power & Light Company



WRA

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-28:

FT. MYERS BRACKISH WATER FACILITY

PRELIMINARY PROCESS SCHEMATIC

Prepared For:
South Florida Water Management District
Florida Power & Light Company

After the coagulant (typically ferric chloride or ferric sulfate), is added to the raw water, the water then enters the first bank of a two-step filtration system. After leaving the second bank of filters, the filtered water would be stored in a wet well, from which low head pumps would deliver the feed water at about 30-50 psig to cartridge filters and then to the high pressure RO feed pumps. Sulfuric acid would be added to the feed stream ahead of the cartridge filters, in this case not only to generate carbon dioxide for the post-treatment lime addition, but also to control calcium carbonate scaling potential. This is a factor for the Ft. Myers site, because the RO plant can be operated at much higher recovery, resulting in a higher level of concentration of salts in the waste stream.

The RO feed pumps would be electric motor driven horizontal or vertical multistage pumps. The pumps would be equipped with energy recovery turbines (ERTs) to recover some of the energy in the concentrate exiting from the RO membranes. In a relatively high TDS brackish water system, the RO assemblies would be arranged in two stages, with the concentrate from the first stage becoming the feedwater to the second stage. In this type of arrangement, it is more effective to use an ERT as a booster pump to increase the first stage concentrate pressure before it enters the second stage as feedwater. The concentrate from the second stage would then drive the ERT. Approximately 30% of the feedwater would become concentrate and the ERTs will recover about 75% of the energy available in this waste stream. The use of ERTs would reduce the energy requirement of the feed pump by about 20-25%.

RO plant operations would be conducted on a 7-day per week, 24-hour day schedule. This continuous schedule maximizes the efficiency of the plant and provides the greatest utilization of the capital investment, which is significant. The plant design will include adequate storage facilities for unexpected interruptions of the power plant, desalination plant or receiving potable water utility systems. In contrast to a continuous operation of the RO plant, an off-peak operation would be an operation only if the demand for the water supply was periodic or other limitations applied such as lack of available power or manpower. This was not the case for this location.

SOURCE WATER QUALITY

The Ft. Myers Power Plant is located on the Caloosahatchee River, which is a fresh water/tidal (brackish) river fed by Lake Okeechobee. Condenser cooling water for the plant is pumped from the Caloosahatchee River and the cooling water discharge is released to a canal leading to the Orange River, which then flows into the Caloosahatchee River, downstream of the cooling water intake point.

Based on data obtained from the report *"Desalination Study of FPL Power Plants,"* (EPRI TR-101236, Project 2662-23, Final Report, December, 1992), during the rainy season, the salinity of the condenser cooling water system intake can be as low as 100 ppm and in the dry season, the TDS level can be as high as 9000 ppm.

It should be noted that sudden fluctuations in TDS levels could occur due to rainfall, stormwater discharges into the river, and/or fresh water being released from the Okeechobee Waterway and Lake Okeechobee. In addition, TDS levels vary on a daily basis due to tidal influences. Based on the referenced data obtained in 1989 and 1990, the mode of the TDS concentrations is less than 250 ppm, occurring about 19% of the time, the median TDS is approximately 4000 ppm, and the sample mean TDS is approximately 3705 ppm.

It is important to note that based on data provided by FPL and the South Florida Water Management District, the salinity of the feedwater is expected to average about 15,000 mg/L TDS. This data taken during the period 1999-2000 shows salinity levels ranging from approximately 200 ppm TDS to 27,000 ppm TDS. Since this concentration is significantly higher than that reported in "*Desalination Study of FPL Power Plants,"* (EPRI TR-101236, Project 2662-23, Final Report, December, 1992), it is recommended that further investigations be conducted to determine the actual salinity ranges that the plant would encounter.

For this study, the design is based on the information provided by FPL and the South Florida Water Management District (15,000 mg/L TDS). During those times of the year that the TDS concentration is lower, it may be possible to bypass part of the pretreated feedwater, reducing the treatment cost. However, since this is a surface water source, the water treatment plant would need to comply with the Surface Water Treatment Rule (SWTR) of the Safe Drinking Water Act. Since RO membranes provide a high level of removal for Giardia, Cryptosporidium, and viruses, the additional treatment steps needed to achieve the removal/inactivation levels required by the SWTR may not be applicable. However, the option exists and should be examined in future studies.

Although the Caloosahatchee River is influenced by fresh water inflows, for the purposes of this study it can be assumed with a reasonable degree of confidence that the predominant ions will be sodium and chloride, in roughly the proportions that they occur in seawater. The freshwater may potentially contribute a higher proportion of divalent ions, such as calcium, magnesium, sulfate, but scaling problems with these ions are not anticipated. Table 5-4, summarizes the predicted ion concentrations that would be encountered for the facility. Silica is assumed to be 50% higher than seawater, at about 12 mg/L, and the raw water pH is assumed to be 8.0. Bicarbonate has been kept at seawater concentration, and an adjustment was made in the chloride concentration to maintain the cation/anion balance.

Table 5-4: SUMMARY OF THE COMPOSITION OF FT. MYERS FEEDWATER

Component	Concentration (mg/L)
Na^+	4,590
K^+	165
Ca^{++}	175
Mg^{++}	553
HCO_3^-	140
SO_4^-	1,152
Cl^-	8,204
Br^-	28
Other	15
Total Dissolved Solids	**15,022**

The pressure requirement for RO is significantly impacted by the water temperature. The higher the temperature, the lower the pressure required to produce the design flow. Along with this benefit comes a drawback, however, which is that salt passage through the membrane increases with temperature. The predicted monthly average of discharge temperatures for the repowered plant, based on prior monthly data, vary from 75.9°F in the winter to 98.6°F in the summer. Based on these predicted monthly discharge temperature averages, the annual average temperature is 87.8°F. The higher temperature is well within the upper temperature limit of the membrane (40°C). The average annual temperature is used for conceptual process design, while the high temperature will determine worst case permeate quality, and the need for a partial second pass treatment unit.

PRETREATMENT REQUIREMENTS

Since the brackish water feed is a surface water source, effective pretreatment of the feed water is essential to long-term efficiency in desalting by reverse osmosis (RO). The brackish water RO treatment process includes chemical pretreatment. Chemicals that may be used include sulfuric acid, and a synthetic scale inhibitor. Sulfuric acid is added if carbonate scale control is needed, and also to ensure that the product water is at the optimum pH for hydrogen sulfide stripping, if necessary. The scale inhibitor is used to control the precipitation of insoluble metal sulfates at the high levels of super saturation usually experienced in brackish water desalting. The use of a scale inhibitor allows higher permeate recovery in terms of yield from the raw water source, thus preserving the resource and lowering energy needs.

A coagulant, such as Ferric Chloride, would be used as part of the pretreatment process to cause particles in the feedwater to form larger masses (floc) that can be removed with filters before the introduction of the water to the RO membranes. The pretreatment filters would be backwashed with filtered brackish water every few days, producing a sludge that contains filter coagulant chemicals. The sludge would then be dewatered and hauled to a landfill for disposal.

PRODUCT WATER YIELD AND POST TREATMENT

A membrane performance model, for a single pass RO system operating at 70% recovery, using seawater-type membranes, provided the following:

Temperature	87.8°F	98.6°F
Feed Pressure	490 psig	457 psig
Permeate TDS	162 mg/L	196 mg/L

The product quality goal for this study has been set at 250 mg/L TDS. The permeate from an RO treatment plant is essentially all sodium chloride, at a low pH. In the majority of applications, the pH must be adjusted, and the water stabilized by the addition of calcium hardness and bicarbonate alkalinity. A calcium hardness goal of 40 mg/L is considered suitable for stabilization. The equivalent bicarbonate alkalinity is 49 mg/L, corresponding to a TDS of 76 mg/L. From the summary above, at the summer temperature, the permeate TDS is 196 mg/L at 70% recovery. If the recovery is lowered to 68%, the permeate quality improves to the point that further treatment of a portion of the RO permeate in a second pass is not necessary. However, it is likely that a second pass membrane system would need to be utilized during the summer, so that the product quality goal of 250 mg/L TDS could be realized.

Post treatment would consist of chemical addition for stabilization and pH adjustment, and disinfection with chlorine. Because both calcium and bicarbonate alkalinity are needed in the finished water, lime addition is assumed as the post treatment chemical used. However, for lime to form bicarbonate alkalinity, carbon dioxide is also required. This can be added in the post treatment area prior to the lime addition, or can be generated by acid addition to the feed seawater. The latter is usually the least expensive approach, and is assumed for this study.

CONCENTRATE MANAGEMENT

The discharge of concentrate would be required to meet all aspects of the Florida Department of Environmental Protection (FDEP) Antidegradation Policy. The Antidegradation Policy contained in FDEP Rules 62-302.3000 and 62-4.242.F.A.C. The basis of the Policy is that new or expanded discharges pass the public interest test in addition to meeting all other FDEP rules. The discharge is not allowed to degrade the quality of the receiving waters below the state standards. Passing the public interest test would require that other alternative disposal methods are not economically and technologically feasible. Providing a safe and reliable drinking water source is a positive factor in a public interest test determination.

The discharge limits for a concentrate discharge would be limited by two factors. The first is the ability of the discharge to pass the whole effluent toxicity standard. Since the RO process does not introduce toxic substances into the concentrate stream, the possibility of toxicity is solely associated with the level of salinity. Research completed in 1995 by the Southwest Florida Water Management District (SWFWMD) for the purpose of establishing the toxicity of a seawater concentrate discharge showed the dilution necessary to meet the FDEP whole effluent toxicity limits for discharge. Results of the test indicated that a seawater concentrate diluted to 45,000 ppm TDS would pass all FDEP toxicity tests for an acceptable discharge. (SWFWMD 1995)

The second limiting factor for the concentrate discharge is the limit on discharge chloride increases per FDEP Rule for Water Quality Standards Section 62-302.530(18) F.A.C. This standard places a limit of 10 percent increase for chlorides over ambient receiving water conditions at the point of discharge. This chloride limit would be proportionately related to the salinity limit measured as Total Dissolved Solids (TDS).

Since the research conducted by the SWFWMD indicated the whole effluent toxicity standard could be met with a salinity of 45,000 ppm TDS, or 36 percent increase in salinity, the 10 percent increase in chlorides (salinity) limit would be the more restrictive condition. In addition, this assumption was tested in the permitting for the Tampa Bay facility that passed all whole effluent toxicity testing with a simulated discharge of chlorides at 10 percent above ambient receiving water chloride levels.

Concentrate Disposal Options

The Ft. Myers site has two possible options for concentrate discharge. The more desirable option from a cost perspective would be a concentrate discharge blended with the power plant cooling water effluent. However, this option may be limited by pending Minimum Flow Rules currently being promulgated by the SFWMD. In addition, for larger desalination plant capacities (>25 mgd), the minimum available cooling water flow may be insufficient. The second option for concentrate discharge would be deep well injection. This option would be more costly and perhaps more difficult to permit, but would serve as an alternative if the blended discharge proved infeasible.

Blended Surface Discharge Option

The Ft. Myers power plant has four (4) discharge structures located along a man-made canal adjacent to the site. The cooling water discharge travels through the discharge structures, into the canal, into the Orange River, into the Caloosahatchee River and eventually reaches the Gulf of Mexico. It appears that the discharge canal provides significant mixing area prior to discharging to the Orange and Caloosahatchee Rivers. Preliminary investigations indicate that it will be possible to combine the RO membrane concentrate with the power plant cooling water prior to discharging to the Orange and Caloosahatchee Rivers. This methodology would provide for dilution of the concentrate prior to discharging to surface waters and would require the construction of a concentrate disposal pipeline, which could range from 24” to 42” in diameter, based on production and recovery rates. This concentrate disposal pipeline would be tied-in with one or more of the existing discharge structures and would provide for blending of the concentrate prior to the discharge point.

Ft. Myers (10 mgd Facility with Blended Surface Discharge)

Plant Capacity:	10 mgd
Source Quality:	15,000 ppm TDS
Recovery Rate:	70%
Concentrate Quantity:	4.3 mgd
Concentrate Quality:	50,000 ppm TDS

Based on a maximum allowable increase in salinity of 10%, (based on FDEP Water Quality Standard Section 62-302.530(18) F.A.C.) the diluted concentrate quality cannot exceed 16,500 ppm TDS. A minimum dilution water flow of 96 mgd at 15,000 ppm TDS would be required to dilute 4.3 mgd of concentrate at 50,000 ppm TDS to a final salinity of 16,500 ppm TDS. FPL data indicates a historical minimum available cooling water flow of 177 mgd (net 163 mgd after desalination process withdrawal) and a projected maximum average cooling water flow of 593 mgd (net 579 mgd after desalination process withdrawal) after repowering is complete. This data would indicate an adequate cooling water dilution volume to FDEP discharge standards. (Table 5-5)

$$Q_d = 10Q_c\left(\frac{C-1.1D}{D}\right)$$

Where:

Q_d = Dilution Water Flow (mgd)

Q_c = Concentrate Flow (mgd)

C = Concentrate Quality (ppm TDS)

D = Dilution Water Quality (ppm TDS)

Table 5-5: DILUTION REQUIREMENTS BASED ON SALINITY LIMITS FOR CO-LOCATED 10 MGD FT. MYERS FACILITY			
Parameter	**Symbol**	**Value**	**Units**
Concentrate Quality (TDS)	C	50,000	ppm
Concentrate Flow	Q_c	4.3	mgd
Dilution Water Quality (TDS)	D	15,000	ppm
Maximum Allowable Salinity for Blended Discharge (TDS) (1)	B	16,500	ppm
Minimum Required Dilution Water Flow	$\mathbf{Q_d}$	**96.0**	**mgd**
Net Minimum Average Available Dilution Water from Power Plant		163.0	mgd
Net Maximum Average Available Dilution Water Flow from Power Plant		579.0	mgd

(1) Water Quality Standard Section 62-302.530(18) F.A.C.

Ft. Myers (25 mgd Facility with Blended Surface Discharge)

Source Quality: 15,000 ppm TDS

Recovery Rate: 70%

Concentrate Quantity: 10.7 mgd

Concentrate Quality: 50,000 ppm TDS

Based on the maximum allowable increase in salinity of 10%, the diluted concentrate quality cannot exceed 16,500 ppm TDS. A minimum dilution water flow of 239 mgd at 15,000 ppm TDS would be required to dilute 10.7 mgd of concentrate at 50,000 ppm TDS to a final salinity of 16,500 ppm TDS. FPL data indicates a historical minimum available cooling water flow of 177 mgd (net 141 mgd after desalination process withdrawal) and a projected maximum average cooling water flow of 593 mgd (net 557 mgd after desalination process withdrawal) after repowering is complete. The data may indicate that sufficient cooling water is not available during times of minimum cooling water flows for a 25 mgd facility. It is important to note that the minimum cooling water flows are based on historical data and that additional quantities of cooling water may be utilized once repowering of the plant is complete. It also may be possible that the owner of the proposed desalination facility could reach an agreement with FPL to ensure that the required minimum cooling water flow be maintained at all times. In addition, a more detailed investigation of this project would determine if in fact there was a sufficient minimum available cooling water flow to support a 25 mgd desalination facility based upon more detailed process calculations and water quality data. (Table 5-6)

Table 5-6: DILUTION REQUIREMENTS BASED ON SALINITY LIMITS FOR CO-LOCATED 25 MGD FT. MYERS FACILITY			
Parameter	**Symbol**	**Value**	**Units**
Concentrate Quality (TDS)	C	50,000	ppm
Concentrate Flow	Q_c	10.7	mgd
Dilution Water Quality (TDS)	D	15,000	ppm
Maximum Allowable Salinity for Blended Discharge (TDS) (1)	B	16,500	ppm
Minimum Required Dilution Water Flow	$\mathbf{Q_d}$	**239.0**	**mgd**
Net Minimum Average Available Dilution Water from Power Plant		141.0	mgd
Net Maximum Average Available Dilution Water Flow from Power Plant		557.0	mgd

(1) Water Quality Standard Section 62-302.530(18) F.A.C.

Deep Well Injection Disposal Option

There is a possibility that the pending SFWMD Minimum Flow Rulemaking for the Caloosahatchee River may prohibit the discharge of an even slightly higher salinity water into the Orange River and ultimately the Caloosahatchee River. If this becomes the case, it may be necessary to discharge the concentrate using deep injection wells. A potential area of concern with respect to deep inject wells is that this geographical area is used for aquifer storage and recovery (ASR). The introduction of significant amounts of chlorides into the ASR system may make permitting more difficult.

If the concentrate is discharged into deep injection wells, hydrogeological services associated with the construction, testing, and permitting of a deep injection well would be required. The main tasks associated with the construction and permitting of a deep injection well could include, but may not be limited to the following tasks:

- **SITE SELECTION AND DATA REVIEW -** A data review would be conducted to determine the general hydrogeology, acceptable injection zones, and a suitable site for the proposed deep injection wells. Data from other deep injection wells would be obtained from FDEP and reviewed for any pertinent information.

- **INJECTION WELL DESIGN -** Based on the information obtained during the Site Selection and Data Review process, injection well and monitor well plans would be designed to meet FDEP specifications for a Class I injection well. These plans would then be utilized to complete a bid package for the selection of a well driller Contractor. Competitive bids would be obtained and the selection of a well driller Contractor would be made.

- **OBTAIN FDEP EXPLORATORY WELL CONSTRUCTION AND TESTING PERMITS -** This task would include the preparation of a conceptual plan of the overall project, a drilling and testing plan, and abandonment plan, and a preliminary area of review study. Data obtained from the previous tasks would be used to complete plans and studies that would be required to obtain an exploratory well construction and testing permit. The permit application would be submitted to FDEP for approval and the FDEP would have 90 days to review the permit application.

- **DRILL BORING AND CONSTRUCT INJECTION WELL -** Once the exploratory well permit is approved, drilling and construction of the well would commence. The exploratory well could be designed as an injection well, since regulations do not allow an on-site monitoring well penetrating the injection zone. However, once all of the testing for the exploratory boring is completed, it could be grouted to an elevation above the upper confining unit of the injection zone and a monitor well could then be constructed. The testing program for the exploratory well would consist of various testing during the drilling of the well and could include the collection of water quality samples, corings and a lithologic log. In addition, a geophysical logging and specific capacity testing would be performed.

  Water quality samples would be obtained during the drilling process to determine the base of the USDW and to assess the water quality of the proposed injection zone. Corings would be utilized to identify the injection zone and the overlying confining unit. Per regulations, after completion of the testing, all available corings would be submitted to the Florida Geological Survey. Geophysical testing may include video survey, resistivity surveys, natural gamma ray, fluid conductance, acoustic velocity, flow meter, caliper survey, temperature survey, cement evaluation survey, oxygen activation log, noise log, and a porosity survey. Finally, the results from the aforementioned tests would be utilized to assess the hydraulic conditions above, below and within the confining unit overlying the injection zone.

- **PERFORM A PUMPING TEST IN THE INJECTION ZONE -** A pumping test would be conducted in the proposed injection zone to ascertain the hydrologic properties of the injection zone. A long-term, 72-hour pumping test is generally sufficient to provide data regarding the transmissivity and storage of the injection zone, and the leakance coefficient of the overlying confining unit. Results of the testing would be utilized to demonstrate effectiveness of the injection zone and the impermeable properties of the overlying confining zone.

- **OBTAIN FDEP CLASS I TEST/INJECTION WELL CONSTRUCTION AND TESTING PERMIT –** Prior to the completion of the well drilling, a permit application for a Class I test/injection well would be submitted to FDEP for review and approval. This permit application would include the following:

    - A map showing the location of the proposed injection well, in addition to all other surrounding wells within the area of review, and any surface water features;
    - Tabulation of data for any wells within the area of review that penetrate into the proposed injection zone;
    - Maps and cross sections within the area of review that illustrate the spatial extent of any USDW, groundwater flow directions, and any other pertinent geologic or hydrologic information;
    - Proposed injection rate and injection pressure;
    - Analysis of proposed injection fluid;
    - Proposed injection testing procedures;
    - Contingency plans for well failure; and
    - Monitoring Plans.

Once the permit is approved, mechanical integrity testing (MIT) would be performed on the injection well to ensure that the well construction is complete. A short-term injection test would be initiated to predict the operating pressure of the injection well. Prior to the long term operational injection testing, the following information would be submitted to the TAC for review:

- Television survey;
- Geophysical logs;
- MIT data;
- Data obtained from the short term injection test;
- Confining zone data;
- Background water quality of the injection zone and the monitor zone(s); and
- Waste stream analysis.

FDEP would then provide written authorization for the operational testing program to commence once they reviewed the data and approved the testing.

- **PERFORM OPERATIONAL INJECTION TESTING -** Prior to granting approval for the operational testing, FDEP would consider the following items:

  - All available logging and testing program data for the well;
  - Results of the MIT(s);
  - Anticipated operating maximum pressure and flow rate;
  - Results of the pumping test program;
  - Actual injection procedure; and
  - Compatibility of injected waste with fluids in the injection zone.

The authorization for the operational testing would include the following:

- Injection pressure limitation
- Injection flow rate limitation
- Injection well monitoring requirements
- Effluent monitoring requirements
- Weekly groundwater sampling of monitor well(s)

Once written authorization is received from FDEP for the operational testing, the well testing would commence and would last for a period not to exceed the two-year limit of the permit. If the results indicate that the system is operating correctly and no upward leakage is occurring, the testing program may be shortened to less than a year.

- **OBTAIN FDEP CLASS I INJECTION WELL OPERATION PERMIT -** Upon successful completion of the operational injection test program, a Class I injection well operation permit application would be submitted to FDEP. The application would include a report containing the following:

  - Results of the information obtained under the construction/testing permit;
  - Record Drawings;
  - Operation and Maintenance manuals, including emergency procedures;
  - Proposed monitoring program; and
  - Copies of mill certificates for casing used in the well construction.

Prior to granting approval for the operation of the injection well, FDEP would consider the following information obtained during the construction and operational testing programs:

- All available logging and testing program data;
- All well construction data;
- Results of the MIT(s);
- Actual or anticipated maximum pressure and flow rates;
- Actual injection procedure;
- Compatibility of injected waste with fluids in the injection zone; and
- Recommendation of the TAC concerning the operational feasibility of the injection well.

According to the USGS publication, *"Types of Secondary Porosity of Carbonate Rocks in Injection and Test Wells in Southern Peninsular Florida,"* (WRI Report 94-4013), an injection well for the North Ft. Myers Wastewater Treatment Plant, located in Section 14, Township 43 South, Range 24 East, along the Caloosahatchee River was drilled to a depth of 2,583 feet into the lower Floridan aquifer. Injection flow rates per well can range from 2 MGD to 6 MGD, based on conversation with Diversified Drilling and the Ft. Myers FDEP office. Therefore, to accept a maximum capacity of 6 MGD, two (2) injection wells may be required. However, field testing (pilot well) would have to be performed to verify how many wells would be required.

PERMIT REQUIREMENTS

Numerous permits will be required for the construction and operation of the desalination facility. All permits will be required to be approved prior to the initiation of construction or actual operation of the plant, depending upon the permit. The following list of permits is based upon experience with similar facilities in Florida.

Assumptions made for the permitting requirements for the Ft. Myers are the following:

1. The desalination plant will be co-located on the FPL Ft. Myers site.
2. The desalination plant will take its feedwater from the cooling water discharge from the power plant.
3. The desalination plant concentrate discharge will be blended with the power plant cooling water discharge or deep well injected.

For purposes of evaluating the permitting potential for each applicable permit, a ranking scale has been provided to estimate the potential for permit approval based upon known factors.

Ranking Description

Poor = *less than 50 % probability of obtaining permit*

Fair = *50 % to 70% probability of obtaining permit*

Good = *greater than 70 % probability of obtaining permit*

OPERATIONAL PERMITS

SFWMD Consumptive Use Permit - This project is designed for a brackish surface water intake from a man-made canal contiguous with the Caloosahatchee River. The intake water from the cooling water stream from the FPL Ft. Myers facility will be the source water for the co-located desalination plant. The SFWMD does not regulate the consumption of seawater but does regulate the consumption or fresh or brackish water. In addition, the since the source water for the desalination facility will be a process water discharge from the FPL plant, there is a question of the need for a Consumptive Use Permit (CUP). It is assumed for the purpose of this study that a SFWMD CUP will be required. An outstanding issue is the pending Minimum Flow Rule for the Caloosahatchee River that may affect the permitting of a 10 or 25 mgd withdrawal. Since this rule is pending, the probability of obtaining a permit will be based on current rule criteria.

Likelihood of obtaining permit: ***Good***

FDEP Industrial Wastewater Facility Permit - The Ft. Myers site has an established cooling water discharge canal from the FPL into the Orange River. Assuming the historical and projected quantities of cooling water are available from the Ft. Myers plant, a sufficient amount of blending source may be available to support a 10 or 25 mgd finished water desalination plant. A Florida Department of Environmental Protection (FDEP) Industrial Wastewater Facility (IWWF) permit will be required for the concentrate discharge into the FPL Ft. Myers plant discharge canal. In addition to the salinity parameter discussed previously, the discharge will also be monitored, at a minimum, for the following parameters:

- Intake Flow
- Dilution Ratio
- Mixing Water Flow
- RO Discharge Flow
- Dissolved Oxygen
- Chlorides
- Conductivity
- Salinity
- Total Recoverable Copper
- Total Recoverable Iron
- Total Recoverable Nickel
- Combined Radium 226/228
- Gross Alpha
- pH
- Chronic Whole Effluent Toxicity

Likelihood of obtaining permit: ***Good***

FDEP Class I Injection Well Operation Permit – In the event a blended discharge cannot be permitted, a deep well injection system for disposal would be necessary. Deep well injection in Lee County has been permitted in the past but each permit must address site-specific criteria. Although no specific obstacles are currently known, deep well injection disposal systems can be difficult to permit, especially at higher volumes.

Likelihood of obtaining permit: Fair

SFWMD Standard General Environmental Resource Permit (ERP) – It is anticipated that stormwater management permits will be required from the SFWMD under a Standard General Environmental Resource Permit (<100 acres project site; $\leq$. 1.0 acre wetland impact). There is no anticipated wetland impacts associated with location of this plant site.

Likelihood of obtaining permit: Good

The United States Army Corps of Engineers (USACOE) Dredge and Fill Permit There are no anticipated wetland impacts associated with the location of this plant site or facilities.

Likelihood of obtaining permit: Not Required

U.S. Environmental Protection Agency (EPA) Notice of Intent for Stormwater Discharges Associated with Industrial Activity under the NPDES General Permit - Standard notification process to EPA with no notable permitting concerns for the projected site. SFWMD ERP stormwater permit should adequately satisfy the requirements for the EPA NPDES notification process.

Likelihood of obtaining permit: Good

Florida Department of Environment Protection (FDEP) Application for a Public Drinking Water Facility Construction Permit - Desalination facilities are commonly permitted as drinking water facilities. The reverse osmosis process is the most common process in Florida for producing drinking water from saline water. The facility design meets all applicable pollution prevention and potable water health protection standards required by FDEP.

Likelihood of obtaining permit: Good

FDEP Air Pollution Sources Permit – An air pollution control permit will be required for the lime silo facility.

Likelihood of obtaining permit: Good

ON-SITE CONSTRUCTION FACILITIES PERMITS

- Florida Department of Health (DOH)/ County Health Department On-Site Sewage Disposal Systems Construction Permit (if applicable)
- U. S. EPA Accidental Release Prevention Regulations
- Lee County Construction Permit

Likelihood of obtaining permits: Good

PIPELINE CONSTRUCTION PERMITS

- **ACOE Dredge and Fill Permit**
- **Florida Department of Environmental Protection (FDEP) Application for a Public Drinking Water Facility Construction Permit**
- **SFWMD Individual Environmental Resource Permit (ERP)**
- **Florida Department of Transportation (FDOT) Right-of-Way Use Permit**
- **U.S. Environmental Protection Agency (USEPA) Notice of Intent for Stormwater Discharges Associated with Industrial Activity under the NPDES General Permit**

Likelihood of obtaining permits: Good

It should be noted that if the desalination facility is located off site from the FPL Ft. Myers facility, but still utilizes the cooling water system for the co-location benefits, all of the above listed permits would still be required. The only foreseeable modification to the "ability to obtain a permit " ranking would be those associated with wetland impacts since the offsite location is not known. However, this permitting issue would be considered minor in the overall scope of the project.

ENVIRONMENTAL ISSUES

The Ft. Myers power plant site and its operation currently exhibits no outstanding environmental concerns with respect to locating a desalination facility. The power plant cooling water intake and discharge are currently not creating environmental problems. The plant maintains a successful Manatee Protection Plan. The desalination plant will only change the quality of the cooling water discharge slightly at the point of discharge into the cooling water canal and will be most likely be undetectable by the time the discharge enters the Caloosahatchee River. The RO process will not elevate the temperature of the cooling water discharge and the dissolved oxygen level will not be lowered. This will ensure that the benthic invertebrates located in the Caloosahatchee River will not be impacted.

The pending Minimum Flow and Level Rulemaking for the Caloosahatchee River does present an unknown with respect to a withdrawal of water from the river and a potentially slightly higher salinity. This potential environmental impact issue also would be based upon the size of the desalination facility and the final MFL Rule language.

The permitting process will handle all normally expected environmental issues such as wetland impacts, stormwater control, and hazardous waste management.

In summary, at this time, there does not appear to be any significant environmental issue that would materially affect the co-location of a desalination facility at the FPL Ft. Myers facility.

LAND USE COMPATIBILITY

Land uses surrounding the Ft. Myers power plant are primarily suburban and rural in nature, consisting of agriculture, low-density residential and low intensity commercial uses. The large power plant site is zoned as industrial property. The site of the proposed desalination plant is located in a cleared area to the immediate west of the cooling-water discharge canal to the north of SR 80. The location of the proposed desalination facility will act to buffer the existing power plant operations from the surrounding land uses. The relatively low profile of the proposed desalination plant will blend in with the adjacent power plant operations. The zoning (industrial) and future land use (industrial) designations of the proposed site are consistent with the construction and operation of a desalination plant.

SERVICE AREAS AND DEMAND

Potential Users

The service area for the Ft. Myers site was identified by locating utilities within Lee County. The plant site is located in Lee County, which has two major suppliers of potable water. The largest supplier, Lee County Utilities, supplies 40 percent of the permitted demand and Cape Coral Utilities supplies 32 percent. The remainder is served by a combination of the City of Ft. Myers and Gulf Environmental Services. Collectively, the utilities in the vicinity have a current total permitted water supply of 75.6 mgd.

Table 5-7: WATER SUPPLY PERMIT DATA FT. MYERS SERVICE AREA		
Utility	**Permit #**	**Average Daily Demands (MGD) Current Water Use Permit**
Ft. Myers Power Plant Service Area		
Lee County BOCC	36-00003-W	17.11
Lee County BOCC	36-00150-W	11.37
Lee County BOCC	36-00152-W	1.51
Lee County Utilities	36-00178-W	0.20
Cape Coral Utilities	36-00046-W	24.40
City of Ft. Myers	36-00035-W	16.14
Gulf Environmental Services	36-00122-W	4.83
		75.56
Phase 1 WS Reduction 15%		**11.33**
Phase 2 WS Reduction 30%		**22.67**
Phase 3 WS Reduction 45%		**34.00**

In one measure of future demand, a comparison of the quantities needed for SFWMD imposed water restrictions that would exempt saline water sources. Table 5-7 shows the quantities required to offset Phase I, II & III Water Shortage Restrictions to permitted quantities for collective utilities within the region.

- Phase I 11.33 mgd permit quantities reduction
- Phase II 22.67 mgd permit quantities reduction
- Phase III 34.00 mgd permit quantities reduction

Based on projected SFWMD Water Shortage reductions, a desalination source that was exempt from such restrictions could be justified for a quantity from 20-35 mgd.

Cost of water produced by desalination facilities

Total projected unit costs for the Ft. Myers facility ranged from an average (2 disposal options) of $1.55 per 1000 gallons for a 10 mgd facility to $1.33 per 1000 gallons for a 25 mgd facility. (Refer to Project Cost Summary Table 5-8) Each of these costs would be higher than costs currently incurred by the utilities in the projected service area of the Ft. Myers plant.

Cost of pumping and treating groundwater in Southwest Florida

The cost of pumping and treating raw water supplies in Southwest Florida can be estimated at only an order-of-magnitude level at this point. WRA contacted utilities in the Lee County area. The utilities provided very rough estimates of the cost of pumping and treating raw water, or the cost of providing water to end users less the cost of transmission, distribution, and related activities. The cost figures were not considered to be reliable due to lack of documentation by the utilities as provided to WRA. None of the utilities has conducted a recent study where this cost was specifically estimated.

Typical end user charges for potable water

A survey of water utilities in the vicinity revealed that average retail charges for potable water, on a cost per 1000-gallon basis was $3.25 per 1000 gallons in the area of the Ft. Myers Power Plant. The average was computed by calculating the monthly charge for a residential customer using 8,000 gallons of water. For some utilities, higher water use amounts result in a lower charge per 1000 gallons up to a point, followed by higher charges due to the imposition of increasing block rates. Basing the average charge per 1000 gallons on the monthly charge for 8,000 gallons per month is considered to be a reasonable basis for estimating average charges.

Effect of using desalination facility water on end user charges

Since the actual production cost of the Lee County service area utilities is not known, it is difficult to assess how much the cost would increase to augment the existing supplies with desalinated product from the Ft. Myers facility. The methods to determine retail cost from wholesale production cost vary greatly between utilities. At the projected cost of $1.62 to $1.87 per 1000 gallons for the finished desalinated water, it can be conservatively assumed that the incremental increase would be between $0.40 and $0.60 per 1000 gallons depending on the production capacity of the desalination facility. It should be noted that is highly unlikely that the residential consumer would be supplied solely by desalinated water, but rather a blended supply together with conventional sources. A residential customer using 8,000 gallons of water per month provided by a 50 percent desalinated water supply source could be expected to experience an increase in the monthly bill of between $1.60 and $2.40, which is a 6 and 9 percent increase respectively.

Table 5-8: SERVICE AREA UTILITIES COST COMPARISON	
Ft. Myers Power Plant Service Area Utilities	**Average Charge for Water (1)**
Lee County	$3.25 per 1000 gal
City of Cape Coral	
City of Ft. Myers	
Gulf Utilities	
Cost Impact to Customer	
Average Monthly Charge (8000 gallons)	$26.00
Incremental Cost for Desalinated Water ($ per 1000 gallons)	$0.40-$0.60
Average Monthly Charge with 50% Desalinated Water	$27.60-$28.40
Average Monthly Increase to Customer	$1.60-$2.40

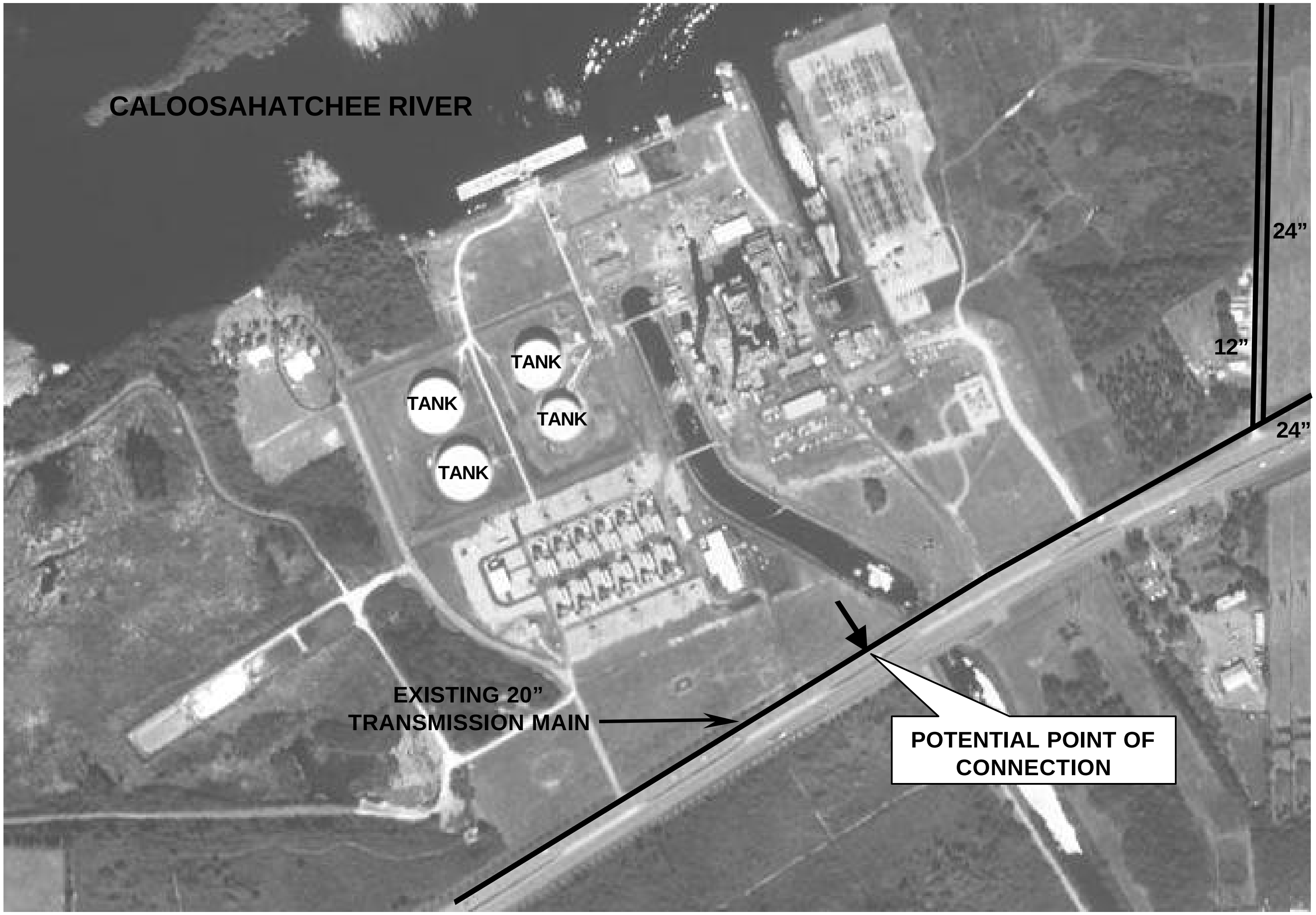
(1) Includes Base Charge

Points of Connection

According to the water atlas maps provided by Lee County Utilities, it appears that a potential point of connection to the existing water distribution system may be located directly south of the area where the brackish water RO facility would be constructed. Figure 5-29, illustrates the potential tie-in location, along with the existing transmission mains and the proposed product water main. As indicated in Figure 5-29, this area has 12-inch and 24-inch mains running north, beneath the Caloosahatchee River, towards North Ft. Myers, a 24-inch main running towards the east, and a 20-inch main running towards the west.

Depending on the design finished water flow, either a 24-inch or 36-inch product water main would need to be constructed for the 10 MGD and 25 MGD projected design flows, respectively. It appears that this product water main would be approximately 1500 ft. in length to the tie-in point along the north right-of-way on State Road 80

Lee County has five (5) water treatment plants currently in service. Each of the service areas connects with the adjacent service areas. There is also a metered water main interconnect between the City of Cape Coral and Lee County Utilities.



Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-29: **FT. MYERS PRODUCT WATER MAIN**
POTENTIAL POINT OF CONNECTION
TO EXISTING DISTRIBUTION SYSTEM

Prepared For:
South Florida Water Management District
Florida Power & Light Company

CAPITAL, O&M and LIFE CYCLE COSTS

All estimated costs for the Ft. Myers co-located desalination facility were evaluated using the Desalination Feasibility Cost Planning Model (Model) developed specifically for this study. The Model is described further in Section 4.2.

Assumptions made for the cost evaluation:

1. The desalination facility will be located on the FPL Ft. Myers Power Plant site.
2. The power plant cooling water will be used for the desalination facility source water.
3. The desalination plant will run continuously based upon the power plant providing source water.
4. The desalination facility will utilize the power plant cooling water discharge facilities for a blended discharge.
5. The source water quality will be based on 15,000 ppm TDS, the average salinity for the Caloosahatchee River at the point of power plant intake.
6. The desalination facility will be costed based on two disposal options:

    a. Discharge Option I - Blended discharge with power plant cooling water
    b. Discharge Option II- Deep well injection

Ft. Myers Desalination Facility

Model Input Parameters

Source Water

Type:	Cooling water from FPL Ft. Myers Power Plant
Quality:	15,000 ppm TDS
	(Average salinity for Caloosahatchee at power plant intake)
Temperature	87.8 degrees F
Distance to source water:	950 feet
Land cost for intake pipeline:	$3000 per acre – annual lease rate

Finished Water	
Quantity of finished water:	10 mgd & 25 mgd
Quality:	250 ppm TDS
Distance to point of interconnection:	1500 feet (0.28 miles)
Land cost for transmission pipeline:	$50,000 per acre purchased easement
Electric Power	
Cost of energy:	$0.048 per kWh (Interruptible power rate)
Concentrate Disposal	
Option I:	Blended discharge
Distance to disposal point:	950 feet (0.28 miles)
Land cost for disposal pipeline:	$3000 per acre - annual lease rate
Concentrate Disposal	
Option II:	Deep well injection
Distance to disposal point:	5280 feet (1.0 miles)
Land cost for disposal pipeline:	$50,000 per acre - purchased easement
Land For Desalination Facilities	
Cost:	$3000 per acre annual lease rate
Financial	
Type of ownership:	Private and public options evaluated
Subsidies:	None
Rate of growth:	2.5%
Interest rate:	5.20% for both 30 and 50 year terms
Inflation rate:	3.20%
Sales tax:	6.50%
Contingency:	25%

Cost estimates based on the above input parameters and assumptions yield the following:

TABLE 5-9: SUMMARY OF FT. MYERS FACILITY LIFE CYCLE COSTS							
Plant Capacity (mgd)		**Concentrate Discharge Option**		**Life Cycle (years)**		**Cost ($ per 1000 gal)**	
10	**25**	**Blended**	**Deep Well**	**20**	**50**	**Private Ownership**	**Public Ownership**
X		X		X		$1.36	
X		X			X	$1.58	
X		X		X			$1.34
X		X			X		$1.56
X			X	X		$1.73	
X			X		X	$1.87	
X			X	X			$1.67
	X		X		X		$1.84
	X	X		X		$1.18	
	X	X			X	$1.38	
	X	X		X			$1.16
	X	X			X		$1.39
	X		X	X		$1.48	
	X		X		X	$1.62	
	X		X	X			$1.43
	X		X		X		$1.60

Table 5-10: CAPITAL, O&M & LIFE CYCLE COSTS					
COST COMPONENT	UNITS	FT. MYERS			
		10 mgd Discharge Option I	10 mgd Discharge Option II	25 mgd Discharge Option I	25 mgd Discharge Option II
INPUT DATA					
Source Water					
Source Type		Cooling Water	Co-Located	Cooling Water	Co-Located
Quantity	mgd	16.70	16.70	35.7	35.7
Quality	ppm TDS	11,000 - 18,999	11,000 - 18,999	11,000 - 18,999	11,000 - 18,999
Temperature	^{o}F	86.0 - 95.0	86.0 - 95.0	86.0 - 95.0	86.0 - 95.0
Distance to Source	lineal feet	950	950	950	950
Land Cost for Intake Pipeline	$ per acre	$3,000	$3,000	$3,000	$3,000
Finished Water					
Quantity **(1) (2)**	mgd	10.00	10.00	25.00	25.00
Quality	ppm TDS	250	250	250	250
Distance to Point of Use	miles	0.28	0.28	0.28	0.28
Land Cost for Transmission	$ per acre	$50,000	$50,000	$50,000	$50,000
Electric Power					
Cost of Energy	cents/kWh	4.80	4.80	4.80	4.80
Concentrate Discharge					
Method		**Blended Surface**	**Injection Well**	**Blended Surface**	**Injection Well**
Injection Wells Required		0	2	0	4
Quantity **(1) (2)**	mgd	6.70	6.70	16.75	16.75
Distance to Discharge Point	lineal feet	950	5,280	950	5,280
Land Cost for Discharge Pipeline	$ per acre	$3,000	$50,000	$3,000	$50,000
Land for Plant Site					
Acquisition Method		Purchase	Purchase	Purchase	Purchase
Cost of Plant Site Land	$ per acre	$3,000	$3,000	$3,000	$3,000
Financial					
Type of Ownership		**Private**	**Private**	**Private**	**Private**
Subsidies		$0	$0	$0	$0
Rate of Growth		2.50%	2.50%	2.50%	2.50%
Nominal Interest Rate		5.20%	5.20%	5.20%	5.20%
Inflation Rate		3.20%	3.20%	3.20%	3.20%
Sales Tax		6.50%	6.50%	6.50%	6.50%
Contingency		25.00%	25.00%	25.00%	25.00%

(1) Calculated value based on projected system yield

(2) The calculated values for the source water and concentrate quantities will vary from the actual design values due to the approximation of an average yield for a range of source water quality inputs for the Model.

Table 5-10: CAPITAL, O&M & LIFE CYCLE COSTS					
COST COMPONENT	UNITS	FT. MYERS			
		10 mgd Discharge Option I	10 mgd Discharge Option II	25 mgd Discharge Option I	25 mgd Discharge Option II
OUTPUT DATA					
CAPITAL COSTS					
Intake System					
Surface Water Pump Station		$1,942,160	$1,942,160	$3,770,454	$3,770,454
Raw Water Structure		$354,993	$354,993	$557,977	$557,977
Intake Pipeline		$96,391	$96,391	$210,547	$210,547
Supply Well System		$0	$0	$0	$0
Pretreatment					
Process Equipment		$60,000	$60,000	$60,000	$60,000
R.O. Process					
Membrane System		$1,944,444	$1,944,444	$4,861,111	$4,861,111
Pumps		$960,000	$960,000	$2,100,000	$2,100,000
Energy Recovery System		$361,548	$361,548	$786,677	$786,677
Post-treatment					
Process Equipment		$75,000	$75,000	$75,000	$75,000
Concentrate Discharge					
Pump Station		$860,133	$905,403	$1,719,367	$1,809,860
Pipeline		$94,456	$552,605	$166,493	$974,054
Deep Wells		$0	$8,000,000	$0	$16,000,000
Infrastructure					
Building		$900,000	$900,000	$2,250,000	$2,250,000
Site Work		$576,000	$576,000	$1,080,000	$1,080,000
Land					
Plant Site		$15,000	$15,000	$36,000	$36,000
Intake Pipeline		$2,290	$2,290	$3,271	$3,271
Discharge Pipeline		$1,636	$151,515	$2,290	$212,121
Transmission Pipeline		$50,909	$50,909	$59,394	$59,394
Transmission					
Pump Station		$1,225,497	$1,225,497	$2,449,712	$2,449,712
Ground Storage Tank(s)		$1,650,000	$1,650,000	$2,600,000	$2,600,000
Transmission Pipeline		$206,976	$206,976	$348,163	$348,163
Professional Services					
Engineering		$910,195	$1,602,459	$1,850,917	$3,219,547
Permitting		$227,549	$400,615	$462,729	$804,887
Legal		$113,774	$200,307	$231,365	$402,443
Capital Cost Totals					

Table 5-10: CAPITAL, O&M & LIFE CYCLE COSTS					
COST COMPONENT	UNITS	FT. MYERS			
		10 mgd Discharge Option I	10 mgd Discharge Option II	25 mgd Discharge Option I	25 mgd Discharge Option II
Subtotal		$12,628,951	$22,234,113	$25,681,467	$44,671,220
Contingency		$3,157,238	$5,558,528	$6,420,367	$11,167,805
Sales Tax		$739,533	$1,301,998	$1,503,870	$2,615,882
Subsidies		$0	$0	$0	$0
Net Total		$16,525,722	$29,094,638	$33,605,703	$58,454,907
Capitalized Interest		$429,669	$756,461	$1,310,622	$2,279,741
Cost of Financing		$508,662	$895,533	$1,047,490	$1,822,039
Construction Insurance		$661,029	$1,163,786	$1,344,228	$2,338,196
Grand Total		$18,125,081	$31,910,417	$37,308,044	$64,894,884
OPERATION AND MAINTENANCE COSTS	**dollars/year**				
Pretreatment					
Chemicals		$304,009	$304,009	$760,386	$760,386
Post-treatment					
Chemicals		$111,956	$111,956	$280,294	$280,294
R.O. Process					
Replacement Membranes (Annualized Over 20 Years)		$228,661	$228,661	$571,653	$571,653
Replacement Membranes (Annualized Over 50 Years)		$365,876	$365,876	$914,690	$914,690
Water Quality Monitoring					
Monitoring of Concentrate and Product Water		$28,444	$50,077	$57,841	$100,611
Energy Consumption					
Power		$1,108,800	$1,108,800	$2,772,000	$2,772,000
Operation and Maintenance					
Replacement Parts		$291,967	$304,230	$575,959	$600,484
Plant Site Lease		$0	$0	$0	$0
Labor		$420,000	$420,000	$560,000	$560,000
Operating Insurance		$165,257	$290,946	$336,057	$584,549
O&M Cost Totals					
Annualized O&M (Based on 20-Year Life Cycle)		$3,491,381	$3,705,616	$7,743,711	$8,167,637
Annualized O&M (Based on 50-Year Life Cycle)		$4,736,053	$5,023,005	$10,521,144	$11,088,961
LIFE CYCLE PROJECT COSTS					
Based on 20-Year Life Cycle					
Total Capital Cost		$18,125,081	$31,910,417	$37,308,044	$64,894,884

Table 5-10: CAPITAL, O&M & LIFE CYCLE COSTS					
COST COMPONENT	UNITS	FT. MYERS			
		10 mgd Discharge Option I	10 mgd Discharge Option II	25 mgd Discharge Option I	25 mgd Discharge Option II
Annualized O&M Cost	dollars/year	$3,491,381	$3,705,616	$7,743,711	$8,167,637
20-Year Life Cycle Cost	per 1000 gal.	$1.36	$1.73	$1.18	$1.48
Based on 50-Year Life Cycle					
Total Capital Cost		$18,125,081	$31,910,417	$37,308,044	$64,894,884
Annualized O&M Cost	dollars/year	$4,736,053	$5,023,005	$10,521,144	$11,088,961
50-Year Life Cycle Cost	per 1000 gal.	$1.58	$1.87	$1.38	$1.62
Public Ownership (3)					
LIFE CYCLE PROJECT COSTS					
Based on 20-Year Life Cycle					
Total Capital Cost		$17,273,327	$30,410,847	$35,514,499	$61,775,132
Annualized O&M Cost	dollars/year	$3,499,329	$3,707,024	$7,763,422	$8,174,419
20-Year Life Cycle Cost	per 1000 gal.	$1.33	$1.67	$1.16	$1.43
Based on 50-Year Life Cycle					
Total Capital Cost		$17,273,327	$30,410,847	$35,514,499	$61,775,132
Annualized O&M Cost	dollars/year	$4,855,800	$5,140,313	$10,790,325	$11,353,333
50-Year Life Cycle Cost	per 1000 gal.	$1.58	$1.84	$1.39	$1.60
(3) Public ownership deletes sales tax and reduces financing interest rate by 0.50%					

5.3.3. PORT EVERGLADES

POWER PLANT OPERATIONS DESCRIPTION

Location

The Port Everglades Plant is located at 8100 Eisenhower Boulevard, Ft. Lauderdale, Broward County.

Generating Equipment

This facility consists of four fossil fuel-fired units and twelve older simple cycle gas turbines. Units 1 and 2 are capable of burning natural gas and fuel oil. Unit 1 began commercial operation in 1960, with Unit 2 following in 1961. Units 3 and 4, are also capable of burning the same fuels. Unit 3 began commercial operation in 1964, with Unit 4 following in 1965. The twelve simple cycle gas turbines, with a total capacity rated at 420 MW, are capable of burning fuel oil and natural gas.

Dispatch

The plant is dispatched as a seasonal base load plant. The smaller Units 1 and 2 are dispatched in cycling service, and Units 3 and 4 are typically dispatched as base load units. Units are often kept in "hot standby" during the winter. According to plant personnel, either Unit 3 or 4 is always in operation. There are no present plans for repowering.

Cooling Water System

The 94-acre FPL Port Everglades site is located to the southwest of Ft. Lauderdale Inlet and uses Lake Mabel on the Atlantic Intracoastal Waterway (Class III Waters) for its source of once-through cooling water. The plant has an intake structure located in a man-made canal drawing water from slip number 3 of Port Everglades. Salinity is expected to range from 31,000 to 33,000 ppm TDS. The intake canal is in an industrialized area and may be subject to periodic light oil and grease contamination requiring a skimmer; however, since the facility's intake structure is fitted with an oil/grease skimmer, this does not appear to be a concern.

There are two inlet pipes/pumps per unit. Units 1 and 2 cooling water flow rates are 216,000 gpm each (311 MGD each) and Units 3 and 4 have cooling water flows of 254,000 gpm each (366MGD each).

The facility has eight discharge structures located along a man-made canal within the site. The annual average flow rate is 1,164 MGD. Since plant personnel stated that at least one of the larger units is on-line all the time, an average cooling water flow of 366 mgd would be available for dilution of R.O concentrate. The discharge travels through the canal to discharge into the Intracoastal Waterway. The discharge canal provides significant mixing area prior to the regulatory Point of Discharge.

The plant's FDEP Industrial Wastewater Facility (IWWF) permit does not have a dissolved oxygen reporting or compliance condition. It does have a temperature reporting condition, but there is no set temperature limit. Cooling water discharge temperature varies according to the season. No chemicals or chlorination are used in the cooling water systems. The plant is in full compliance with all environmental operating permits. There are no outstanding compliance issues.

The facility operates with a Manatee Protection Plan, but does not have an observation area established for manatee viewing. However, manatees can come all the way into the discharge canal during the winter months.

TREATMENT TECHNOLOGY

SEAWATER DESALINATION REVERSE OSMOSIS PROCESS

Based on information provided by FPL, the salinity of the feedwater for the Port Everglades facility would be expected to range from approximately 31,000 ppm to 33,600 ppm TDS, which is approximately the same as what is generally considered normal seawater salinity of about 34,500 ppm TDS. Based on this information, the Port Everglades facility would be generally considered a seawater reverse osmosis (SWRO) desalination facility. Since the feedwater salinity is slightly lower than normal seawater, it may be possible to obtain slightly higher product water yields than would be obtained for normal seawater.

The first SWRO membranes capable of reducing the high chloride concentrations contained in seawater to below 250 mg/L (the secondary standard) in a single pass were developed in the mid 1970's. Prior to that time, SWRO membranes were essentially high rejection brackish water membranes, and the permeate, or part of it, needed to be further desalted in a second pass, increasing both capital and operating costs.

The generally accepted product water recovery for a SWRO desalination facility required to produce water of 250 mg/L or less in a single pass from standard seawater is around 50% (with the feedwater at ambient temperature). Under certain circumstances, recovery may be increased, but this will result in higher energy usage and increased salinity in the permeate water, unless a second pass is utilized. At 50% recovery, the permeate flow is approximately equal to the feedwater flow, so for a 25 MGD plant, approximately 50 MGD of feedwater would require pretreatment.

Since the seawater feed is a surface water source, effective pretreatment of the feedwater is essential to long-term efficiency in desalting by SWRO membranes. Pretreatment for RO must accomplish two primary objectives; reduce the feed water turbidity and the SDI (Silt Density Index, a fouling test specific to RO), and reduce bio-fouling potential. The standard method of seawater pretreatment includes two-stage media filtration, with a ferric salt used as a coagulant.

An alternative pretreatment has been discussed and pilot tested in recent years, and has reportedly been used in the Middle East. This alternative is the use of membrane filtration, either micro-filtration or ultra-filtration, in lieu of the standard approach. This technology may reduce the frequency of which the RO membranes are cleaned. Since ultra-filtration rejects bacteria so well, the need for chlorination/dechlorination may not be required.

Alternative pretreatment processes and technologies that eliminate the need for biocides may also be used. For example, ultraviolet light may be used instead of chlorination/dechlorination to inactivate biological organisms. Ultraviolet light is more expensive than biocides, but is an effective control method that reduces the risk of membrane damage by chlorine. Other strategies are also available, but as yet have not been widely used on anything but very small systems.

In SWRO plants, cleaning the membranes will produce dilute chemical wastes. The membranes must be cleaned to maintain their performance at intervals from three to six months, depending on feedwater quality and plant operation. The membrane cleaning formulations are usually dilute alkaline or acid aqueous solutions. In addition, a preservative solution must be used if the membranes are stored while a plant is shut down. These chemicals should be treated before discharging to the receiving waters to remove any potential toxicity.

After pretreatment, the filtered seawater passes through cartridge filters, normally fitted with cartridges that have a nominal rating of 5 microns (5/1000th of a millimeter). These filters are present solely for protecting the membranes from a sudden upset in the raw water source. Such an upset can cause high turbidity and suspended solids, which will plug the membranes if they are left unprotected.

After passing through the cartridge filters, the water is pressurized and introduced to the SWRO membranes at pressures of approximately 800-1000 psig. These pressures are usually generated from the use of high-horsepower, horizontal split-case pumps. As a means of reducing energy usage, these pumps are routinely fitted with energy recovery turbines, which can reduce the feed water pumping power needs by 30 to 40%. To ensure that maintenance and replacement costs are minimized, special attention must be given to the selection of the materials that are wetted by the seawater, such as pumps, piping and valves.

The permeate from SWRO membranes is essentially a very dilute solution of sodium chloride, and requires the addition of calcium hardness and bicarbonate alkalinity prior to use in drinking water distribution systems. One approach is to blend the permeate with water from another source that contains higher levels of hardness and alkalinity. Pure permeate is acidic and is very corrosive to ferrous piping, so it needs to be stabilized. The typical post-treatment method is to add lime to the permeate, in the presence of carbon dioxide.

Since the introduction of the SWRO membrane, approximately 60% of the world's SWRO desalination plants have been constructed in the Middle East. The world's largest desalination plant is located in Saudi Arabia and produces approximately 250 million gallons per day (MGD) of desalted water by the use of a multi-stage flash process. The largest SWRO desalination plant is located in the Middle East, and produces approximately 40 MGD. About 12% of the world's desalination plants are located in the Americas and most of these are located in Florida (utilizing brackish water) or the Caribbean (utilizing seawater). Several other facilities have been constructed in other parts of the United States.

The first large SWRO desalination facility in the United States is currently under construction at the Tampa Electric Company's Big Bend Power Station site located near Apollo Beach in southern Hillsborough County, and is scheduled to be in operation by December 31, 2002. The plant will produce 25 MGD of water initially and may be expanded in the future to produce 35 MGD. When operational, it will be the largest seawater desalination facility in North America. Tampa Bay Desal, LLC, a subsidiary of Poseidon Resources Corporation, is the developer and owner of the project and will sell the desalinated water to Tampa Bay Water, the region's governmental agency that provides wholesale water to the greater Tampa Bay area. Covanta Water (formally Ogden Energy Group) is constructing the facility, and will be responsible for operating the plant.

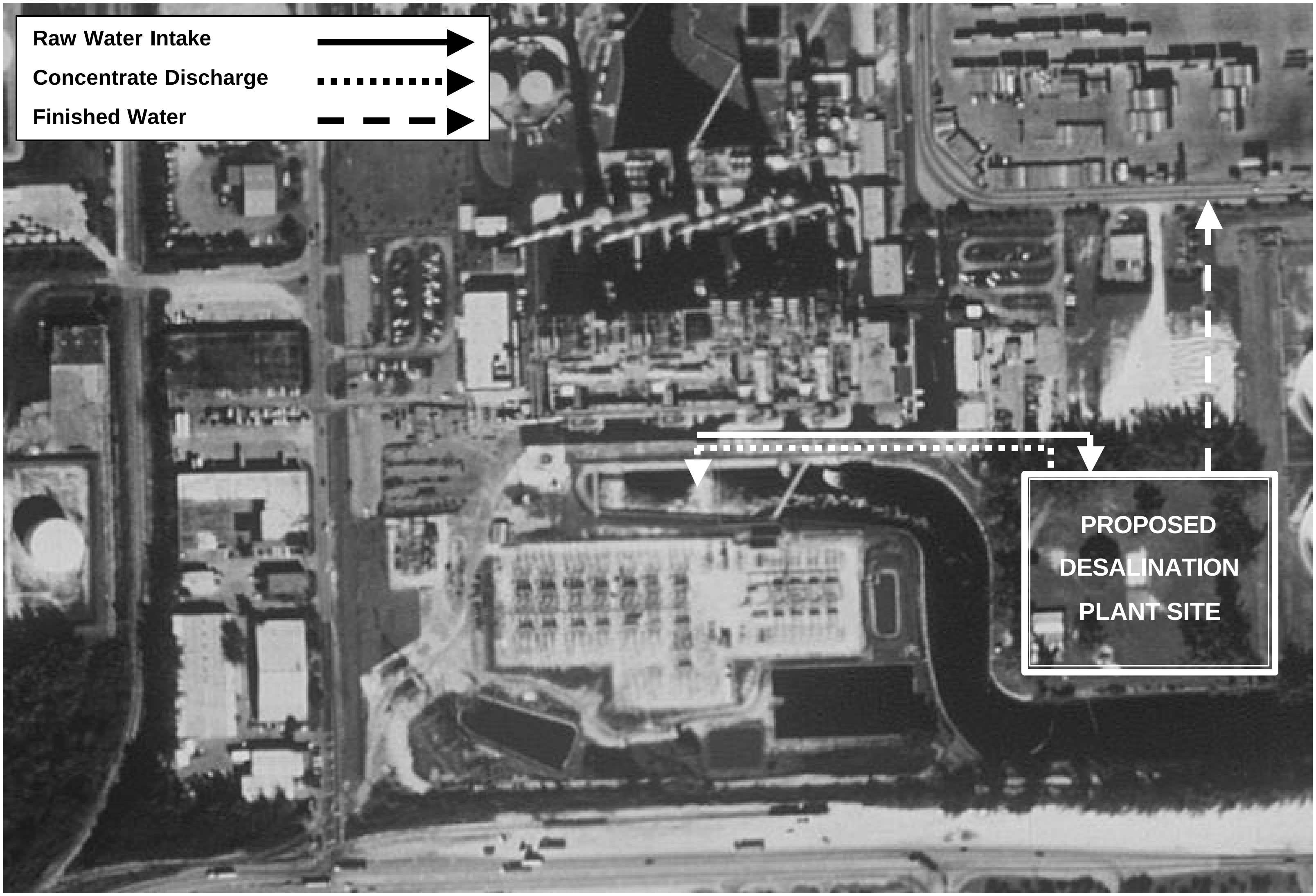
The Tampa Bay facility will be unique in several ways. Since the facility will be co-located with an existing power plant, it will use condenser cooling water that is discharged from the power plant as feedwater, resulting in a relatively high feedwater temperature. The high feedwater temperature will be beneficial in terms of both reducing energy needs and increasing permeate recovery rates; however, the high feedwater temperatures will increase the permeate salinity. The feedwater salinity for the facility is expected to range from approximately 18,000 mg/L to 32,000 mg/L. Although this is lower than normal seawater levels, a second pass will be in operation most of the time due to the increased temperature and salt passage, so that the maximum allowable chloride level of 100 mg/L is to be maintained. The overall system will use a patented design that separates the first pass permeate into low and high salinity streams, which will reduce the size of the second pass. The use of a second pass will allow some of the high chloride water from the first pass to become permeate, thus increasing the product water to feedwater ratio. The product water recovery relative to feedwater for the Tampa Bay facility is predicted to be about 60%.

During the past few years, the technology for SWRO desalination has advanced significantly. The greatest benefit from the technological advances is the potential for cost reduction in desalted water. It is likely that further improvements in pretreatment technology will lead to further reduction in operating costs. Although the cost of water produced by seawater desalination will most likely always be higher than water produced from groundwater or surface water treatment facilities, it appears that seawater desalination is becoming a more viable option.

DESALINATION PLANT OPERATIONS

The Port Everglades Power Plant has adequate land available (approximately 7 acres) for the construction of a SWRO desalination facility. The site is surrounded by port-related and other industrial land uses. Numerous parcels near the existing power plant site appear to be suitable for the co-location of a desalination plant. The most ideal of these parcels is located to northeast of the cooling water discharge canal on an approximately four-acre site. Additional land (approximately 5 acres) to the immediate east could possibly be used once the unused fuel storage tanks are removed. A potential location exists along the eastern side of the facility's discharge canal, which is in close proximity to the power plant's condenser cooling water discharge system. (Refer Figure 5-30) This system could potentially serve as both an intake and discharge for the SWRO desalination facility. According to information provided by FPL, the depth of the discharge canal near the power plant is approximately 11 feet.

As illustrated on Figure 5-31, the desalination process would begin with the extraction of the heated seawater from the discharge side of the power plant's condenser cooling water system. A chlorination system would be incorporated into the feedwater pumping station for intermittent



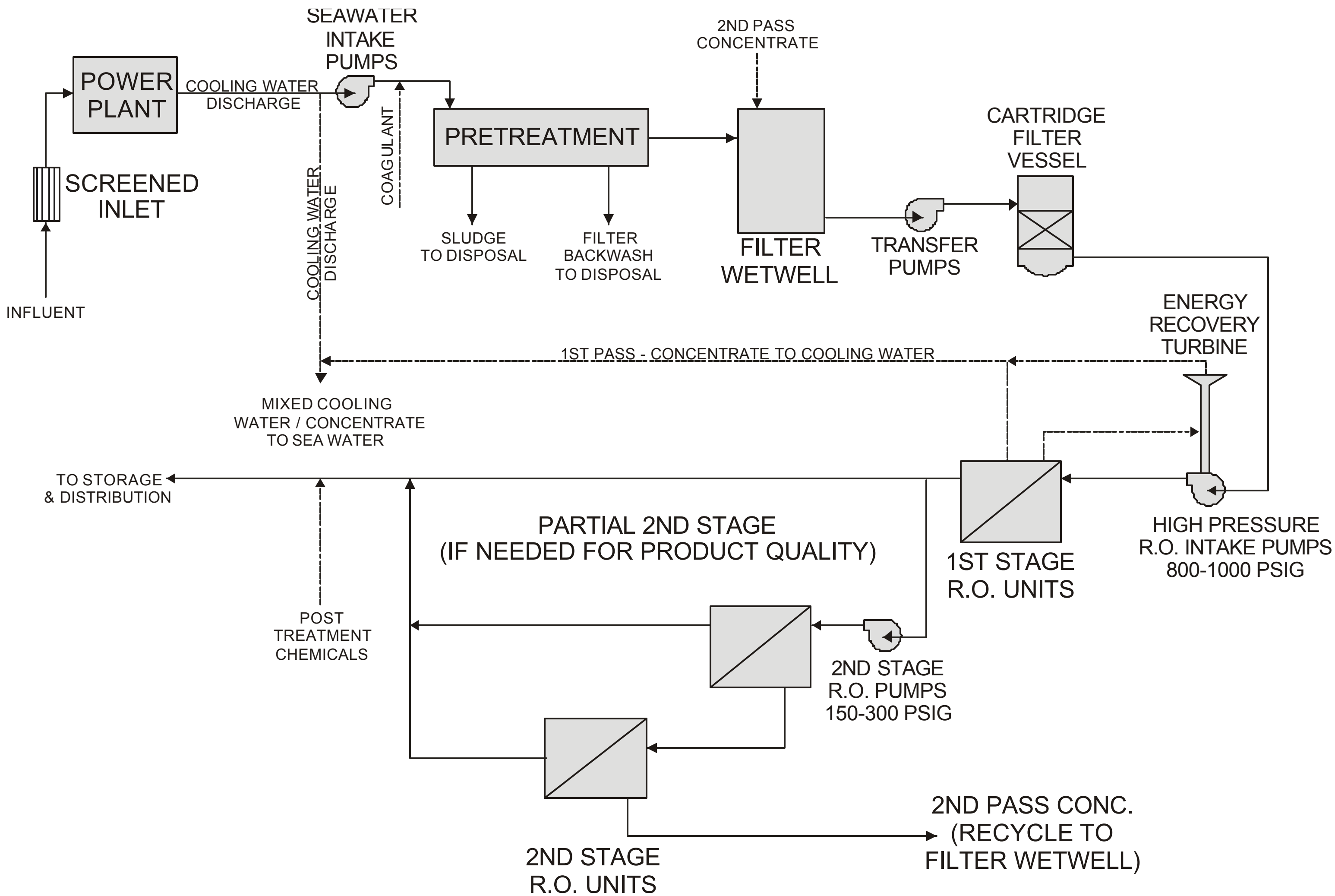
WRA

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-30:

CONCEPTUAL DESALINATION PLANT CONFIGURATION,
PORT EVERGLADES SITE

Prepared For:
South Florida Water Management District
Florida Power & Light Company



WRA

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-31:

PORT EVERGLADES FACILITY

PRELIMINARY PROCESS SCHEMATIC

Prepared For:

South Florida Water Management District

Florida Power & Light Company

shock chlorination of the pretreatment system. This system would be used to control bio-fouling in the feedwater system up to the inlet to the RO membranes. Since RO membranes cannot tolerate chlorine, a dechlorination system would be required. The raw water volume pumped would be slightly greater than the feedwater volume required, due in part to the water needed for backwashing the pretreatment filtration system, which is usually about 2-5% of the filter capacity.

After the addition of the coagulant to the raw water, the water would then enter the first bank of a two-step filtration system. After leaving the second bank of filters, the filtered water would be stored in a filtered water wet well, from which low head vertical turbine pumps would deliver the feedwater at about 30-50 psig to the cartridge filters and then to the high pressure RO feed pumps. Sulfuric acid may be added upstream of the cartridge filters, for carbonate scale control, and to provide carbon dioxide for the post-treatment step. The RO feed pumps would be horizontal multistage pumps, electric motor driven, with energy recovery turbines (ERTs) fitted to the end opposite the motor. Because of hydraulic losses through the RO membrane assemblies, the ERTs accept the RO concentrate at about 40 psig lower pressure than the feedwater entering the RO unit. Approximately 50% of the feedwater would then become concentrate, and the ERTs would recover about 85% of the energy available in the concentrate stream. ERTs may reduce the energy requirement of the high pressure RO feed pumps by about 30-40%.

As discussed earlier, part of the permeate may be treated in a second pass unit. The second pass concentrate would return to the filtered feed water wet well, and the permeate would be combined with the untreated portion of the first pass permeate, in preparation for post treatment.

RO plant operations would be conducted on a 7-day per week, 24-hour day schedule. This continuous schedule maximizes the efficiency of the plant and provides the greatest utilization of the capital investment, which is significant. The plant design will include adequate storage facilities for unexpected interruptions of the power plant, desalination plant or receiving potable water utility systems. In contrast to a continuous operation of the RO plant, an off-peak operation would be an operation only if the demand for the water supply was periodic or other limitations applied such as lack of available power or manpower. This was not the case for this location.

SOURCE WATER QUALITY

Based upon sampling data obtained from June 8, 1995 to June 10, 1995, (NPDES No. FL0001538), approximately 1.2 billion gallons per day (BGD) of once-through cooling water and auxiliary equipment cooling water. This water is currently discharged, via canal, to the Intracoastal Waterway. The referenced sample contained approximately 33,600 ppm salinity during the testing period. Based on data obtained during 2000, the monthly average discharge temperatures for the units indicate a high temperature of 98°F and an annual average discharge temperature of 89°F. The annual average cooling water flow rate was 1.164 BGD in 2000.

Toxicity tests were performed on the sample in accordance with methods described by Weber, 1993, *"Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, 4th Edition"*, (EPA/600/4-90/027F). The test species used for the bioassays were the Mysid Shrimp, *Mysidopsis Bahia*, and the Inland Silverside, *Menidia Beryllina*. The sample of effluent collected from the Port Everglades Power Plant on June 7, 1995 did not indicate any toxicity.

Based on recent information provided by FPL, the salinity of the feed water is expected to range from 31,000 ppm to 33,600 ppm TDS. These values are slightly below what is generally considered normal seawater salinity of about 34,500 ppm TDS (Principles of Desalination, Second Edition – Academic Press, 1980). The major ions in seawater are sodium and chloride, which together account for over 75% of the total ions.

Table 5-11 summarizes the composition of normal seawater, and provides estimates of the composition of the seawater available at the Port Everglades plant, based on the aforementioned ranges.

Table 5-11: SUMMARY OF THE COMPOSITION OF PORT EVERGLADES FEEDWATER			
Component	**Seawater (34,500 mg/L)**	**Port Everglades (31,000 mg/L)**	**Port Everglades (33,000 mg/L)**
Na^+	10,561	9,490	10,100
K^+	380	341	363
Ca^{++}	400	359	382
Mg^{++}	1,272	1,143	1,217
HCO_3^-	140	128	134
SO_4^-	2,650	2,381	2,534
Cl^-	18,980	17,054	18,154
Br^-	65	58	62
Other	34	31	32
Totals	34,482	30,985	32,978

Since coastal seawater is influenced by fresh water from various sources, the ionic compositions estimated for Port Everglades may not be representative of the actual seawater that would be encountered. However, the prediction of SWRO performance is primarily based on the concentrations of sodium and chloride, which are the most difficult to reject in an RO membrane, and the TDS, which establishes the osmotic pressure of the water. Based on these facts, the ion compositions shown above provide a reasonable level of accuracy, and were used as inputs for the various membrane performance models.

It is important to note that the feed pressure requirement for SWRO membranes is significantly impacted by the feedwater temperature. The higher the temperature, the lower the pressure required to produce the design flow and the higher the salt passage through the membrane. For Port Everglades, the annual average power plant condenser discharge temperature was reported as 89^{o}F (31.6^{o}C), with a summer maximum of 98^{o}F (36.7^{o}C). The higher temperature is well within the upper temperature limit of the membrane (40^{o}C). Therefore, it may be possible to design the Port Everglades facility without the use of a cooling water loop connected to the condenser inlet water (a cooling water loop was a requirement for the Tampa Bay facility). The average annual temperature is used for conceptual process design, while the high temperature will determine the worst case permeate quality and will determine the need for a partial second pass treatment unit.

PRETREATMENT REQUIREMENTS

Since the Port Everglades site would use essentially “normal” seawater as its feedwater source, a standard method of seawater pretreatment including two-stage media filtration, with a ferric salt as a coagulant would be utilized. Other chemicals that may be used include sulfuric acid and/or a synthetic scale inhibitor. Sulfuric acid would be added if carbonate scale control is needed, while a scale inhibitor may be used to control the precipitation of insoluble metal sulfates. The use of a scale inhibitor allows higher permeate recovery in terms of yield from the feedwater source, thus preserving the resource and lowering energy needs. Since algae and bacteria could grow in a facility such as this, a biocide (usually chlorine) would be required. Since RO membranes cannot tolerate chlorine, dechlorination techniques would be implemented.

A coagulant, such as ferric chloride, would be used as part of the pretreatment process to cause particles in the feedwater to form larger masses (floc) that can be removed with filters before the introduction of the water to the RO membranes. The pretreatment filters would be backwashed with filtered seawater periodically, producing a sludge that contains the suspended solids and filter coagulant chemicals. The sludge would then be dewatered and hauled to a landfill.

PRODUCT WATER YIELD AND POST TREATMENT

A membrane performance model, for a single pass SWRO system operating at 50% recovery, provided the following:

Temperature	89^{o}F	98^{o}F
Feed Pressure	860 psig	837 psig
Permeate TDS	367 mg/L	425 mg/L

The product quality goal for this feasibility study has been set at 250 mg/L TDS. The permeate from an SWRO treatment plant is essentially all sodium chloride, with a low pH. The pH of the product water would be adjusted, and the water stabilized by the addition of calcium hardness and bicarbonate alkalinity. A calcium hardness goal of 40 mg/L is considered suitable for stabilization. The equivalent bicarbonate alkalinity is 49 mg/L, corresponding to a TDS of 76 mg/L. Thus, the permeate quality from the Port Everglades plant must be not greater than 174 mg/L (250 mg/L – 76 mg/L = 174 mg/L).

The permeate quality at the average and high temperatures is predicted to be 367 mg/L and 425 mg/L, respectively. Since the TDS concentration is limited to 250 mg/L in the product water, a second pass RO unit would be required to further treat part of the permeate from the seawater. This system would be sized to maintain the finished water quality at the worst-case scenario, which would correspond to the maximum temperature condition. The permeate quality from the second pass will be less than 20 mg/L TDS. To maintain the required quality of the finished water, between 50% and 60% of the first pass permeate would need to be treated at the high temperature condition.

This partial second pass would consist of a high recovery, high rejection brackish water RO system. Because the feedwater contains virtually all sodium chloride, there is no scaling potential. Therefore the second pass can operate at high recovery (usually 90-95%), and the concentrate can be recycled with the filtered seawater feed, reducing the volume of seawater that would need to be pretreated. Since the second pass feedwater consists solely of RO permeate, pretreatment would not be needed for the second pass feedwater. Therefore, the second pass system would consist solely of a booster pumps, and membrane arrays.

Post treatment would consist of chemical addition for stabilization and pH adjustment, and disinfection with chlorine. Because both calcium and bicarbonate alkalinity would be needed in the finished water, lime addition is assumed as the post treatment chemical used. However, for lime to form bicarbonate alkalinity carbon dioxide is also required. This could be added in the post treatment area prior to the lime addition, or could be generated by acid addition to the feed seawater. The latter is usually the least expensive approach, and was assumed for this feasibility study.

CONCENTRATE MANAGEMENT

The Port Everglades site is well suited for a blended surface water discharge. The site has adequate cooling water flow and the current discharge is located near an open ocean location. The open ocean location means the receiving water will not be subject to SFWMD Minimum Flows Rules or consumptive use rules that could limit future discharges.

The discharge of concentrate would be required to meet all aspects of the Florida Department of Environmental Protection (FDEP) Antidegradation Policy. The Antidegradation Policy contained in FDEP Rules 62-302.3000 and 62-4.242.F.A.C. The basis of the Policy is that new or expanded discharges pass the public interest test in addition to meeting all other FDEP rules. The discharge is not allowed to degrade the quality of the receiving waters below the state standards. Passing the public interest test would require that other alternative disposal methods are not economically and technologically feasible. Providing a safe and reliable drinking water source is a positive factor in a public interest test determination.

The discharge limits for a concentrate discharge would be limited by two factors. The first is the ability of the discharge to pass the whole effluent toxicity standard. Since the RO process does not introduce toxic substances into the concentrate stream, the possibility of toxicity is solely associated with the level of salinity. Research completed in 1995 by the Southwest Florida Water Management District (SWFWMD) for the purpose of establishing the toxicity of a seawater concentrate discharge showed the dilution necessary to meet the FDEP whole effluent toxicity limits for discharge. Results of the test indicated that a seawater concentrate diluted to 45 ppm TDS would pass all FDEP toxicity tests for an acceptable discharge. (SWFWMD 1995)

The second limiting factor for the concentrate discharge is the limit on discharge chloride increases per FDEP Rule for Water Quality Standards Section 62-302.530(18) F.A.C. This standard places a limit of 10 percent increase for chlorides over ambient receiving water conditions at the point of discharge. This chloride limit would be proportionately related to the salinity limit measured as Total Dissolved Solids (TDS).

Since the research conducted by the SWFWMD indicated the whole effluent toxicity standard could be met with a salinity of 45,000 ppm TDS, or 36 percent increase in salinity, the 10 percent increase in chlorides (salinity) limit would be the more restrictive condition. In addition, this assumption was tested in the permitting for the Tampa Bay facility that passed all whole effluent toxicity testing with a simulated discharge of chlorides at 10 percent above ambient receiving water chloride levels.

Blended Surface Discharge

The Port Everglades plant has eight (8) discharge structures located along a man-made canal adjacent to the site. The condenser cooling water discharge travels through the structures, into the canal, and eventually reaches the Intracoastal Waterway and Atlantic Ocean. It appears that the canal provides significant mixing area prior to discharging to the Intracoastal Waterway. Preliminary investigations indicate that it may be possible to combine the SWRO membrane concentrate with the condenser cooling water discharge prior to discharging to the Intracoastal Waterway. This methodology would provide for dilution of the concentrate prior to discharging to surface waters and would require the construction of a concentrate disposal pipeline, which could range from 24" to 42" in diameter, based on production and recovery rates. This concentrate disposal pipeline would be tied-in with one or more of the existing discharge structures and would provide for blending of the concentrate prior to the discharge point.

Port Everglades (10 mgd Facility with Co-Located Discharge)

Plant Capacity:	10 mgd
Source Quality:	33,000 ppm TDS
Recovery Rate:	50%
Concentrate Quantity:	10 mgd
Concentrate Quality:	66,000 mgd TDS

Based on a maximum allowable increase in salinity of 10%, the diluted concentrate quality cannot exceed 36,300 ppm TDS. A minimum dilution water flow of 90 mgd at 33,000 ppm TDS would be required to dilute 10 mgd of concentrate at 66,000 ppm TDS to a final salinity of

36,300 ppm TDS. FPL data indicates a historical minimum available cooling water flow of 366 mgd (net 346 mgd after desalination process withdrawal) and a projected maximum average cooling water flow of 1164 mgd (net 1144 mgd after desalination process withdrawal) after repowering is complete. This data would indicate an adequate cooling water dilution volume to meet FDEP discharge standards. (Table 5-12)

Equation for Dilution Water Flow (Q_d)

$$Q_d = 10Q_c\left(\frac{C - 1.1D}{D}\right)$$

Where:

Q_d = Dilution Water Flow (mgd)

Q_c = Concentrate Flow (mgd)

C = Concentrate Quality (ppm TDS)

D = Dilution Water Quality (ppm TDS)

TABLE 5-12: DILUTION REQUIREMENTS BASED ON SALINITY LIMITS FOR CO-LOCATED 10 MGD PORT EVERGLADES FACILITY

Parameter	Symbol	Value	Units
Concentrate Quality (TDS)	C	66,000	ppm
Concentrate Flow	Q_c	10.0	mgd
Dilution Water Quality (TDS)	D	33,000	ppm
Maximum Allowable Salinity for Blended Discharge (TDS) (1)	B	36,300	ppm
Minimum Required Dilution Water Flow	**Q_d**	**90.0**	**mgd**
Net Minimum Average Available Dilution Water from Power Plant		346	mgd
Net Maximum Average Available Dilution Water Flow from Power Plant		1134	mgd

(1) Water Quality Standard Section 62-302.530(18) F.A.C.

Port Everglades (25 mgd Facility with Co-Located Discharge)

Plant Capacity:	25 mgd
Source Quality:	33,000 ppm
Recovery Rate:	50%
Concentrate Quantity:	25 mgd
Concentrate Quality:	66,000 mgd
Maximum Dilution Water Flow:	1164 mgd

Based on a maximum allowable increase in salinity of 10%, the diluted concentrate quality cannot exceed 36,300 ppm TDS. A minimum dilution water flow of 225 mgd at 33,000 ppm TDS would be required to dilute 25 mgd of concentrate at 66,000 ppm TDS to a final salinity of 36,300 ppm TDS. FPL data indicates a historical minimum available cooling water flow of 366 mgd (net 316 mgd after desalination process withdrawal) and a projected maximum average cooling water flow of 1164 mgd (net 1114 mgd after desalination process withdrawal) after repowering is complete. This data would indicate an adequate cooling water dilution volume to FDEP discharge standards. (Table 5-13)

TABLE 5-13: DILUTION REQUIREMENTS BASED ON SALINITY LIMITS FOR CO-LOCATED 25 MGD PORT EVERGLADES FACILITY

Parameter	Symbol	Value	Units
Concentrate Quality (TDS)	C	66,000	ppm
Concentrate Flow	Q_c	25.0	mgd
Dilution Water Quality (TDS)	D	33,000	ppm
Maximum Allowable Salinity for Blended Discharge (TDS) (1)	B	36,300	ppm
Minimum Required Dilution Water Flow	$\mathbf{Q_d}$	**225.0**	**mgd**
Net Minimum Average Available Dilution Water from Power Plant		366	mgd
Net Maximum Average Available Dilution Water Flow from Power Plant		1164	mgd

(1) Water Quality Standard Section 62-302.530(18) F.A.C.

PERMIT REQUIREMENTS

Numerous permits will be required for the construction and operation of the desalination facility. All permits will be required to be approved prior to the initiation of construction or actual operation of the plant, depending upon the permit. The following list of permits is based upon experience with similar facilities in Florida.

Assumptions made for the permitting requirements for the Port Everglades are the following:

1. The desalination plant will be co-located on the FPL Port Everglades site.
2. The desalination plant will take its feedwater from the cooling water discharge from the power plant.
3. The desalination plant concentrate discharge will be blended with the power plant cooling water discharge.

For purposes of evaluating the permitting potential for each applicable permit, a ranking scale has been provided to estimate the potential for permit approval based upon known factors.

Ranking Description
Poor *= less than 50 % probability of obtaining permit*
Fair *= 50 % to 70% probability of obtaining permit*
Good = greater than 70 % probability of obtaining permit

OPERATIONAL PERMITS

SFWMD Consumptive Use Permit - This project is designed for a saline surface water intake from a man-made canal contiguous with the Atlantic Intracoastal Waterway. The salinity of the intake water from the cooling water stream from the FPL Port Everglades facility will be the source water for the co-located desalination plant. The SFWMD does not regulate the consumption of seawater.

Likelihood of obtaining permit: ***Not Required***

<u>FDEP Industrial Wastewater Facility Permit</u> - The Port Everglades site has an established cooling water discharge canal from the Florida Power Plant into the Atlantic Intracoastal Waterway. Assuming the historical and projected quantities of cooling water are available from the Port Everglades plant, a sufficient amount of blending source will be available to support a 10 or 25 mgd finished water desalination plant. A Florida Department of Environmental Protection (FDEP) Industrial Wastewater Facility (IWWF) permit will be required for the concentrate discharge into the FPL Port Everglades plant cooling system discharge. In addition, based on a permit issued at TECO, to the salinity parameter discussed previously, the discharge will also be monitored, at a minimum, for additional parameters. Using the recently issued FDEP IWWF Permit for the Tampa Big Bend Project, the following parameters would also be required to be maintained.

- Intake Flow
- Dilution Ratio
- Mixing Water Flow
- RO Discharge Flow
- Dissolved Oxygen
- Chlorides
- Conductivity
- Salinity
- Total Recoverable Copper
- Total Recoverable Iron
- Total Recoverable Nickel
- Combined Radium 226/228
- Gross Alpha
- pH
- Chronic Whole Effluent Toxicity

Likelihood of obtaining permit: ***Good***

SFWMD Standard General Environmental Resource Permit (ERP) – It is anticipated that stormwater management permits will be required from the SFWMD under a Standard General Environmental Resource Permit (<100 acres project site; ≤. 1.0 acre wetland impact). There is no anticipated wetland impacts associated with location of this plant site.

Likelihood of obtaining permit: ***Good***

The United States Army Corps of Engineers (USACOE) Dredge and Fill Permit There are no anticipated wetland impacts associated with the location of this plant site or facilities.

Likelihood of obtaining permit: ***Not Required***

U.S. Environmental Protection Agency (EPA) Notice of Intent for Stormwater Discharges Associated with Industrial Activity under the NPDES General Permit - Standard notification process to EPA with no notable permitting concerns for the projected site. SFWMD ERP stormwater permit should adequately satisfy the requirements for the EPA NPDES notification process.

Likelihood of obtaining permit: ***Good***

Florida Department of Environment Protection (FDEP) Application for a Public Drinking Water Facility Construction Permit - Desalination facilities are commonly permitted as drinking water facilities. The reverse osmosis process is the most common process in Florida for producing drinking water from saline water. The facility design meets all applicable pollution prevention and potable water health protection standards required by FDEP.

Likelihood of obtaining permit: ***Good***

FDEP Air Pollution Sources Permit – An air pollution control permit will be required for the lime silo facility.

Likelihood of obtaining permit: ***Good***

ON-SITE CONSTRUCTION FACILITIES PERMITS

- Florida Department of Health (DOH)/ County Health Department On-Site Sewage Disposal Systems Construction Permit (if applicable)
- U. S. EPA Accidental Release Prevention Regulations
- Broward County Construction Permit

Likelihood of obtaining permits: ***Good***

PIPELINE CONSTRUCTION PERMITS

- ACOE Dredge and Fill Permit
- Florida Department of Environmental Protection (FDEP) Application for a Public Drinking Water Facility Construction Permit
- SFWMD Individual Environmental Resource Permit (ERP)
- Florida Department of Transportation (FDOT) Right-of-Way Use Permit(s)
- Broward County Right-of-Way Use Permit(s)
- U.S. Environmental Protection Agency (USEPA) Notice of Intent for Stormwater Discharges Associated with Industrial Activity under the NPDES General Permit

Likelihood of obtaining permits: ***Good***

It should be noted that if the desalination facility is located off site from the FPL Port Everglades facility, but still utilizes the cooling water system for the co-location benefits, all of the above listed permits would still be required. The only foreseeable modification to the "ability to obtain a permit " ranking would be those associated with wetland impacts since the offsite location is not known. However, this permitting issue would be considered minor in the overall scope of the project.

ENVIRONMENTAL ISSUES

The Port Everglades power plant site and its operation currently exhibits no outstanding environmental concerns with respect to co-locating a desalination facility. The power plant cooling water intake and discharge are creating no environmental problems. The plant maintains a successful Manatee Protection Plan. The desalination plant will only change the quality of the cooling water discharge slightly at the point of discharge into the cooling water canal and will be most likely be undetectable by the time the discharge enters the Atlantic Intracoastal Waterway. The RO process will not elevate the temperature of the cooling water discharge and the dissolved oxygen level will not be lowered. This will ensure that the benthic invertebrates located in the Atlantic Intracoastal Waterway will not be impacted.

The permitting process will handle all normally expected environmental issues such as wetland impacts, stormwater control, and hazardous waste management.

In summary, there does not appear to be any significant environmental issue that would materially affect the co-location of a desalination facility at the FPL Port Everglades facility.

LAND USE COMPATIBILITY

The proposed desalination plant location is immediately adjacent to the east and north sides of the cooling-water discharge canal of the Port Everglades Power Plant. The entire area of Port Everglades is zoned and has future land use designations as industrial land uses. This area is one of the most heavily industrialized areas of Broward County. The area is surrounded by port operations such as: container storage and bulk fuel storage and handling; vehicle and equipment storage; transshipment operations; electric power generation, ship repair, and numerous other heavy industrial land uses. The construction and operation of a desalination facility will be consistent with the existing zoning and future land use designations of this area.

SERVICE AREAS AND DEMAND

Potential Users

The service area for the Port Everglades site was identified by locating utilities within a reasonable distance of the plant site. The proposed facility is located in Broward County, which has several major suppliers of potable water. The largest, the City of Ft. Lauderdale, supplies 34 percent of the permitted demand, while seven other utilities supply the remainder of the permitted demand. (Table 5-14)

The specifics of the interconnection opportunities between these utilities were not determined, but rather the review was done to estimate the collective demand potential for the region located about the Port Everglades FPL plant. Collectively, the utilities in the vicinity have a current total permitted water supply of 187.5 mgd.

In one measure of future demand, a comparison of the quantities needed for SFWMD imposed water restrictions that would exempt saline water sources. Table 5-14 shows the quantities required to offset Phase I, II & III Water Shortage Restrictions to permitted quantities for collective utilities within the region.

- Phase I 28.13 mgd permit quantities reduction
- Phase II 56.25 mgd permit quantities reduction
- Phase III 84.38 mgd permit quantities reduction

Table 5-14: WATER SUPPLY PERMIT DATA
PORT EVERGLADES SERVICE AREA

Utility	Permit #	Average Daily Demands (MGD) Current Water Use Permit
Port Everglades Power Plant Service Area		
North Lauderdale	06-00004-W	4.73
Hollywood	06-00038-W	26.67
Pompano	06-00070-W	24.08
Plantation	06-00103-W	25.00
Ft. Lauderdale	06-00123-W	64.64
Lauderhill	06-00129-W	10.24
Davie	06-00134-W	5.73
Broward (2A)	06-00142-W	13.00
Broward (1A, 1B)	06-00146-W	12.43
Femcrest	06-00170-W	0.99
		187.51
Phase 1 WS Reduction 15%		**28.13**
Phase 2 WS Reduction 30%		**56.25**
Phase 3 WS Reduction 45%		**84.38**

Based on projected SFWMD Water Shortage Plan reductions, a desalination source that was exempt from such restrictions could be justified for a quantity from 25-80 mgd.

Cost of water produced by desalination facilities

Total projected unit costs for the Port Everglades facility ranged from $2.40 per 1000 gallons for a 10 mgd facility to $2.14 per 1000 gallons for a 25 mgd facility. (Refer to Project Cost Summary Table 5-15)

Cost of pumping and treating groundwater in South Florida

The cost of pumping and treating raw water supplies in South Florida can be estimated at only an order-of-magnitude level at this point. The project team contacted utilities in the area of each of the two potential desalination facilities. The utilities provided very rough estimates of the cost of pumping and treating raw water, or the cost of providing water to end users less the cost of transmission, distribution, and related activities. None of the utilities has conducted a recent study where this cost was specifically estimated.

The Broward County Office of Environmental Services, which provides water supplies in much of the unincorporated area of Broward County, estimated that its average cost for providing potable water at the treatment plant, without taking into account transmission and distribution, is about $1.25 per 1000 gallons. This figure includes an allowance for administrative and other overhead charges. However, the figure varies a great deal among treatment plants. Higher volume facilities experience lower unit costs, while the reverse occurs at the lower volume plants. For the system as a whole, water transmission and distribution costs add about $1.00 to the cost per 1000 gallons.

A survey of water utilities in the vicinity revealed that average retail charges for potable water, on a cost per 1000-gallon basis were $2.81 in the area of the Port Everglades Power Plant. These cost averages are shown in Table 5-15. The monthly cost averages were computed by calculating the monthly charge for a residential customer using 8000 gallons of water. For some utilities, higher water use amounts result in a lower charge per 1000 gallons up to a point, followed by higher charges due to the imposition of increasing block rates. Basing the average charge per 1000 gallons on the monthly charge for 8,000 gallons per month is thought to be a reasonable basis for estimating average charges.

Effect of using desalination facility water on end user charges

At the projected cost of $2.14 to $2.40 per 1000 gallons for the finished desalinated water, it can be conservatively assumed that the incremental increase over the average Broward County area production cost of $1.25 would be between $0.89 and $1.15 per 1000 gallons depending on the production capacity of the desalination facility. It should be noted that is highly unlikely that the residential consumer would be supplied solely by desalinated water, but rather a blended supply together with conventional sources. A residential customer using 8,000 gallons of water per month provided by a 50 percent desalinated water supply source could be expected to experience an increase in the monthly bill of between $4.76 and $5.80 which is a 21 and 26 percent increase respectively.

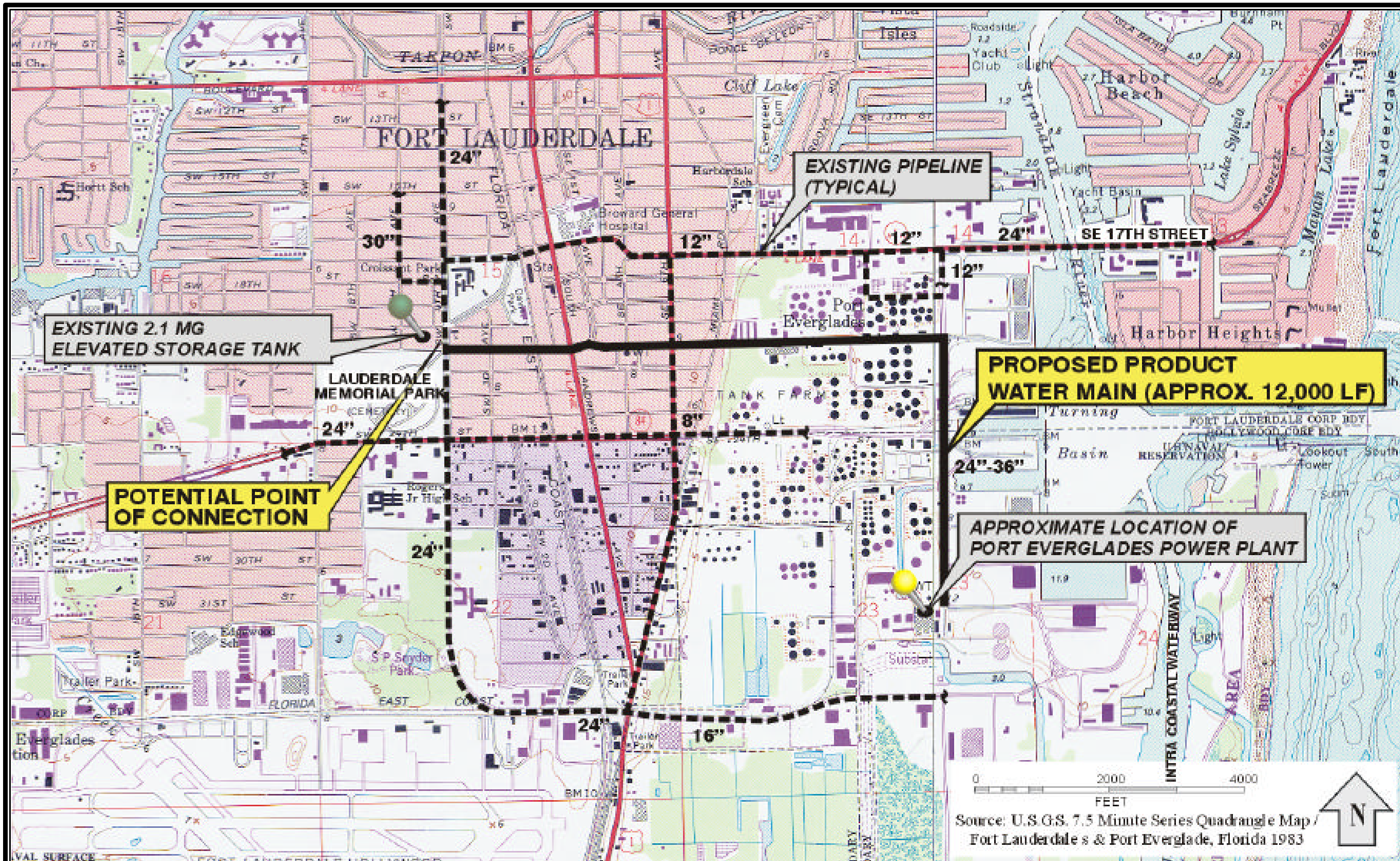
Table 5-15: SERVICE AREA UTILITIES COST COMPARISON	
Port Everglades Power Plant Service Area Utilities	**Average Charge for Water (1)**
City of North Lauderdale	$2.81 per 1000 gal
City of Hollywood	
City of Pompano Beach	
City of Plantation	
City of Ft. Lauderdale	
Town of Davie	
Broward County	
Femcrest	
Cost Impact to Customer	
Average Monthly Charge (8000 gallons)	$22.48
Incremental Cost for Desalinated Water ($ per 1000 gallons)	$1.19-$1.45
Average Monthly Charge with 50% Desalinated Water	$27.24-$28.28
Average Monthly Increase to Customer	$4.76-$5.80

(1) Includes Base Charge

Potential Points of Connection

According to the water atlas maps provided by the City of Ft. Lauderdale Utilities Department, it appears that a potential point of connection to the existing water distribution system may exist in the vicinity of the northern portion of the Lauderdale Memorial Park. Figure 5-32, illustrates the potential tie-in location, along with the existing transmission mains and the proposed product water main. As indicated in Figure 5-32, this area has an existing 24-inch main running north and south, an additional 30-inch main running to the north, and several smaller mains that run east west. In addition, this area has a 2.1 MG elevated storage tank (standpipe) already in place. The PL Dixie water treatment plant, which provides potable water for the local service area, is located approximately 2.5 miles to the west of this potential tie-in point. The City's water distribution system is looped, so that all of the City's service areas are interconnected. In addition, the City has the ability to provide metered potable water to Broward County.

Depending on the design product water flow, either a 24-inch or 36-inch product water main would need to be constructed. Depending on the exact routing used for the product water main, it appears that approximately 12,000 ft. of product water main would need to be installed. Since Port Everglades owns the property generally bounded on the north by Southeast 17th Street, on the east by the Intracoastal Waterway, and on the west by Highway A1A, the routing of the product water main through the Port Everglades property has may possible options. However, once the main reaches the limits of the City of Ft. Lauderdale, the routing options will become more limited. If the main were to be constructed in this area, a detailed route study would need to be conducted. The route study may include, but may not be limited to existing utilities, easements, future development plans, ease of obtaining required permits, geotechnical evaluations, and political ramifications.



WRA

Project: Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electric Power Plants

Figure 5-32:
PORT EVERGLADES PRODUCT WATER MAIN
POTENTIAL POINT OF CONNECTION TO EXISTING DISTRIBUTION SYSTEM

Prepared For:
South Florida Water Management District
Florida Power & Light Company

CAPITAL, O&M AND LIFE CYCLE COSTS

All estimated costs for the Port Everglades co-located desalination facility were evaluated using the Desalination Feasibility Cost Planning Model (Model) developed specifically for this study. The Model is described further in Section 4.2.

Assumptions made for the cost evaluation:

1. The desalination facility will be located on the FPL Port Everglades Power Plant site. Figure 5-30.
2. The power plant cooling water will be used for the desalination facility source water.
3. The desalination plant will run continuously based upon the power plant providing source water.
4. The desalination facility will utilize the power plant cooling water discharge facilities for a blended discharge.
5. The source water quality will be based on 33,000 ppm TDS, the average salinity of the feed water at the point of power plant intake.

Port Everglades Desalination Facility

Model Input Parameters

Source Water

Type:	Cooling water from FPL Port Everglades Power Plant
Quality:	33,000 ppm TDS
Temperature:	89.0 degrees F
Distance to source water:	500 feet
Land cost for intake pipeline:	$9000 per acre – annual lease rate

Finished Water

Quantity of finished water:	10 mgd & 25 mgd

Quality :	250 ppm TDS
Distance to point of interconnection:	2.27 miles)
Land cost for transmission pipeline:	$300,000 per acre purchased easement

Electric Power

Cost of energy:	$0.048 per kWh (Interruptible power rate)

Concentrate Disposal

Discharge Option:	Blended surface discharge
Distance to disposal point:	500 feet
Land cost for disposal pipeline:	$9000 per acre - annual lease rate

Land For Desalination Facilities

Cost:	$9000 per acre annual lease rate

Financial

Type of ownership:	Private and public options evaluated
Subsidies:	None
Rate of growth:	2.5%
Interest rate:	5.20% for both 30 and 50 year terms
Inflation rate:	3.20%
Sales tax:	6.50%
Contingency:	25%

Cost estimates based on the above input parameters and assumptions yield the following:

TABLE 5-16: SUMMARY OF PORT EVERGLADES FACILITY LIFE CYCLE COSTS					
Plant Capacity (mgd)		**Life Cycle (years)**		**Cost ($ per 1000 gal)**	
10	**25**	**20**	**50**	**Private Ownership**	**Public Ownership**
X		X		$2.40	
X			X	$2.70	
X		X			$2.33
X			X		$2.68
	X	X		$2.14	
	X		X	$2.44	
	X	X			$2.08
	X		X		$2.43

TABLE 5-17: CAPITAL, O&M & LIFE CYCLE COSTS			
COST COMPONENT	UNITS	PORT EVERGLADES	
		10 mgd	25 mgd
INPUT DATA			
Source Water			
Source Type		Cooling Water	Cooling Water
Quantity	mgd	20.00	50.00
Quality	ppm TDS	19,000 - 35,000	19,000 - 35,000
Temperature	^{o}F	86.0 - 95.0	86.0 - 95.0
Distance to Source	lineal feet	500	500
Land Cost for Intake Pipeline	$ per acre	$9,000	$9,000
Finished Water			
Quantity **(1)**	mgd	10.00	25
Quality	ppm TDS	250	250
Distance to Point of Use	miles	2.27	2.27
Land Cost for Transmission	$ per acre	$300,000	$300,000
Electric Power			
Cost of Energy	cents/kWh	4.80	4.80
Concentrate Discharge			
Method		Blended Surface	Blended Surface
Injection Wells Required		0	0
Quantity **(1)**	mgd	10.00	25.00
Distance to Discharge Point	lineal feet	500	500
Land Cost for Discharge Pipeline	$ per acre	$150,000	$150,000
Land for Plant Site			
Acquisition Method		Purchase	Purchase
Cost of Plant Site Land	$ per acre	$9,000	$9,000
Financial			
Type of Ownership		**Private**	**Private**
Subsidies		$0	$0
Rate of Growth		2.50%	2.50%
Nominal Interest Rate		5.20%	5.20%
Inflation Rate		3.20%	3.20%
Sales Tax		6.50%	6.50%
Contingency		25.00%	25.00%
(1) Calculated value based on projected system yield			

TABLE 5-17: CAPITAL, O&M & LIFE CYCLE COSTS			
COST COMPONENT	UNITS	PORT EVERGLADES	
		10 mgd	25 mgd
OUTPUT DATA			
CAPITAL COSTS			
Intake System			
Surface Water Pump Station		$2,213,014	$4,296,281
Raw Water Structure		$381,734	$624,828
Intake Pipeline		$64,763	$130,141
Supply Well System		$0	$0
Pretreatment			
Process Equipment		$4,040,000	$10,040,000
R.O. Process			
Membrane System		$4,608,295	$11,520,737
Pumps		$1,600,000	$3,500,000
Energy Recovery System		$500,000	$1,100,000
Post-treatment			
Process Equipment		$75,000	$75,000
Concentrate Discharge			
Pump Station		$1,164,222	$2,327,227
Pipeline		$66,500	$111,863
Deep Wells		$0	$0
Infrastructure			
Building		$1,200,000	$3,000,000
Site Work		$576,000	$1,080,000
Land			
Plant Site		$45,000	$108,000
Intake Pipeline		$3,616	$5,165
Discharge Pipeline		$51,653	$60,262
Transmission Pipeline		$2,476,364	$2,889,091
Transmission			
Pump Station		$1,225,497	$2,449,712
Ground Storage Tanks		$1,650,000	$2,600,000
Transmission Pipeline		$1,677,984	$2,822,609
Professional Services			
Engineering		$1,889,571	$3,899,273
Permitting		$472,393	$974,818
Legal		$236,196	$487,409
Capital Cost Totals			
Subtotal		$26,217,800	$54,102,416
Contingency		$6,554,450	$13,525,604

TABLE 5-17: CAPITAL, O&M & LIFE CYCLE COSTS			
COST COMPONENT	UNITS	PORT EVERGLADES	
		10 mgd	25 mgd
Sales Tax		$1,535,277	$3,168,159
Subsidies		$0	$0
Net Total		$34,307,527	$70,796,179
Capitalized Interest		$891,996	$2,761,051
Cost of Financing		$1,055,986	$2,206,717
Construction Insurance		$1,372,301	$2,831,847
Grand Total		$37,627,809	$78,595,794
OPERATION AND MAINTENANCE COSTS	**dollars/year**		
Pretreatment			
Chemicals		$547,540	$1,368,790
Post-treatment			
Chemicals		$172,780	$432,368
R.O. Process			
Replacement Membranes (Annualized Over 20 Years)		$397,672	$994,180
Replacement Membranes (Annualized Over 50 Years)		$636,306	$1,590,766
Water Quality Monitoring			
Monitoring of Concentrate and Product Water		$59,049	$121,852
Energy Consumption			
Power		$1,838,400	$4,596,000
Operation and Maintenance			
Replacement Parts		$559,973	$1,220,652
Plant Site Lease		$0	$0
Labor		$420,000	$560,000
Operating Insurance		$343,075	$707,962
O&M Cost Totals			
Annualized O&M (Based on 20-Year Life Cycle)		$5,687,999	$13,086,411
Annualized O&M (Based on 50-Year Life Cycle)		$7,722,317	$17,787,436
LIFE CYCLE PROJECT COSTS			
Based on 20-Year Life Cycle			
Total Capital Cost		$37,627,809	$78,595,794
Annualized O&M Cost	dollars/year	$5,687,999	$13,086,411
20-Year Life Cycle Cost	per 1000 gal.	$2.40	$2.14
Based on 50-Year Life Cycle			
Total Capital Cost		$37,627,809	$78,595,794

TABLE 5-17: CAPITAL, O&M & LIFE CYCLE COSTS			
COST COMPONENT	UNITS	PORT EVERGLADES	
		10 mgd	25 mgd
Annualized O&M Cost	dollars/year	$7,722,317	$17,787,436
50-Year Life Cycle Cost	per 1000 gal.	$2.70	$2.44
Public Ownership (2)			
LIFE CYCLE PROJECT COSTS			
Based on 20-Year Life Cycle			
Total Capital Cost		$35,859,560	$74,817,385
Annualized O&M Cost	dollars/year	$5,696,584	$13,111,370
20-Year Life Cycle Cost	per 1000 gal.	$2.33	$2.08
Based on 50-Year Life Cycle			
Total Capital Cost		$35,859,560	$74,817,385
Annualized O&M Cost	dollars/year	$7,911,714	$18,231,220
50-Year Life Cycle Cost	per 1000 gal.	$2.68	$2.43
(2) Public ownership deletes sales tax and reduces financing interest rate by 0.50%			

FUNDING ALTERNATIVES

6.0 FUNDING ALTERNATIVES

Funding alternatives for a proposed desalination water supply facility would include opportunities to receive funds from a variety of sources including local, state and federal public grant sources, private financing and local utility partnerships. The available source would depend on a number of factors such as ownership of the desalination facilities, wholesale or retail sale of the finished water supply to the customer, location of the plant and other unique features that the facility design may entail.

This section of the Study will provide an outline of potential finding sources and ownership options that could provide insight into a plan to seek funds for development of a selected project.

Local Funding

Local utilities have the ability to secure municipal bonds secured by the fees received for selling the finished potable water to customers. Desalination facilities would fall within the same category of financing as the development of a potable drinking water or wastewater facility. Utilities or municipalities with good financial history can receive very favorable tax-exempt financing rates that can lower the cost of the project. Local utilities would need to be at minimum a partner in the desalination facility to be able to provide funds bonded by their local government.

Federal Legislative Initiatives

The District has been very successful over the past several years with Congressional appropriations for water supply development within south Florida. The District's initiative has grown into a statewide effort to gain recognition of water management issues and solutions in Florida at the Federal level. There is currently a consolidated effort to obtain Federal dollars for water projects between Florida's five water management districts and FDEP. This effort continues to realize dollars for Florida for municipal water supply projects and some municipal/agricultural reclaimed water projects.

Potential Federal Funding Sources

There are several different places in the federal budget where Congress can include water projects. The two most prominent are in the EPA's budget and in the Army Corps of Engineers' budget. As a general matter, the EPA budget deals with "dirty" water projects such as stormwater, sewage treatment, and reclaimed water projects, while the Corps' budget addresses flood control and water supply issues. However, this description oversimplifies the issues - where a particular project end up has as much to do with legislative strategy as it does with policy.

In general, a water project is attractive to congressional appropriations committees when it has a hook that sets it apart from a typical sewage treatment plant. Innovative technology, regional partnerships or exigent circumstances all can help put a project over the finish line for federal funding. The key is to put together a compelling story for members of Congress and their staffs that plays up to the strengths of the project and the aspects of it that is unique and deserving of federal attention.

Water Desalination Research and Development Program

Administered by the United States Department of the Interior, Bureau of Reclamation (Reclamation), the Water Desalination Research and Development Program serves as the principal source of federal assistance for desalination projects. Authorized by the Water Desalination Act of 1996, Public Law 104-298, the primary objective of the Program is to develop more cost-effective, technologically efficient, and implementable means by which potable water can be produced from saline and brackish water sources. More specifically, the Desal R & D Program funds development and demonstration activities that test technological advancements, confirm economic estimates, and gain public acceptance for desalination projects.

Selection Criteria

Applicants eligible for financial assistance include the following: academic institutions, commercial and industrial organizations, private profit and nonprofit entities, public entities including State, Local and Tribal Governments, and United States-Mexico binational research foundations. The criteria for rating and selecting proposals from a pool of applicants include the following factors.

Technical Factors

- Demonstrated familiarity with the current technology in the field of work and understanding of the potential difficulties in carrying out the work.

- Impact of the proposed work on the current technology and on its related economics if a completely successful outcome was achieved.

- Novelty of approach to the work.

- Probability of a successful outcome of work.

- Availability of equipment, instruments, and test facilities required for the work.

Managerial Factors

- The qualifications, capabilities, and experience of the proposed project manager and other key personnel who are critical to achievement of the proposed objectives.

- Adequacy, completeness and realism of the research schedule, task phasing, and milestones.

- The applicants' capabilities, related experience, facilities, techniques, or unique combinations of these that are integral factors for achieving the proposed objectives.

Pricing Factors

- Cost realism and reasonableness: This requires that costs be directly relatable to items in the research work plan, reasonable, and be appropriate to the project in terms of dollar amount and quantity.

- Cost-share: Applicants proposing to provide the most cost-share will be given greater consideration.

Examples of Funded Projects

Examples of previously funded projects include the following:

- Development of a New Ultrafiltration Capillary Membrane and Study of Fouling Parameters, Flux Restoration, and Pathogens Retention Using Membrane Sampling Device.
- Membrane Fouling: Influence of Natural Organic Matter Properties and Membrane Surface Treatment on Adhesion and Flux Decline.
- Characterization of the Hydrophilicity of Polymeric Reverse Osmosis and Nanofiltration Membranes: Implications to Membrane Fouling.
- Application of Electret (permanently polarized or charged dielectric materials) Technology to Low Cost Desalination.
- Innovative Photocatalytic Process for Silver Recovery and Wash Water Reuse.
- Side-by-side Comparison of Membrane Bioreactors for Water Purification.

Program Funding

The Federal share of the cost of a desalination development or demonstration project carried out under this Act shall not exceed 50 percent of the total cost of the project. A Federal contribution in excess of 25 percent for a project carried out under this Act may not be made unless the Secretary of the Interior determines that the project is not feasible without such increased Federal contribution. Costs of operation, maintenance, repair, and rehabilitation of facilities funded under the authority of this Act shall be nonfederal responsibilities. In each fiscal year, if sufficient funds are appropriated, up to $1,000,000 may be awarded to institutions of higher education, including United States-Mexico binational research foundations and interuniversity research programs established by the two countries, for research grants without any cost-sharing requirement.

Financial Assistance for selected individual projects ranges from the smallest available award of $10,000, to the largest of $125,000.

VA-HUD-Independent Agencies Funding

Federal funding appropriated by the Departments of Veterans Affairs (VA), Housing and Urban Development (HUD), and Independent Agencies is also a potential source of financial assistance for desalination projects.

Community Development Block Grant (CDBG) Program

The Federal government administers a number of programs that assist rural communities in developing water and wastewater systems. One of the most prominent is a program run by the Department of Housing and Urban Development (HUD). HUD commonly administers assistance under the Community Development Block Grant (CDBG) program, a program developed by the Housing and Community Development Act of 1974.

CDBG funds are used by localities for a broad range of activities intended to result in decent housing in a suitable living environment. Water supply and wastewater disposal needs compete with many other public activities for this assistance and account for approximately 10% to 20% of CDBG grants. HUD requires that at least 70% of all appropriated funds benefit low/moderate-income persons. Thirty percent (30%) of CDBG funds ($1.4 billion in FY 1999) are allocated by formula to the states for distribution to small communities and may be available for rural community projects. The larger portion of total CDBG funds, 70%, is allocated by formula to metropolitan areas and cities with populations of 50,000 or more and statutorily defined urban counties and thus do not assist rural areas directly.

VA-HUD-Independent Agencies Appropriations Bill

Each fiscal year millions of dollars in appropriated federal funds are granted to assist water supply and wastewater projects through the VA-HUD-Independent Agencies Appropriations Bill. Two California desalination projects were funded as part of the FY 2000 Appropriations Bill. These grants include $2,500,000 for a desalination facility in Carlsbad, California, and $500,000 for the California-based Desalination Research and Innovation Partnership Program.

Capitalization Grants for Clean Water State Revolving Funds

Overview

The EPA award grants to States to capitalize their Clean Water State Revolving Funds (SRFs). The States, through the SRF, make loans for high priority water quality activities. As loan recipients make payments back into the fund, money is available for new loans to be issued to other recipients. While traditionally used to build wastewater treatment facilities, loans are used increasingly for other water quality management activities, including: (1) agricultural, silviculture, rural and urban runoff control; (2) estuary improvement projects; (3) wet weather flow control, including stormwater and sewer overflows; (4) alternative wastewater treatment technologies; and (5) nontraditional projects such as landfills and riparian buffers.

Eligibility

- Capitalization grant funds available to States, Puerto Rico, Territories, and D.C. Indian Tribes can receive project grants from either the EPA or Indian Health Service.
- States lend money to municipalities, communities, citizens' groups; nonprofit organizations; and private citizens implementing NPS and estuary management activities (provided for in State plans developed under CWA Sections 319 and 320.)

Assistance Provided

- Loans provided by States to eligible recipients.
- 20 percent State match is required.

Legislative Authority

Clean Water Act, Section 601-607.

CONCLUSIONS

7.0 CONCLUSIONS

The Feasibility Study for Co-Locating Reverse Osmosis Treatment Facilities with Electrical Power Plants reviewed 23 potential power plant and RO desalination co-location sites in the SFWMD. After a three-tier series of evaluations, the FPL Ft. Myers and Port Everglades sites were found to be "highly desirable" for co-location. Based on these evaluations and a review of the seawater desalination development efforts in Tampa Bay, Florida, the following conclusions were reached:

1. Seawater desalination has become a feasible water supply source for Florida, offering high quality potable water on a dependable basis regardless of hydrologic conditions.

2. The Tampa Bay Seawater Desalination Project proved that a co-located seawater desalination plant could be developed at a cost significantly below historical costs experienced for similar size projects. Cost savings due to co-location alone resulted in a reduction of approximately 15 percent of historical costs.

3. The experience gained from the Tampa Bay Seawater Desalination Project answered a number of concerns regarding the feasibility of co-locating a power plant with a desalination facility. However, it should also be recognized that the project was unique in many ways and can best serve only as a guide for future desalination projects.

4. Many existing and proposed power plant sites within the SFWMD are not feasible for co-location of a desalination plant for a number of reasons including:

    a. Lack of sufficient or dependable cooling water flow;
    b. Cooling water source susceptible to oil spills or other contamination;
    c. Expected plant life too short;
    d. Source water is not sufficiently saline (already fresh);
    e. Nuclear fuel source can cause public perception concerns.

5. The Ft. Myers location is rated as a “highly desirable” co-location site for the following reasons:

   a. Sustainable water supply source from Caloosahatchee River;
   b. Lower salinity brackish water supply;
   c. Recently upgraded power plant with projected long life span;
   d. Significant existing and increasing future potable water demand in region;
   e. Available on-site or nearby land for desalination facility;
   f. Two viable concentrate disposal options;
   g. Close local utility interconnection opportunity.

6. The Port Everglades location also rates as a “highly desirable” co-location site providing the following features:

   a. Sustainable water supply source from Atlantic Intracoastal Waterway;
   b. Significant existing and increasing future potable water demand in region;
   c. Available on-site land for desalination facility;
   d. Excellent concentrate disposal opportunity by blending with cooling water discharge;
   e. Reasonably close local utility interconnection opportunity;
   f. Cooling water flow would support the production of large quantities of desalination water.

7. The projected costs for the Ft. Myers and Port Everglades facilities illustrate pricing reflective of the cost savings resulting from co-location with an existing power plant. Cost savings are primarily due to:

   a. Use of existing source intake and discharge systems;
   b. Reduced pipeline costs for RO plant source water intake and concentrate discharge;
   c. Increased RO process yield due to higher temperature cooling water.

8. Past research indicates consumers are willing to purchase higher cost desalinated water if provided value such as regulatory incentives, increased water quality and greater dependability for their water supply.

9. The SFWMD has directed staff to provide regulatory incentives for the use of sustainable alternative water-supply sources such as desalinated water. This will provide a necessary and important incentive for utilities to consider developing a desalination water supply.

10. Additional information and evaluation is necessary to fully determine precise details of a desalination project at either Ft. Myers or Port Everglades. Such information would include site-specific water quality data, RO system alternatives, energy cost reduction alternatives, future potable water demands, specific permitting criteria, funding and ownership options.

11. A desalinated water supply source, blended with existing water supplies, provides a sustainable, affordable water supply mix for the consumer, with the added benefit of drought protection.

RECOMMENDATIONS

8.0 RECOMMENDATIONS

A significant amount of information was obtained for this study from the Tampa Bay Seawater Desalination Project. This project is currently under construction and scheduled for startup in December 2002. The experience gained from this project has answered a number of concerns regarding the feasibility of seawater desalination plants in Florida. However, that project was also unique in many ways and may best serve only as a guide for the co-location of future desalination development projects, when supplemented with site-specific data.

This study, sponsored by the SFWMD and FPL, reviewed 23 existing and proposed power plant sites for co-locating a desalination facility. The two most advantageous sites evaluated were Ft. Myers and Port Everglades, both operated by FPL. Both sites proved feasible for the purpose of producing a sustainable desalinated water supply at a cost effective price. To further develop the potential for these two sites and desalination as a water supply source in the SFWMD, additional site-specific information would be required.

The following recommendations pertain to information required for the Ft. Myers and Port Everglades sites and in addition generally address the SFWMD's desalination development efforts to further their water supply development goals.

1. The final design of the RO desalination process depends primarily on the source water quality and RO membrane performance. In order to gain a more precise cost estimate for planning purposes, additional water quality information and the resulting membrane specifications for a specific power plant cooling water source would be required.

   Recommendation: <u>Conduct additional evaluations, emphasizing laboratory and software analysis tools to determine more detailed information relating to the following issues that can materially affect the cost of the desalinated product water:</u>

   a. <u>Source water quality including salinity, seasonal suspended solids loading, bioactivity, temperature variation, oil and grease, and membrane scaling potential.</u>
   b. <u>Specific RO membranes, membrane arrangements and life expectancy under site-specific conditions.</u>

2. Energy costs represent approximately 25 percent of the overall unit cost to produce desalinated seawater. Methods to reduce the energy consumption and cost should be investigated to decrease the overall unit cost and provide a more environmentally sensitive energy source.

   Recommendation: Investigate opportunities available to reduce energy costs including high recovery RO, hybrid systems, new desalination technologies, on-site power generation, alternative energy and negotiated lower unit costs for electricity.

3. Both the Ft. Myers and Port Everglades sites were determined to have a high probability of gaining the necessary permits to construct and operate a co-located desalination facility. To gain a greater comfort in the ability of either site to gain all necessary regulatory approvals, site-specific information and interaction with the regulatory agencies would be necessary.

   Recommendation: Perform detailed evaluation site characteristics and permitting requirements to determine site-specific regulatory issues.

4. The development of a co-located desalination facility should be designed to work in concert with the power plant operation. As the power plant operation evolves over time, opportunities may develop for design synergies between the power and desalination operations.

   Recommendation: Perform more detailed evaluations of current and projected power plant operations to determine cost reduction opportunities based on synergies between power plant systems and the desalination process, as well as between power plant and desalination plant operations and maintenance staffing skills.

5. Acceptance by local water utilities is crucial to the success of any desalination project. Water utilities have two major concerns; to protect the integrity of their water supply system and provide a low cost, safe water supply to their customers. A complete understanding of the components of their water treatment and delivery system, as well as their customer expectations is necessary to gain public acceptance of a desalination project.

   Recommendation: Work with utilities in service areas of proposed desalination facility areas to:

   a. Conduct detailed evaluations for existing and projected water demand within the utility service areas associated with the selected power plants.
   b. Conduct customer surveys to determine willingness to accept desalinated water and elasticity of demand;
   c. Determine needs for such items as product water quality and blending requirements, storage, and delivery systems.

6. The development of alternative sources of water can be expedited by the implementation of incentives to local governments supplying potable water. The Tampa Bay Seawater Desalination Project was initiated by a combination of regulatory and financial incentives to make the project more feasible in the near term.

   Recommendation: Investigate additional regulatory and financial incentives for developing desalinated water supplies.

7. The capital cost of alternative water source projects can be reduced by state and federal matching grants. These grants can have a dramatic impact on the overall feasibility of developing a desalinated water supply.

   Recommendation: Investigate state and federal funds for developing a pilot or full-scale desalination project.

8. There are many ownership options that can be used to develop a desalination project. Private sector ownership has many benefits, as does public ownership. Each ownership option should be reviewed to determine the best combination of legal, financial and other combinations. The role of the power company should also be considered to determine the role that they may wish to participate in the development of a desalination facility.

   Recommendation: Investigate various project development options including public, private and public/private partnerships such as Design-Build-Operate (DBO), Design-Build-Own-Operate-Transfer (DBOOT) and various levels of involvement by the power utilities.

9. The Tampa Bay Seawater Desalination Project continues to evolve from construction to the operation phase in late 2002. This project can provide valuable information to be applied to future such projects in the SFWMD. Close attention and monitoring this project could well provide a more confident course to a successful project in the SFWMD.

   Recommendation: Closely monitor the development of the Tampa Bay Seawater Desalination Project to assess potential opportunities or obstacles to development of similar facility in the SFWMD.

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APPENDIX

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