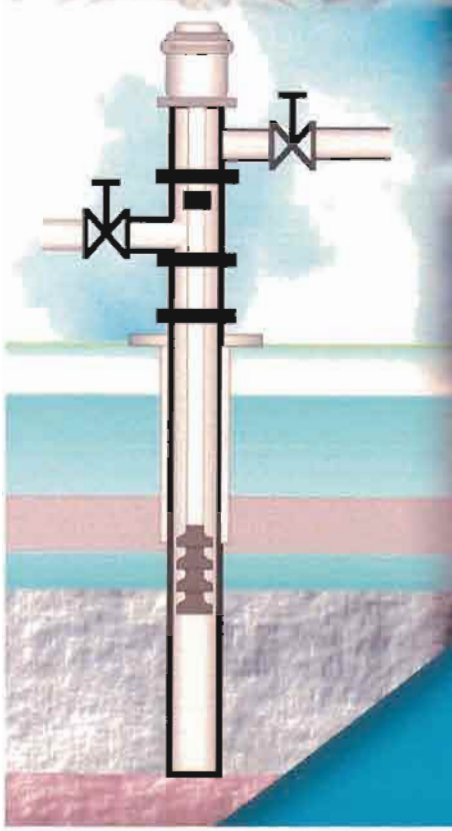
CDM

Water Supply Cost Estimation Study



South Florida Water Management District

February 2007

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List of Abbreviations

AADD	Annual average day demand
ACOE	U.S. Army Corps of Engineers
ADD	Average day demand
ASR	Aquifer Storage and Recovery
AWT	Advanced Wastewater Treatment
bls	Below land surface
BNR	Biological nutrient removal
BOD5	Biochemical oxygen demand (5-day)
BODR	Biochemical Oxygen Demand Removed
CBOD5	Carbonaceous biochemical oxygen demand (5-day)
CCI	Construction Cost Index
CDR	Commercial Demand Reduction Rate
CILC	Commercial Industrial Load Control
CS	Carbon steel
CSI	Construction Specification Institute
D	Disinfection
DBFO	Design, Build, Finance and Operate
DBO	Design, Build and Operate
DIP	Ductile iron pipe
DIW	Deep injection wells
EAA	Everglades agricultural area
EJCDC	Engineer's Joint Contract Document Committee
ENR	Engineering News Record
EPA	Environmental Protection Agency
F	Filtration
F.S.	Florida Statute
FP&L	Florida Power & Light
FRP	Fiberglass reinforced plastic
FT	Feet
FW	Fresh Water
GFD	Gallons per square feet of membrane per day
GPM	Gallons per minute
GW	Ground Water
HS	High Service
HVAC	Heating, ventilation, air conditioning
ID	Inner diameter
KB	Kissimmee Basin
KGAL	Thousand gallons
KWH, KW-hr	Kilowatt hour
LB	Pounds

List of Abbreviations

LEC	Lower East Coast
LF	Linear Foot
LPHO	Low-pressure high-output
LPRO	Low pressure reverse osmosis
LWC	Lower West Coast
MBR	Membrane Bioreactor
MDD	Maximum day demand
MF	Microfiltration
MG	Million gallons
mg/L	Milligrams per liter
MGD	Million gallons per day
MGY	Million gallons per year
MIT	Mechanical integrity test
MLE	Modified Ludzack-Ettinger MBR configuration
MM	Millimeter
MP	Medium pressure
NF	Nanofiltration
NTU	Nephelometric turbidity unit
O&M	Operations and maintenance
OD	Outer diameter
OUC	Orlando Utilities Commission
PBCWUD	Palm Beach County Water Utilities Department
PHD	Peak hour demand
pph	Pounds per hour
PTS	Partially treated surface water
PVC	Polyvinyl chloride
R&R	Renewal and replacement
RAS	Return activated sludge
RO	Reverse Osmosis
RPR	Resident project representative
RTS	Radioactive tracer survey
RW	Reclaimed water
SCADA	Supervisory Control And Data Acquisition
SFWMD	South Florida Water Management District
SJRWMD	St. Johns River Water Management District
SS	Stainless steel
SW	Seawater
SWRO	Seawater reverse osmosis
TBW	Tampa Bay Water
TDH	Total dynamic head

List of Abbreviations

TDS	Total dissolved solids
TGW	Treated ground water
TN	Total nitrogen
TP	Tubing-and-packer
TS	Total solids
TSS	Total suspended solids
TSW	Treated surface water
UEC	Upper East Coast
UF	Ultrafiltration
USDW	Underground source of drinking water
UV	Ultraviolet light
UVT	Ultraviolet transmittance
VT	Vertical turbine
WEF	Water Environment Federation
WTP	Water treatment plant

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Executive Summary

The South Florida Water Management District (SFWMD) develops long-term comprehensive regional water supply plans to provide for current and future water use, while protecting South Florida's water resources. Chapter 373, Florida Statutes (F.S.), requires the SFWMD to prepare water supply plans for regions where projected water demands have the potential to exceed available supply over the next 20 years. The SFWMD has committed to preparing regional water supply plans for all the basins within its jurisdiction and to updating these plans every five years. As part of this effort, it is necessary to estimate the costs of water supply alternatives. In addition, the SFWMD has an established on-going alternative water supply funding program. Current development costs of alternative water supply options are used to evaluate these proposals.

SFWMD has tasked CDM with estimating the costs of various alternative water supplies in the District's four planning areas in terms of capital, operation and maintenance (O&M), and total production costs on a unit cost basis expressed in dollars per 1000 gallons. Treatment facilities with the following production plant capacities are examined: 5 mgd, 10 mgd, 15 mgd, and 20 mgd. These capacities refer to the maximum daily flows (for water treatment methods) and annual average flows (for wastewater treatment methods). This report provides estimates of costs for wells, water treatment methods and individual components, wastewater treatment methods, deep injection well disposal, aquifer storage and recovery, and surface water storage projects.

CDM has developed opinions of probable cost for various technologies. All costs are assumed to be current as of August, 2006 unless otherwise indicated. They are considered to be order-of-magnitude estimates as defined by the American Association of Cost Engineers. These are estimates made without detailed engineering data. These opinions of probable cost are considered to be accurate within +50% or -30%. Plots of construction, O&M and total production cost curves are provided for each treatment technology with the +50%/-30% envelope plotted in addition to the probable cost curve.

Costs of water infrastructure have risen significantly in recent years. This rise has been manifested in higher fuel and labor costs and increased materials costs, especially those of steel, cement and petroleum based products such as PVC pipe. These increases can be partially attributed to hurricanes in 2004 and 2005. Within Florida the damage caused by the hurricanes increased the demand for construction materials and in the Gulf Coast area adversely impacted the availability of PVC pipe and other petroleum based products. Drilling equipment and supplies are now selling at premium prices as they are also utilized in oil and gas drilling which has also experienced rapid growth. The significance is that the recent instability in prices makes it harder to assure that the costs are accurately presented at August 2006 price levels.

In the future capital costs presented in this report can be periodically updated through use of the Engineering News Record, Construction Cost Index (ENR CCI).

The opinion of probable capital cost includes individual process and plant component items followed by general plant improvements (such as yard piping, electrical, instrumentation and controls) that are estimated by a factor applied to the process/plant component subtotal. The contractor's administrative costs are also included in the capital cost and these include general requirements, overhead and profit, and construction contingency. The opinion of probable construction cost is presented as a subtotal. This cost may be considered to be comparable to a general contractor's "bid price" for the traditional design-bid-build project delivery method.

The "owner's costs" are presented following the opinion of probable construction cost. These include technical services (e.g., engineering design, permitting, surveying, geotechnical engineering, engineering services during construction, etc.), owner administration and legal (e.g., internal expenses associated with project management and administration), and project contingency (for unknowns related to design conditions, water quality, etc.).

The total opinion of probable capital cost is presented as the sum of the above items. To compare the costs for various technologies, capital investments are converted to equivalent annual capital costs. The parameters used in this amortization of initial capital investment are a term of 20 years and a discount rate of seven percent (7%). The 20-year term approximates the overall cost-weighted useful life of the capital investment in facilities and equipment. The seven percent discount rate reflects an "all-in" interest cost, including issuance costs, debt service reserve, and capitalized interest during construction, all of which are items not considered when expressing an average coupon interest rate.

The opinion of annual operation and maintenance (O&M) cost is developed for each technology. This cost is broken up into variable and fixed costs. Variable costs include items such as power, chemicals, and replacement parts and materials. These costs vary in proportion to the amount of finished water produced by the plant over the study period. Fixed costs include labor (plant staffing), administration, and regulatory compliance that are independent of the water production rate.

CDM also presents an opinion of total production costs for each technology. The total production costs include the annualized capital cost, the annual O&M cost for each production rate and an annual renewal and replacement (R&R) fund deposit that is not included as part of the O&M costs. The annual R&R fund deposit is equal to 10 percent of the equivalent annual capital cost and is for replacement of major equipment during the course of the 20-year service life of the facilities. As with the O&M costs, annual production costs are given for two cases, production equal to the plant capacity rating, and production equal to the annual average day demand (AADD).

ES.1 Well and Wellhead Construction and Operation and Maintenance (O&M) Costs

Well construction costs were obtained from utilities within each of the four planning areas. In addition, two drilling firms provided review of the costs. Costs obtained for the most part were either bid tab costs, information from utility personnel, or engineer's opinions of probable cost. Well costs have rapidly increased over the past several years as addressed above. Well construction costs have generally risen faster than the ENR CCI and for this reason, the best estimates of well construction costs are bids that are very recent. In cases of older wells, costs have been adjusted using ENR CCI to August 2006 to provide the most realistic approximation of current well costs.

Well cost evaluations can be affected significantly by many factors. Economies of scale are important because the bid for a large number of wells may be very different per well than if only one well is bid. Bids between contractors can vary significantly and participation by a given set of contractors can have an important impact on the ultimate successful bid. Site specific variables and specification variations such as the amount of site work, size of site, location of utilities, proximity to environmentally sensitive areas, access to construction water and disposal requirements as well as site specific geology impact price materially.

The well construction costs represent well construction, development, and a nominal amount of testing. Additional testing for test production wells including drilling deeper, continuous coring and packer tests generally adds about $200,000 to the overall cost of construction based on bids examined in this study. The wellhead installation costs include well pad, submersible pumps and motor, mechanical and electrical, telemetry, valves, and flowmeter.

Well costs presented are believed to be typical of what wells would have cost as of August 2006.

Table ES-1 Typical Well Costs for SFWMD Upper East Coast Planning Area

Aquifer	Casing Material	Well Depth (feet)	Cased Depth (feet)	Inner Casing Diameter (inches)	Capacity (gpm)	Well Construction Cost	Wellhead Installation Cost
Surficial	PVC	100-160	68-100	12-20	150-700	$110,000	$320,000
Floridan	PVC	1250	500	12	1400	$630,000	$500,000

Table ES-2 Typical Well Costs for SFWMD Lower East Coast Planning Area

Aquifer	Casing Material	Well Depth (feet)	Cased Depth (feet)	Inner Casing Diameter (inches)	Capacity (gpm)	Well Construction Cost	Wellhead Installation Cost
Surficial	PVC	235	191	25	800	$210,000	$320,000
Biscayne	PVC	150	90	24	700-1400	$100,000	$320,000
Floridan	PVC/FRP	1480	1200	12-24	1400	$610,000-$650,000	$500,000

Table ES-3 Typical Well Costs for SFWMD Lower West Coast Planning Area

Aquifer	Casing Material	Well Depth (feet)	Cased Depth (feet)	Inner Casing Diameter (inches)	Capacity (gpm)	Well Construction Cost	Wellhead Installation Cost
Lower Tamiami	FRP	120	80	12	700	$50,000	$450,000
Hawthorn Zone 1	FRP	700	450	16	350	$200,000	$450,000
Lower Hawthorn	FRP	1100	750	16	1000	$360,000	$500,000
Floridan	PVC	1400	1050	16	1000	$460,000	$730,000

Notes: PVC - polyvinyl chloride pipe
FRP - fiberglass reinforced plastic

Table ES-4 Typical Well Costs for SFWMD Kissimmee Planning Area

Aquifer	Casing Material	Well Depth (feet)	Cased Depth (feet)	Inner Casing Diameter (inches)	Capacity (gpm)	Well Construction Cost	Wellhead Installation Cost
Upper Floridan	Steel	600	200	18-24	2500	$300,000	$160,000
Lower Floridan	Steel	1350	850	24	4200	$660,000	$180,000

O&M costs were provided by only a small number of utilities. Power costs were based on a rate of $0.10/KWh. Surficial aquifer wells have significant O&M costs by comparison with Floridan aquifer wells because of screen deterioration, siltation, iron bacteria growth and calcium encrustation.

Table ES-5 Typical Well Operations and Maintenance (O&M) Costs

Planning Area	Aquifer	Electrical Costs ($/1000 gallons)	Maintenance and Repair ($/1000 gallons)	Total O&M Costs ($/1000 gallons)
Lower West Coast	Combined aquifer usage	0.080	0.040	0.120
Upper East Coast	Surficial	0.047	0.059	0.106
	Floridan	0.036	0.003	0.040
Lower East Coast	Surficial	0.047-0.08	0.030-0.059	0.106-0.110
	Floridan	0.036-0.047	0.003	0.040-0.050
Kissimmee Basin	Floridan	0.036	.003	.040

ES.2 Water Treatment Technologies

CDM has developed opinions of probable capital, operation and maintenance (O&M), and total production costs for various potable water treatment technologies, treatment process and plant components, and disinfection technologies. In addition to general opinions of cost for these components, which are provided for plant capacity increments of 5, 10, 15, and 20 million gallons per day (mgd) on a maximum day

demand (MDD) basis, specific recent Florida project case studies are summarized for reference, as noted below.

Within this Section, the assembled cost data are broken up into the following four general groups of tables:

- General Water Treatment Technologies: This cost data set can be viewed as comprising costs for developing completely new plants of various capacity ranges and various treatment technologies (costs for finished water storage and high service pumping costs are not included). The capital costs include: raw water supply, pretreatment, process equipment, post treatment, intermediate storage (clearwell), transfer pumping, plant infrastructure, residuals disposal, yard piping, electrical, instrumentation and controls, site work, general requirements, contractor overhead and profit, construction contingency, technical services, owner administration, legal, and project contingency. Treatment technologies examined include various membrane processes, as well as a case study of a fresh surface water supply (i.e., the Tampa Bay Actiflo Surface Water project). The cost tables under this category include development of the raw water supply, either groundwater wells or surface water intake, as appropriate for the specific technology and indicated in **Table ES-6**.

Table ES-6 Summary of Opinion of Probable Costs for Various Treatment Technologies

Plant Capacity (MGD)	Raw Water Source	Concentrate Disposal	Capital Cost	Annual O&M Cost	Production Cost ($/1000 gallons)[a]
Microfiltration/Ultrafiltration					
5	Surface Water	Note 1	$14,191,000	$1,078,000	$2.10
10	Surface Water	Note 1	$24,397,000	$1,720,000	$1.57
15	Surface Water	Note 1	$33,064,000	$2,289,000	$1.36
20	Surface Water	Note 1	$41,025,000	$2,841,000	$1.22
Nanofiltration					
5	Groundwater	Deep Injection Well (DIW)	$24,178,000	$1,646,000	$3.42
10	Groundwater	DIW	$33,576,000	$2,836,000	$2.34
15	Groundwater	DIW	$41,573,000	$3,913,000	$1.95
20	Groundwater	DIW	$50,188,000	$4,992,000	$1.75
Brackish Water RO-Groundwater					
5	Groundwater	DIW	$34,693,000	$1,758,000	$4.41
10	Groundwater	DIW	$48,579,000	$3,181,000	$3.04
15	Groundwater	DIW	$64,086,000	$4,526,000	$2.65
20	Groundwater	DIW	$79,077,000	$5,910,000	$2.42
Brackish Water RO-Surface Water					
5	Surface Water	DIW	$37,594,000	$1,846,000	$4.73
10	Surface Water	DIW	$48,963,000	$3,371,000	$3.13
15	Surface Water	DIW	$62,180,000	$4,818,000	$2.68
20	Surface Water	DIW	$76,073,000	$6,310,000	$2.43
Seawater RO Co-Located with Power Plant					
5	Surface Water	Coolant Water Outfall	$39,429,000	$3,145,000	$5.95
10	Surface Water	Coolant Water Outfall	$64,094,000	$6,230,000	$4.77
15	Surface Water	Coolant Water Outfall	$92,828,000	$9,248,000	$4.48
20	Surface Water	Coolant Water Outfall	$115,436,000	$12,432,000	$4.18

Note 1: MF/UF do not produce a concentrate steam as with NF and RO systems. Residuals need to be removed from the backwash water and chemicals in the backwash solution may require neutralization prior to disposal.
[a] Annual O&M and production costs are based on average daily demand using a maximum daily demand/annual average daily demand ratio.

- Water Treatment Technology Process Components: This cost data set can be viewed as comprising costs for adding incremental treatment process capacity to an existing water treatment plant (not including raw water supply or other ancillary equipment that is likely to already be available on an existing water treatment plant site). Treatment technologies examined include nanofiltration and reverse osmosis membrane processes. This data set is reflected in **Table ES-7**.

Table ES-7 Summary of Opinion of Probable Costs of Water Treatment Plant and Distribution Components

Capacity (MGD)	Capital Cost	Annual O&M Cost	Production Cost ($/1000 gallons)
Nanofiltration Treatment Units			
5	$20,863,000	$1,646,000	$3.13
10	$27,066,000	$2,836,000	$2.09
15	$33,424,000	$3,913,000	$1.75
20	$39,080,000	$4,992,000	$1.55
Brackish Water RO Treatment Units			
5	$26,297,000	$1,757,000	$3.69
10	$31,787,000	$3,180,000	$2.40
15	$38,905,000	$4,525,000	$2.03
20	$45,500,000	$5,909,000	$1.82
High Service Pumping Capacity			
5	$918,000	$86,000	$0.15
10	$1,350,000	$187,000	$0.12
15	$1,594,000	$290,000	$0.11
20	$2,029,000	$401,000	$0.10
Ground Storage Tanks			
5	$1,515,000	*	$0.12
10	$2,754,000	*	$0.10
15	$3,715,000	*	$0.08
20	$4,402,000	*	$0.07

*Included in plant operation and maintenance labor.

- Water Distribution Plant Components: This cost data set may be viewed as comprising costs for water treatment plant components that are likely to be common among the various treatment technologies for each capacity increment examined. Plant components examined include finished water storage and high service pumping (components which were not included in the first group of tables). This data set is reflected in Table ES-7.

- Disinfection Plant Components: This cost data set is similar to the third group, except that various technologies for the disinfection process component are examined. The disinfection technologies examined include on-site generation of sodium hypochlorite, ozone, and ultraviolet light (UV). This data set is reflected in Table ES-8.

Table ES-8 Summary of Opinion of Probable Costs for Various Disinfection Technologies

Capacity (MGD)	Capital Cost	Annual O&M Cost	Production Cost ($/1000 gallons)
On-site Generation of Sodium Hypochlorite			
5	$2,530,000	$18,000	$0.23
10	$4,264,000	$36,000	$0.18
15	$5,778,000	$54,000	$0.16
20	$7,172,000	$72,000	$0.14
Ozonation			
5	$2,823,000	$69,500	$0.30
10	$4,350,000	$101,600	$0.20
15	$5,740,000	$133,700	$0.17
20	$6,943,000	$167,300	$0.15
Ultraviolet Light (UV)			
5	$909,000	$48,600	$0.12
10	$1,804,000	$64,200	$0.09
15	$2,893,000	$80,100	$0.09
20	$3,915,000	$98,200	$0.09

Opinions of probable capital, O&M, and total production cost are presented for the following treatment technologies, process components, and plant components:

General Water Treatment Technologies

- Microfiltration/ultrafiltration (MF/UF).
- Nanofiltration (NF).
- Brackish ground water reverse osmosis (low pressure), (LPRO) with deep injection well disposal of concentrate.
- Brackish surface water reverse osmosis (low pressure), (LPRO) with deep injection well disposal of concentrate.
- Seawater reverse osmosis (SWRO) co-located with a power plant.

Water Treatment Technologies – Case Studies

- SWRO surface water case study - 29 mgd Tampa Bay Seawater Water Treatment Plant co-located with Tampa Electric power plant with concentrate discharge to the cooling water outfall from the power plant.
- Fresh surface water case study – 66 mgd Tampa Bay Surface Water Project.

Water Treatment Technology Process Components

- NF process units.
- RO process units.

Water Distribution Plant Components

- Finished water storage plant component.
- High service pumping plant component.

Disinfection Plant Components

- On-site generation sodium hypochlorite disinfection.
- Ozone disinfection.
- Ultraviolet light (UV) disinfection.

The majority of the water treatment technologies addressed in the cost tables utilize membranes. MF membranes generally have pore sizes of 0.1 to 0.2 micron range. UF membranes generally have smaller pore sizes, in the 0.01 to 0.04 micron range. Common contaminant particle size ranges vary from 5 to 15 micron for Giardia, 3 to 5 micron for Crypto, and 0.01 to 0.1 micron for viruses. The pore sizes for MF/UF membranes are much smaller than the typical particle size for Giardia and Crypto, so theoretically, MF/UF should provide essentially 100% removal of these contaminants. Due to their smaller size, MF is not as effective in removing viruses, while a higher level of removal could be expected from with UF membranes.

NF membranes are generally effective in the .001 to .01 micron particle size range. This makes them effective at removing high molecular weight molecules (e.g., dissolved organics such as disinfection by-product precursors) and hardness ions. This is the reason NF membranes are commonly applied in softening applications, and the technology is sometimes referred to as "membrane softening".

RO membranes are effective at removing dissolved ions (aqueous salts), and are therefore effective in desalination of brackish and sea water raw water supplies. Due to the level of removal efficiency, a typical RO application may require a raw water blend stream (bypassing the RO process) with the finished water, and/or the post-treatment addition of calcium hardness, alkalinity, and corrosion inhibitor to produce a stable finished water that does not present corrosion concerns with the downstream distribution system.

ES.3 Reclaimed Water Treatment Technologies

Capital, Operation and Maintenance (O&M), and production cost tables and curves were developed to add advanced treatment facilities to existing secondary treatment plants. Costs include capital and O&M costs for design plant capacity of 5 MGD, 10 MGD, 15 MGD, and 20 MGD.

Advanced Wastewater Treatment (AWT) Bardenpho Process

AWT refers to a level of treatment that meets effluent limits of 5 mg/L Total Suspended Solids (TSS), 5 mg/L Carbonaceous Biochemical Oxygen Demand (CBOD5) , 3 mg/L Total Nitrogen (TN), and 1 mg/L Total Phosphorus (TP) on an annual average basis. Many process configurations have been developed for activated sludge systems to accomplish biological nutrient removal (BNR). The selection of a BNR configuration depends heavily on the influent wastewater characteristics and effluent requirements. One configuration that is commonly used in Florida to provide high levels of nitrogen and phosphorus removal is the five-stage Bardenpho process. These cost estimates assume a five-stage Bardenpho process configuration for nutrient removal and deep bed filters after secondary clarification to further remove TSS, and consequently the incremental BOD5, phosphorous, and nitrogen included in the suspended solids.

Membrane Bioreactor (MBR)

For the MBR option, the design rates represent the annual average daily flows. Peak factors were considered in the probable capital cost when applicable. The O&M cost is based on the annual average flows. The modified Ludzack – Ettinger (MLE) process is assumed for the MBR configuration. The construction costs of the MBR plants are based on the following process modules: influent pumping, preliminary treatment, anoxic and aeration tanks, membrane tanks, UV disinfection, effluent pump station, and sludge treatment and handling. Sludge treatment includes thickening, stabilization, and dewatering to produce a Class B product for land application. Previous CDM studies, MFR equipment costs, construction bids, and technology cost curves were used to determine cost estimates.

Microfiltration/Reverse Osmosis (MF/RO)

MF/RO facilities include 2-mm fine screening, microfiltration (MF) system, and a reverse osmosis (RO) system. Order-of-magnitude estimates are based on cost-capacity curves, scale factors, bid prices, technical literature, and probable costs from other studies. The design plant capacity (5 MGD, 10 MGD, 15 MGD, and 20 MGD) refers to the production capacity (RO permeate). Microfiltration System cost is based on a submerged microfiltration system. Cost includes equipment, concrete, and installation.

Reverse Osmosis System cost includes membranes, break tank, in-line pump station, and chemical feed and storage systems for pH adjustment and corrosion protection. The cost estimate is based on an RO system with 80 percent recovery rate.

Granular Media Filters with UV (GMF/UV)

Granular media filters include filter media, air/water distribution blocks, backwash blowers and pumps, backwash troughs, internal vales and piping, and instrumentation and controls. The granular media filters are followed by a UV medium pressure in vessel system which includes process equipment and instrumentation and controls. Granular Media Filters with UV include costs for the equipment, concrete, plant infrastructure, and installation. This technology is used for production of irrigation quality (IQ) water.

Costs associated with AWT, MBR, MF/RO, and GMF/UV are shown in **Table ES-9**.

Table ES-9 Summary of Opinion of Probable Costs for Various Wastewater Treatment Technologies

Plant Capacity (MGD)	Capital Cost ($ millions)	Annual O&M Cost ($ millions)		Production Cost ($/1000 gallons)	
Advanced Wastewater Treatment					
		12 Month	6 Month	12 Month	6 Month
5	$25.1	$1.4	$0.7	$2.20	$3.60
10	$40.3	$2.7	$1.4	$1.90	$3.00
15	$55.5	$4.0	$2.0	$1.80	$2.80
20	$70.0	$5.3	$2.7	$1.70	$2.70
Membrane Bioreactor					
5	$73.8	$2.2		$5.40	
10	$113.6	$3.6		$4.20	
15	$151.0	$5.1		$3.80	
20	$177.9	$6.9		$3.50	
Microfiltration/Reverse Osmosis					
5	$65.6	$3.3		$5.50	
10	$106.8	$6.3		$4.80	
15	$142.0	$7.2		$4.00	
20	$172.0	$9.6		$3.80	
Granular Media Filters with UV					
5	$6.2	$0.4		$0.59	
10	$12.1	$0.8		$0.58	
15	$18.1	$1.3		$0.57	
20	$23.0	$1.7		$0.56	

Note: Wastewater treatment plant capacities are average day flows.

ES.4 Deep Injection Wells (DIW)

Within the SFWMD only one contractor constructs DIW and that is Youngquist Brothers, Inc., of Ft. Myers (Youngquist). DIW used for the disposal of reverse-osmosis concentrate require a tubing-and-packer construction (TP).

The costs of DIW have risen dramatically in the past several years. According to Youngquist the cost of an average DIW with Tubing and Packer and with a monitor well is about $5.5 million in 2006 dollars. The annual O&M cost for a deep injection well is about $45,000 (**Table ES-10**). This cost includes labor associated with each O&M item below. Generally, for concentrate disposal, there are no additional power costs associated with disposal of concentrate down a deep injection well. The concentrate pressure from the membrane trains is usually sufficient to inject the concentrate without booster pumps.

Table ES-10 Class I Injection Well Operation and Maintenance Costs (2006)

Item	Annual Costs
Laboratory analyses	$14,650
Mechanical integrity test ($50,000 every 5 years)	$10,000
Operational Permit renewal (including application fee ($50,000 every 5 years)	$10,000
Allowance for miscellaneous repairs	$10,000
Estimated Total Cost	**$44,650**

ES.5 Aquifer Storage and Recovery Capital and O&M Costs

For SFWMD the average unit capital cost is $1.24 million per MGD of recovery capacity. This is the average of Hillsboro Canal and Kissimmee River unit costs including ASR well and monitor well construction, plus surface facilities, updated to August 2006. This cost reflects the higher yields of wells in this part of Florida, offsetting the relatively high investment costs in wellhead and pretreatment facilities. These are both for CERP projects storing partially treated surface water. Pretreatment includes wellhead filtration and UV disinfection. A reasonable estimate is that unit costs for water utility ASR wellfields within SFWMD will cost about $1.0 million per MGD of recovery capacity while CERP ASR wells will cost about $1.25 million per MGD recovery capacity. The difference in unit cost is primarily attributable to the need for pretreatment of recharge water for CERP projects.

Some differences may be anticipated in ASR unit capital costs within the four planning areas of the SFWMD, reflecting variability in hydrogeology, well depths and well yields. Potential ASR storage zones along the southwest coast of Florida may tend to be lower yielding than those along the southeast coast. Consequently relatively higher unit costs may be anticipated in the southwestern planning areas.

Only four sites provided information on operation and maintenance costs. These averaged $106,000 per year per MGD of recovery capacity, within a range of $61,000 to $173,000.

Table ES-11 SFWMD ASR Capital and O&M Costs

Type of ASR Facility	Capital Cost per MGD of Recovery Capacity[1]	Average Annual O&M Cost per year per MGD of Recovery Capacity
Water Utility ASR Wellfields	$1,000,000	$106,000 ($61,000 - $173,000)
CERP ASR Wellfields	$1,250,000	$106,000 ($61,000 - $173,000)

Note: 1) Capital cost includes ASR well and monitor well construction, plus surface facilities, updated to August 2006.

ES-6 Reservoir Costs

Capital and O&M costs for various SFWMD reservoirs are shown in **Tables ES-12 and ES-13**. The source of this information is the Acceler8 Progress Report, October 2006, except for the Tampa Bay Water's Surface Water Treatment Plant Reservoir. The Tampa Bay Water Reservoir is the only existing reservoir. Reservoir costs are estimated costs based on the current level of design for the projects and may change in the future. Costs do not include the costs associated with land acquisition.

Table ES-12 Reservoir Construction Costs

Storage Reservoir	Site 1 Impoundment[1]	C-44[1]	C-43[1]	Tampa Bay Water Reservoir[2]	C-9 Impoundment[1]	C-11 Impoundment[1]	EAA Reservoir[1]	Taylor Creek[4]
Design Cost	$6,566,991	$21,301,065	$12,749,672	$24,424,880	$7,565,303	$7,330,204	$16,790,481	$5,916,938
Interim Land Management Cost	$30,000	$2,467,414	$2,184,222	--	$57,551	$611,558	$485,465	$337,500
Construction Cost	$34,700,000	$316,000,000	$320,776,156	$175,561,971	$50,600,000	$77,600,000	$482,900,000	$116,115,520
Total Capital	$41,296,991	$339,768,479	$335,710,050	$199,986,851	$58,222,854	$85,541,762	$500,175,946	$122,369,958
Total Area (acres)[5]	1,660	12,657	10,489 [3]	980	1,804	1,790	16,414	4,785
Estimated Depth of Water (feet)	8	15	20 [3]	49	4	4	12	7
Estimated Storage Capacity (acre-feet)	13,280	50,200	170,000	47,570	6,600	5,960	190,000	32,000
Unit Capital Cost ($/acre-foot)	$3,110	$6,768	$1,975	$4,204	$8,822	$14,353	$2,633	$3,824

Notes:

1) Acceler8 Progress Report, October 2006. Costs are in October 2006 dollars. Total area is the total area of land acquired for the project, not the area of the reservoir.

2) Bid Comparison Worksheets, Tampa Bay Water Master Plan South Section, Tampa Bay Regional Reservoir Project/Reservoir Transmission Main Project

3) Phone correspondence with LuAnn McVicker, Project Manager, Acceler8 on November 13, 2006. Nominal depth of reservoir is 20 feet. Actual depths range from 15 feet to 25 feet.

4) Construction cost from latest version of Basis of Design Report, Opinion of Probable Construction Cost, 15% Design, October 2006. Cost is for Alternative 2-B with a reservoir footprint of 2,010 acres.

5) Total area is total area for the project but reservoir area may be a smaller footprint.

6) Interim Land Management Cost is not the cost of real estate but the cost of management of land already purchased.

Table ES-13 Reservoir Annual O&M Costs

Storage Reservoir	Site 1 Impoundment	C-44	C-43	Tampa Bay Water Reservoir	C-9 Impoundment	C-11 Impoundment	EAA Reservoir	Taylor Creek
Total Annual O&M Cost	$1,472,848	$2,243,603	$1,974,639	$3,463,195	$1,399,707	$1,724,797	$3,783,047	---
Total Area (acres)	1,660	12,657	10,489	980	1,804	1,790	16,414	4,785
Estimated Depth of Water (feet)	8	15	20 [a]	49	4	4	12	7
Estimated Storage Capacity (acre-feet)	13,280	50,200	170,000	47,570	7,216	7,160	190,000	32,000
Unit O&M Cost per ac-ft ($/ac-ft)	$111	$45	$12	$73	$194	$241	$20	--

Notes:

1)The source of this information is: "Opinion of Annual Operation and Maintenance Costs," Acceler8 Program, SFWMD, 2006.

2) O&M costs is the proposed Fiscal Year 2007 Budget which includes operation staff contract, security, mowing, water quality monitoring, electricity, chemicals, engineering , regulatory oversight, surveying, mitigation/ecological monitoring, and mitigation maintenance. Cost is in August 2006 dollars.

3) Total area is total area for the project but reservoir area may be a smaller footprint.

a) Phone correspondence with LuAnn McVicker, Project Manager, Acceler8 on November 13, 2006. Nominal depth of reservoir is 20 feet. Actual depths range from 15 feet to 25 feet.

ES.7 Opinion of Probable Pipe Costs

SFWMD requested the cost of installation per linear foot (LF) of ductile iron pipe (DIP). Unit prices include: transporting, storing, furnishing, and installing the pipe, removal and disposal of small trees and brush, excavation, dewatering, pipe bedding, backfilling and compaction cleaning and testing. Additionally, results from this analysis were compared to bid tabs from Fort Lauderdale and jobs being awarded in Dania Beach, City of Clewiston and Palm Beach County Lake Region Water Treatment Plant. Costs are estimated for August, 2006.

Table ES-14 summarizes the probable costs of installation per linear foot of DIP pipe for URBAN, SUB-URBAN and RURAL settings.

Table ES-14 Installed Pipe Costs Per Linear Foot

Diameter	COST OF PIPE ($)	Total Cost of installed DIP Pipe ($)	Total Cost of installed DIP Pipe ($)	Total Cost of installed DIP Pipe ($)
		URBAN	SUB-URBAN	RURAL
16-inch	43	95	78	60
20-inch	58	107	91	74
24-inch	79	184	149	106
30-inch	113	235	194	154

Section 1
Introduction

The South Florida Water Management District (SFWMD or District) develops long-term comprehensive regional water supply plans to provide for current and future water use, while protecting South Florida's water resources. Chapter 373, Florida Statutes (F.S.), requires the SFWMD to prepare water supply plans for regions where projected water demands have the potential to exceed available supply over the next 20 years during a 10-year drought. The SFWMD has committed to preparing regional water supply plans for all the basins within its jurisdiction and to updating these plans every five years. As part of this effort, it is necessary to estimate the costs of water supply alternatives. In addition, the SFWMD has an established on-going alternative water supply funding program. Current development costs of alternative water supply options are used to evaluate these proposals.

Chapter 373, F.S. (and as updated in Senate Bill 444 of 2005), requires that the regional water supply plans include a list of water resource options for water supply projects for local water users to meet their future water needs. Each water-source option and project should provide an estimated amount of water available for use, estimated development costs, potential sources of funding and a list of development projects that meet applicable funding criteria. Section 373.019, F.S., defines "water supply development" as the planning, design, construction, operation and maintenance of public or private facilities for water collection, production, treatment, transmission, or distribution for sale, re-sale, or end-use. This section further defines "Alternative Water Supplies" as: salt water; brackish surface and ground-water; surface water captured predominantly during wet-weather flows; sources made available through the addition of new storage capacity for surface or ground-water; water that has been reclaimed after one either public supply, municipal, industrial, commercial, or agricultural uses; the downstream augmentation of water bodies with reclaimed water; stormwater; and any other water supply source that is designated as non-traditional for a water supply planning region in the applicable regional water supply plan.

The SFWMD covers nearly 20,500 square miles and is divided into four regional planning areas that are generally defined by hydrologic divides, namely, Lower East Coast (LEC), Upper East Coast (UEC), Lower West Coast (LWC) and Kissimmee Basin (KB), as shown on the attached map (**Figure 1-1**). There are some notable differences between the regions in terms of water sources and uses. For example, the Floridan Aquifer is the primary source of water in the Kissimmee Basin where its quality is generally fresh.

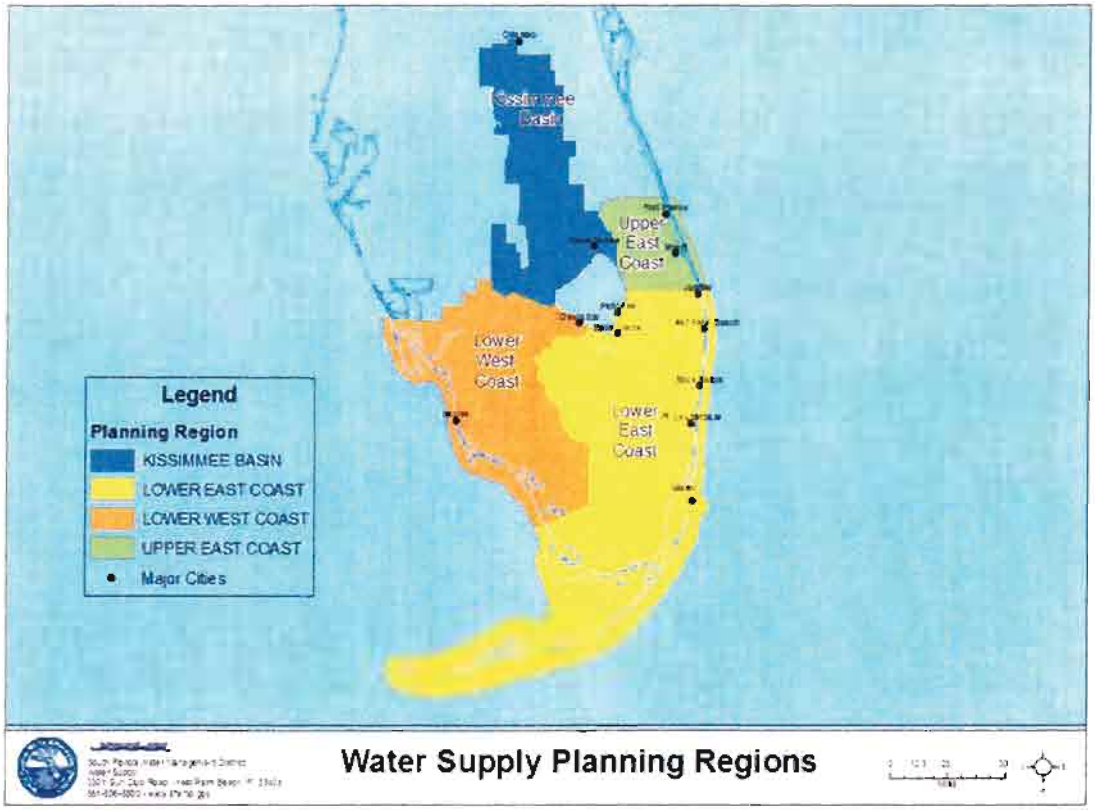


Figure 1-1

However, in most of the other areas of the SFWMD, the Floridan Aquifer is considered as an alternative source because its water quality is brackish and requires desalination treatment or blending with freshwater prior to use. The Lower West Coast region uses numerous aquifers to meet its urban and agricultural water demands. Although the Floridan Aquifer was in the past considered an alternative source of water supply in the LWC planning area, it is now becoming a major source because the use of freshwater aquifers has nearly been nearly maximized in places of the coastal portions of the region. By comparison, the Lower East Coast region relies heavily on the surficial aquifer, especially the Biscayne Aquifer to meet its demands but Floridan aquifer usage is increasing.

The water supply planning efforts help to identify major roles for individual water users, utilities, regional water suppliers and the SFWMD in meeting the future demands for water in South Florida by environmentally compatible means. Individual water users are expected to have a role in developing their individual source of supply as well as irrigation systems which follow cost-effective water conserving practices. Utilities may develop wellfields and supplement their withdrawal capabilities through aquifer storage and recovery (ASR) systems and by desalination of brackish groundwaters. Utilities may also select the appropriate water treatment methods to meet customer needs and potable drinking water standards.

Furthermore, utilities are encouraged to implement long-term water conservation programs to assure the effectiveness of water use.

As part of the SFWMD's mission to promote development of alternative water supplies, grants are offered to entities seeking to develop cost-effective, safe and appropriate alternative water supplies. Using alternative water sources can greatly offset the growing demand on South Florida's natural supplies of freshwater and reduce potential for environmental impact.

In 1995, Florida's legislature initially directed the state's five water management districts to share revenues from property tax assessments with public and private entities willing to develop suitable alternative water supplies. Subsequently, in 2005, the Legislature authorized a new program (under Senate Bill 444) that provides annually recurring State funding, in conjunction with SFWMD funds, to assist water users in the development of alternative water supplies.

Current water supply plans have concluded that historically used freshwater sources will not be sufficient to meet all the future water needs of South Florida. An important step in water supply planning and implementation involves investigating and developing alternative water resources to offset increased use of fresh ground and surface water.

Section 2
Objectives

Water supply development costs are key factors for evaluating alternatives in water supply plans. In current water supply planning efforts, the District relies primarily on the cost estimates that were developed by a contractor (PBS&J) in 1989 and cost information obtained from the St. Johns River Water Management District (SJRWMD) Special Publication SJ99-SP4 titled 'Water Supply Needs and Sources Assessment - Alternative Water Supply and Wastewater Systems Component Cost Information". The cost information contained in the SJRWMD document was updated to reflect 2006 dollars using a projected 2006 Engineering New Record's Construction Cost Index.

The objective of this project is to provide the SFWMD with current engineering cost data and cost estimation relationships and curves for evaluating water supply alternatives for South Florida, including options that involve groundwater, surface water, seawater, reclaimed water and storage options, such as ASR and reservoirs, that make water sources available during times of the year that they are not typically available. Where treatment technologies are addressed, the costs associated with facilities of 5 mgd, 10 mgd, 15 mgd and 20 mgd have been evaluated. Where larger systems have been developed for some technologies, such as surface water treatment and seawater treatment, actual plant sizes and their costs have been addressed.

This report investigates the costs of various alternative water supplies in the District's four planning areas in terms of capital, operation and maintenance (O&M), and total production costs on a cost/1000 gallons basis. Costs are planning level estimates. Plots of construction and total production cost curves are provided for each treatment technology, with the +50%/-30% envelope plotted in addition to the estimated cost curve. Costs presented in this report are with respect to August 2006. Through use of the Engineering News Record, Construction Cost Index (CCI), these costs can be periodically updated with respect to CCI at future points in time.

Section 3
Scope of Work

The purpose of this effort is to identify the most relevant water supply facilities and their development costs and to provide cost data and curves for predicting future system costs. This scope of work includes planning level costs for various water source options in South Florida, including groundwater (both fresh and brackish), surface water, stormwater, reclaimed water, seawater, and ASR water.

The cost information is based on various water treatment technologies that use membrane processes such as nanofiltration, ultrafiltration, microfiltration, and reverse osmosis (RO), including both low and high pressure RO. Three advanced wastewater treatment processes including advanced wastewater treatment (AWT) Bardenpho, membrane bioreactor (MBR), and a combination of microfiltration and RO were examined. Specific sections of treatment plants that could be considered add-on items were also examined including membrane treatment units, high service pumping capacity and ground storage tanks. Chlorination technologies evaluated include on-site chlorine generation, ozonation, and ultraviolet light. The capital cost is presented in millions of dollars. The operation and maintenance (O&M) costs are annual costs in millions of dollars. The production costs are in terms of dollars per 1000 gallons of product water. The unit production costs are computed based on financing of a particular facility at a 7 percent interest rate over a 20-year period.

The construction cost information for each water supply component or technology is the total estimated amount expected to be paid to a qualified contractor to build the required facilities, including costs for all materials, equipment and installation. Non-construction costs include engineering design, permitting, administration and construction contingency associated with the constructed facilities.

The O&M costs are the costs of operating and maintaining the water supply system components each year. These costs include the energy costs, chemical costs, component (e.g., desalination membrane) replacement costs, and labor costs.

Where appropriate, CDM has identified the appropriate cost escalation factors based on the Engineering News Record Construction Cost Index and placed cost estimates in a consistent base, namely, August, 2006 dollars. The sources of the cost escalation factors are specified so that the relationships can be updated to consistent future year dollars. However, it should be pointed out that well construction costs appear to be escalating at a much faster rate than the ENR CCI; well construction costs are best indicated by the most recent bids.

Section 4
Capital and O&M Costs for the Construction and Outfitting of Wells

Capital and O&M costs for the construction and outfitting of wells have been researched for each of the following water supply planning areas:

- Lower West Coast including the Lower Tamiami, Mid-Hawthorn and Lower Hawthorn aquifers;
- Lower East Coast including the Floridan aquifer and Biscayne Aquifer;
- Upper East Coast for the Floridan aquifer; and
- Kissimmee Basin for the Floridan aquifer.

4.1 Lower West Coast

The data collected for the Lower West Coast includes costs for Lower Tamiami, Hawthorn Zone I, Lower Hawthorn, and Floridan aquifer public supply wells including well pumps and associated wellhead facilities; and operation and maintenance costs (O&M) for the various types of wells including power costs to run the submersible pumps that are favored by most of the utilities in this area. The methods and procedures utilized during the investigation and the results obtained are presented below.

4.1.1 Data Collection

A number of sources were contacted to obtain information regarding public supply well costs in the Lower West Coast Region of South Florida. The well drilling companies solicited include: Youngquist Brothers Drilling, Diversified Drilling Corporation, Southeast Drilling Services and Wells and Water Systems, Inc. Collier County and the City of Cape Coral water department staffs were contacted to obtain information regarding operation and maintenance costs for the wells they operate. The firms of JLA Geosciences Inc., Barnes Ferland and Associates, and Missimer Groundwater Science Inc., were contacted. Suppliers of PVC and fiberglass well casing were also solicited for information.

4.1.2 Well Costs

Public supply production well costs have increased significantly over the past two to three years in the Lower West Coast Region of Florida. For example, bids from Diversified Drilling Corporation for Hawthorn Zone I and Lower Hawthorn aquifer wells for Collier County during July of 2004 ranged from $155K to $185.5K (two phases of construction) for the Hawthorn Zone I wells and $199K for the Lower Hawthorn wells. These wells were constructed to supply brackish water to the North County Regional Water Treatment Plant (NCRWTP) during the period from October

2004 through February 2006. The actual constructed costs for the wells averaged approximately $130K and $160K, respectively for the Hawthorn Zone I wells for each phase of construction and $180K for the Lower Hawthorn wells. Bids received from Diversified Drilling Corporation for Hawthorn Zone I and Lower Hawthorn reliability wells currently under construction in the Collier South reverse osmosis wellfield came in at $200K for Hawthorn Zone I wells and $360K for Lower Hawthorn wells. It should be noted that the above costs are for well construction, development, and testing only. Costs for submersible pumps, well houses, wellhead completions and other appurtenances are not included.

The bid price for the Hawthorn Zone I wells increased approximately 17.5 percent in two years while the bid price for the Lower Hawthorn wells increased almost 81 percent during the same period. Conversely, the overall construction cost index (CCI) compiled by the Engineering News Record (ENR) only increased by approximately 8 percent during the period from July 2004 to July 2006. The cost for Burgess 16-inch diameter fiberglass well casing increased by approximately 18 percent during the period from January 2002 to June 2006 or roughly 4 percent per year.

The rapid increase in well costs can be attributed to a number of factors including: higher fuel and labor costs, increased materials cost, impacts of hurricanes Charlie (August 2004) and Katrina (August 2005), and the basic economic principle of supply and demand. Southwest Florida has experienced very rapid growth over the last few years. Work for contractors has been abundant in part caused by the availability of funding from the SFWMD which has contributed to cost escalation. Damage caused by the hurricanes increased the demand for construction materials and adversely impacted the availability of PVC pipe and other petroleum based products. Steel and cement prices have also increased significantly over the past few years which impacts well construction costs.

4.1.3 Well Pumps and Appurtenances

The majority of municipal public supply wells in the Lower West Coast Region utilize submersible pumps for withdrawal purposes. Pump horsepowers typically range from 40 hp up to 125 hp for wells that generally yield from 0.5 million gallons per day (mgd) to 1.5 mgd. The majority of well pumps currently in use by utilities in the region range from 50-75 hp. The wells are often enclosed in a vault, well house, or placed on a cement slab at a minimum.

Various valves, fittings, electrical and mechanical work, control panel, and a flowmeter typically complete the wellhead. Estimated costs for outfitting production wells with pumps and associated equipment were determined based on actual bid costs received by Collier County, the City of Clewiston, and the Lakes Region Water Treatment Plant. The cost typically ranges from $400K to $750K and includes provision of power (electrical feed) and telemetry for remote operation and monitoring of the wells (SCADA). A summary of estimated 2006 well costs is provided in **Table 4-1**. Estimated cased and total depths for the wells are provided in

the table along with anticipated pump horsepowers. It should be noted that aquifer depths and pump sizes can vary with location. For example, in Cape Coral the Lower Hawthorn aquifer is tapped for raw water supply but the well depths are similar to those listed for Hawthorn Zone I wells in Table 4-1. In addition, some utilities prefer to utilize alternative casing materials which can impact well construction costs.

Table 4-1 Estimated Well Cost Summary (2006) for Production Wells in the Lower West Coast Planning Area

Aquifer	Inner Casing Diameter (Inches)	Casing Material	Total Depth (FT)	Casing Depth (FT)	Submersible Pump (HP)	Well Capacity (gpm)	Well Construction Cost	Wellhead Cost
Lower Tamiami	12	FRP	120	80	60	700	$50,000	$450,000
Hawthorn Zone 1	16	FRP	700	450	40	350	$200,000	$450,000
Lower Hawthorn	16	FRP	1100	750	75	1000	$360,000	$500,000
Floridan	16	PVC	1400	1050	75	1000	$460,000	$730,000

The costs provided for production wells also include wellhead equipment costs. Wellhead equipment includes: submersible pumps and motors, electrical supply, flowmeter, valves, and miscellaneous fittings.

The above costs are based on recent (2006) bids for wells constructed for Collier County and other public supply utilities in the southwest Florida region. It should be noted that well construction costs are very volatile and the sizes, depths, and equipment requirements of the different types of wells may vary considerably which impacts the final cost of construction. There is also a significant economy of scale. The unit cost per well is typically significantly less in multiple well projects compared to single well projects. The costs provided in the table do not include fees for design, permitting, construction management, property acquisition or easement purchase and do not include transmission piping from the wells to a treatment facility. These tasks can add from $200K to over $500K per well depending upon land costs and the amount of transmission piping required. For example, the turn key construction cost for five new Lower Tamiami aquifer production wells to be constructed during 2008 for Collier County was estimated to be $5.8 million or approximately $1.2 million per well in the draft Potable Water Supply Development Plan prepared by CDM (November 2005). Typically design and construction management of wells is equal to about 15 percent of the construction cost although this may vary considerably.

The City of Cape Coral recently expanded their Southwest Reverse Osmosis Water Treatment Plant and Production Wells. The construction end date was May 30, 2006. Cape Coral provided the following information for expansion of their Lower

Hawthorn wellfield (Wells 112, 226, 227, 228, 229, 230, 231, 232). The wells are all 12 inches in diameter. Cased depth ranges from 435-470 feet and total depth ranges from 700 to 721 feet. Flow from each well is 720,000 gallons per day. The basis for these costs was a bid tab. In this case, Montgomery Watson Harza (MWH) served as program manager and their costs are also shown in **Table 4-2**.

Table 4-2 Costs for City of Cape Coral's Southwest RO WTP Expansion of Eight Lower Hawthorn Production Wells

Total well drilling cost For 8 Lower Hawthorn Wells (included submersible pump cost at $33, 532)	$1,762,256
Cost per well + submersible pump	$220,282
MWH Costs	$280,393
Costs for outfitting 8 wells with pumps, electrical and instrumentation	$599,278
Cost for outfitting per well	$74,910
Insurance and bonds	$60,989
Contingency	$48,813
Total costs for 8 wells	$2,751,729
Cost per well	$343,966
Estimated O&M per well	$14,460

Cape Coral also provided an engineers estimate for the construction of 15 Lower Hawthorn production wells at their North Reverse Osmosis Plant. No facilities exist at this location and the construction end date is anticipated to be August 2007. The well drilling costs alone per well are estimated to be $300,000.

4.1.4 Well Operation and Maintenance (O&M) Costs

The primary operation cost associated with public supply production wells is power (electricity) to run the submersible well pumps. Maintenance for the production wells includes periodic well rehabilitation (acidification), motor replacement, and other minor equipment repairs. The O&M requirements and estimated costs for the various types of wells are described in more detail below.

4.1.5 Public Supply Production Wells

The majority of public supply production wells in the Lower West Coast Region are equipped with submersible pumps that are powered by electricity. The cost for operation of these pumps can be estimated using the following formula (Welldrillers Handbook):

$$\text{Power consumption (\$/hr)} = \frac{\text{Q (gpm)} \times \text{TDH (feet)} \times 0.746 \times \text{Power cost (\$/Kwh)}}{3960 \times \text{Efficiency (pump)} \times \text{Efficiency (motor)}}$$

Assuming a flow rate of 700 gpm (approximately 1.0 mgd) with 170 feet of total dynamic head, pump and motor efficiencies of 70 percent and 90 percent, respectively and continuous operation yields a monthly electric cost of approximately $2,500 per well. This is equivalent to approximately $.08/1000 gallons to pump water from the

production wells to the water plants. The Collier County water department was contacted to obtain billing data from FP&L in order to assess actual historic power costs for the wells. The water department has 30 accounts with FP&L that supply power to the production wells, high service pumps, and water treatment facilities. A cost factor of $0.10/Kwh was utilized in the above calculation based on the FP&L billing data provided by Collier County. The amount of power consumed by a particular well depends upon the motor horsepower, the TDH against which the pump must operate, number of hours used per day, and other factors. Monthly electric power billings for the County wells (both fresh and brackish water) range from less than $1,000 to over $3,000 per well. The power cost for Collier County to run both the South and North water plants and their respective wellfields for the 12 month period ending September 2006 was well over $2 million.

In addition to power, periodic maintenance is required for the pumping equipment and the wells themselves. Typical maintenance operations include well acidification, chlorination, replacing pump motors, and repairing valves and fittings. Estimated costs for these activities are provided in **Table 4-3**.

Table 4-3 Estimated Production Well Maintenance Costs Per Event (2006)

Maintenance Item	Cost Range ($1000)	Comments
Chlorinate	$1.5-3.5	Depends on well size
Acidify	$5.0-20.0	Depends on well size
Pull Pump and Motor	$2.5-5.0	Effect minor repairs
Replace Pump Motor	$4.0-12.5	Depends on horsepower
Replace valves, flowmeters, etc.	$1.0-10.0	Depends on equipment

The annual cost for routine wellfield maintenance and repairs depends on a number of factors including: the number of wells owned and operated by the utility, the age of the wellfield, the quality of the water, and other factors. The Collier County water department staff was contacted and asked to provide data regarding historic well repair and maintenance costs. Data for the period from October 2004 through June 2006 were obtained for work performed for the County by Diversified Drilling Company under a continuing services contract. During the last three months of 2004 and through 2005, average expenditures ranged from $50K-60K per month. This includes the fresh and brackish water wellfields operated by the County (approximately 60 operable wells). It should be noted that repairs and equipment replacements were common place during this period to improve wellfield reliability, particularly in the County North RO wellfield. Fees paid to Diversified Drilling Company during the first six months of 2006 averaged only $10K per month. Estimated average annual costs for production well maintenance and repairs range from $5K-10K per well. Assuming the higher figure of $10K per well, the cost for operation and maintenance of the production wells amounts to approximately $.04/1000 gallons. This does not include the cost for power to run the well pumps. For a well operating a 700 gpm, the power costs would be $0.08/1000 gallons. Total cost for power and well maintenance would be about $0.12/1000 gallons.

Groundwater withdrawals from the wellfields must be permitted with the SFWMD. The permits need to be renewed periodically and there are some monitoring requirements included with the permit limiting conditions. Water level and water quality monitoring are typically required. Permitting and monitoring costs are not very high and likely amount to less than $1,000 per well/year.

Construction costs for public supply production wells in the Lower West Coast Region of Florida have increased rapidly over the past three years and have outstripped the inflation rate. The cost for drilling and outfitting a public supply production well with a submersible pump and associated equipment ranges from approximately $500K for a Lower Tamiami aquifer well (shallow), to well over $1 million for a deep Floridan aquifer well. Costs for engineering, permitting, land acquisition, and transmission piping may add from $200K to over $500K per well for a complete installation.

4.2 Upper East Coast

Attached are summary tables of the costs for construction of wells in the Upper East Coast Planning Area. The costs were obtained from public sources and in some cases from personal communications with engineers and contractors in the well construction and well outfitting (wellheads and pumps) industry and from the files of JLA Geosciences, Inc. The wellhead construction cost information that was available is also included.

The costs for Floridan wells constructed at Martin County's Tropical Farms Water Treatment Plant, and North Water Treatment Plant, St. Lucie West Services District, and South Martin Regional Utility are shown in **Table 4-4**. These wells were constructed from the year 2000 to 2005 and show a range in costs from $328,820 to $428,596. The most recent well is the more costly well. As indicated for the Lower West Coast, construction of multiple wells usually results in less cost per well and costs for well drilling have risen dramatically.

David Mellert, Capital Projects Engineer for Ft. Pierce Utilities Authority (FPUA), in correspondence dated October 30, 2006 wrote that FPUA is attempting to "piggy back" on another publicly bid project. The project construction is scheduled to start in January 2007 and to be completed in August 2007. Preliminary discussion with well drillers have indicated that a 16-inch diameter Floridan well cased to 500 feet with a total depth of 1,250 feet and with a capacity estimated to be between 1,000 and 1,200 gallons per minute could cost between $500,000 to $600,000. Estimates for wellhead pumps and controls for a 60 horsepower installation are between $200,000 and $250,000. Total costs could range from $700,000 to $850,000 per new Floridan aquifer well.

Table 4-4 Floridan Aquifer Well System Costs SFWMD Upper East Coast (UEC) Planning Area

WELL LOCATION	UTILITY/OWNER WELL ID	CONSTR. DATE	CONSTR. COST INDEX (CCI) (3)	ORIGINAL CONSTR. COST	WELL DEPTH (FT)	CASING DEPTH (FT)	WELL CAPACITY (GPM)	CASING MATERIAL	CASING DIAMETER	AUGUST 2006 CCI (3)	ADJUSTED CONSTR. COST	WELLHEAD COSTS
Martin County	Martin County Utilities Tropical Farms WTP TFRO-1, 2, 3, 4, 5	12/2003	6782	$410,197	1367(1)	1125(1)	1400	PVC	16"x12" (4) open hole	7722	$467,051 (2)	NA
Martin County	Martin County Utilities North WTP RO-4	09/2000	6224	$335,790	1375	1065'	1578	PVC	16"x12" (4) open hole	7722	$416,608	NA
St. Lucie County	St. Lucie West Services District RO 1, 2, 3	06/2005	7415	$428,596	1195(1)	886(1)	1400	PVC	16"x12" (4) or 17.4" (5) open hole	7722	$446,341 (2)	NA
Martin County	South Martin Regional Utility RO-1, 2	02/2000	6160	$328,820	1495(1)	1225(1)	1400	PVC	16"x12" (4) open hole	7722	$412,199 (2)	NA

Notes:

1. Based on average well depth (as built)
2. Based on average well price (as built)
3. Costs indices obtained from the Engineering News Record publication.
4. Indicates wells built with two casing sizes for the final casing string (telescoped design).
5. Construction techniques and casing diameters varied between wells.

Limited information is available on O&M costs for Floridan aquifer wells in the Upper East Coast Planning Area. As indicated by Mellert from FPUA in his October 2006 letter, existing FPUA Floridan well electrical costs are approximately $1,500 monthly with each well pumping about 500 million gallons annually for an electrical cost of about $0.036/1000 gallons.

Table 4-5 presents information on the cost of surficial aquifer wells for the Upper East Coast Planning Area. Well costs are presented for Martin County's North Jensen Water Treatment Plant and Tropical Farms; South Martin Regional Utility and Ft. Pierce Utilities Authority Wells N1 and S1. For wells that are in the 100 ft to 160 ft depth range, the cost varied from $34,175 for a well constructed in 1999 to $91,200 (160 feet deep) for a well constructed in 2002. The most recent well constructed was in 2003 and that well was $85,852.

4.3 Lower East Coast

Appendix A shows the bids that were received for the Floridan aquifer wells at the Lake Region Water Treatment Plant on June 10, 2004. The low bid was for two wells at $450,000 each and then six additional wells at $341,500 each. Even though these wells were constructed only two years ago, the costs of wells have risen dramatically since then. **Appendix B** presents the bid tabulation from August 2006 for installation of pumps and other work associated with the Lake Region Water Treatment Plant. The unit price for pump installation for each of the Floridan wells was $492,000.

Table 4-6 presents information on the cost of other Floridan aquifer wells in the Lower East Coast Planning Area. Costs are presented for Floridan wells constructed for the Town of Jupiter, a confidential client in Broward County, FPL Turkey Point Unit 1, and the City of Lake Worth. Costs for these wells ranged from $461,696 for a well constructed in 2003 to $636,965 for a well constructed in June 2006. The wellhead cost for the FPL Floridan aquifer well on a per well basis is $333,232 based on a construction estimate; this estimate includes pump purchase and installation, pump structural support and foundation, and electrical and instrumentation installation. This cost is an average of three wells plus one monitoring well. The total construction and wellhead costs for the FPL Floridan aquifer wells on a per well basis is estimated to be $973,000; this cost is actually an over-estimation because it includes one-third of the cost of an associated monitor well.

Table 4-5 Surficial Aquifer Well System Cost SFWMD Upper East Coast (UEC) Planning Area

WELL LOCATION	UTILITY/OWNER WELL ID	CONSTR. DATE	CONSTR. COST INDEX (CCI) ([3])	ORIGINAL CONSTR. COST	WELL DEPTH	CASING DEPTH (FT)	WELL CAPACITY (GPM)	CASING MATERIAL	CASING DIAMETER	AUGUST 2006 CCI ([3])	ADJUSTED CONSTR. COST	WELLHEAD COSTS
Martin County	Martin County Utilities North Jensen Wells 11,12,13,14,15	05/2002	6512	$91,200	160'([1])	100'([1])	150-700	PVC	12" screened	7722	$108,146 ([2])	NA
Martin County	Martin County Utilities Tropical Farms Wells 19,22	04/2003	6635	$85,852	100'([1])	68'([1])	220	PVC	12" screened	7722	$99,917 ([2])	NA
Martin County	South Martin Regional Utility Well 8R	06/2002	6532	$32,977	100'	90'	260	PVC	20" open hole	7722	$38,985	NA
St. Lucie County	Fort Pierce Utilities Authority Wells N1 and S1	04/1999	6008	$34,175	112' ([1])	77' ([1])	350	PVC	12" screened	7722	$43,925 ([2])	NA

Notes:
1. Based on average well depth (as built)
2. Based on average well price (as built)
3. Costs indices obtained from the Engineering News Record publication.

Table 4-6 Floridan Aquifer Well System Costs SFWMD Lower East Coast (LEC) Planning Area

WELL LOCATION	UTILITY/OWNER WELL ID	CONSTR. DATE	CONSTR. COST INDEX (CCI) ([6])	ORIGINAL CONSTR. COST	WELL DEPTH	CASING DEPTH (FT)	WELL CAPACITY (GPM)	CASING MATERIAL	CASING DIAMETER	AUGUST 2006 CCI ([6])	ADJUSTED CONSTR. COST	WELLHEAD COSTS
Palm Beach County	Town of Jupiter RO 11-13	08/2003	6733	$461,696	1400'([1])	1168'([1])	1400	PVC	17.4" open hole	7722	$529,514 ([2])	NA
Palm Beach County	Seacoast Utility Authority Test Well	Bid Awarded	--	$810,000	TBD	TBD	TBD	PVC	16"x12" ([7]) open hole	--	$810,000 ([3])	NA
Broward County	Confidential Client	12/2004	7308	$527,000	1363'	913'	1400	PVC	10" open hole	7722	$556,855	NA
Miami - Dade County	FPL Turkey Point Unit 1 PW-1,3,4	06/2006	7700	$639,965	1246'([1])	1007'([1])	4500	FRP	24" open hole	7722	$641,793 ([2])	$334,184 ([5])
Palm Beach County	City of Lake Worth F-2	07/2006	7721	$605,826	1484'	1220'	1400	PVC	17.4" open hole	7722	$605,904	NA

Notes:
1. Based on average well depth (as built)
2. Based on average well price (as built)
3. Contract price for one well based on notice of award, well has not been constructed (personal communication with Allwebb's Enterprises, well contractor.
4. Contract price for one well from personal communication with Glen Miller, Miller Engineering, Inc. regarding a Floridan Aquifer well installed for a confidential client in southeastern Broward County.
5. Wellhead under construction. Price based on construction estimate. Original estimate was $333,232.
6. Costs indices obtained from the Engineering News Record publication.
7. Indicates wells built with two casing sizes for the final casing string.

Table 4-7 presents information on the cost of Floridan aquifer wells at the City of North Miami Beach. Floridan aquifer well costs for wells constructed in 2002-2003 and 2003-2005 ranged from $435,700 to $562,000, respectively. ENR CCI adjusted construction costs for the wells ranged from $502,536 to $593,756 when adjusted to August 2006. Well bids that were separated by about 15 months increased in cost by $126,000 per well or about 29 percent. Taking into consideration completion dates the ENR CCI increased by 9 percent over this same time period. The cost for outfitting each of the four wells with pumps and electrical systems (excluding piping) was $146,900. Total adjusted costs for construction and outfitting of the Floridan wells was $671,970 for the wells bid in 2002 and $748,957 for the wells bid in 2003. North Miami Beach also had some significant design and construction management costs as shown in Table 4-7. Total adjusted costs for the Floridan wells that included construction, outfitting of the wells, design and construction management costs ranged from $929,177 to $974,785 for North Miami Beach.

The most recent bid was for a Floridan aquifer test/production well not yet constructed by Seacoast Utility Authority at a cost of $810,000. Information on that bid is shown in **Appendix C**.

The engineer's opinion of probable construction cost for two Floridan aquifer test production wells in the City of Ft. Lauderdale Peele-Dixie WTP is shown in **Appendix D**. Drilling costs for the first well are estimated at $806,250 and for the second well, $550,950. With other fees, allowances and a 20 percent contingency, the estimated cost for the two wells is $1,646,640 if the plugging and abandonment costs of two production wells at $90,000 is subtracted from the total estimate. This cost represents some additional cost due to implementation of various testing procedures.

Table 4-8 presents information on the cost of surficial aquifer and Biscayne aquifer wells for the Lower East Coast Planning Area. Well costs are presented for the Town of Jupiter, City of Royal Palm Beach, Lake Worth Utilities, City of Ft. Lauderdale Dixie Wellfield and the Village of Palm Springs. Wells ranged in depth from 120 feet to 235 feet. The deepest well (235 feet) located in Lake Worth was also the most costly, $202,290 and was constructed in August 2005. Other well costs for wells in the range of 120 feet to 147 feet deep, ranged in cost from $64,420 to $190,000. Wellhead costs for the City of Lake Worth Well 9R were $161,700. Total construction cost together with wellhead cost for the City of Lake Worth Well 9R were $393,990.

Biscayne aquifer well construction at North Miami Beach with a bid date of September 2003 was $120,307 for a well with a casing diameter of 30 inches, a cased depth of 75 feet and a total depth of 90 feet (Production well No. 13). A second well with the same bid date was $111,307 with a casing diameter of 30 inches, a cased depth of 105 feet, and a total depth of 125 feet (Production well No. 17) based on information from the City.

Table 4-7 City of North Miami Beach Floridan Aquifer Well Costs

Well Name	Production Well 1F	Production Well 2F	Production Well 3F	Production Well 4F
County	Dade	Dade	Dade	Dade
Bid Date	Jun-02	Jun-02	Sep-03	Sep-03
Inner Casing Diameter (inches)	17.4	17.4	17.4	17.4
Casing Depth (feet)	1,000	1,000	1,000	1,000
Total Depth (feet)	1,250	1,250	1,250	1,250
Well Capacity (gallons per minute)	2,000	2,000	2,000	2,000
Pump Capacity (horsepower)	125	125	125	125
Completion Date	Jul-03	Jul-03	Mar-05	Mar-05
Midpoint of Construction	Dec-02	Dec-02	May-04	May-04
ENR CCI Value for Completion Date	6,563	6,563	7,065	7,065
August 2006 CCI ENR Value	7,722	7,722	7,722	7,722
Construction Cost ([1])	$435,700	$435,700	$562,000	$562,000
Adjusted Construction Cost	$512,643	$512,643	$614,262	$614,262
Cost to Outfit Wells	$146,900	$146,900	$146,900	$146,900
Bid Date	Jul-03	Jul-03	Mar-05	Mar-05
CCI ENR Value	6,695	6,695	7,309	7,309
Adjusted Cost to Outfit Wells	$169,434	$169,434	$155,201	$155,201
Total Adjusted Construction and Wellheads	$682,077	$682,077	$769,463	$769,463
Design and Construction Management Cost	$223,000	$223,000	$213,750	$213,750
Cost Date	Jul-03	Jul-03	Mar-05	Mar-05
CCI ENR Value	6,695	6,695	7,309	7,309
Adjusted Design and Construction Management Cost	$257,208	$257,208	$225,828	$225,828
Total Adjusted Cost	$939,285	$939,285	$995,291	$995,291
Sources	Letter dated November 6, 2006; Correspondence with Jeff An, Utility Planning Manager, City of North Miami Beach, Florida Public Services Department.			

Notes:
1) Construction costs were escalated using the initial cost index based on the midpoint of construction. The midpoint of construction is the date half way between the bid date and the end of construction.

Table 4-8 Biscayne / Surficial Aquifer Well System Cost SFWMD Lower East Coast (LEC) Planning Area

WELL LOCATION	UTILITY/OWNER WELL ID	CONSTR. DATE	CONSTR. COST INDEX (CCI) (4)	ORIGINAL CONSTR. COST	WELL DEPTH (FT)	CASING DEPTH (FT)	WELL CAPACITY (GPM)	CASING MATERIAL	CASING DIAMETER	AUGUST 2006 CCI (4)	ADJUSTED CONSTR. COST	WELLHEAD COSTS
Palm Beach County	Town of Jupiter 39,44,45,46,50, 67,68	05/2000	6233	$64,474	144(1)	114(1)	220-900	PVC	20" open hole	7722	$79,876 (2)	NA
Palm Beach County	City of Royal Palm Beach Well 13	06/2000	6238	$65,420	120	70	500	PVC	12" screened	7722	$80,983	NA
Palm Beach County	Lake Worth Utilities Well 9R	08/2005	7479	$202,290	235	191	800	PVC	25.25" screened	7722	$208,863	$166,954 (3)
Broward County	City of Ft Lauderdale Dixie Wellfield 30,31,32	06/2006	7700	$76,333	115-120	100	1400	PVC	24" open hole	7722	$76,551 (2)	NA
Palm Beach County	Village of Palm Springs 18,19	12/2005	7647	$190,642	146.5 (1)	94 (1)	-	PVC	24" screened	7722	$192,512 (2)	NA

Notes:
1. Based on average well depth (as built)
2. Based on average well price (as built)
3. Original cost was $161,700.
4. Costs indices obtained from the Engineering News Record publication.

Discussion of wellhead installation costs with one drilling firm indicated that current prices are in the vicinity of $300,000 for surficial/Biscayne aquifer wells.

O&M costs were provided by the Town of Jupiter which operates and maintains surficial and Floridan Aquifer wells. O&M costs obtained for wells include: outsourced well maintenance/rehabilitation costs and well pump electricity costs. The contractor performing rehabilitation for Jupiter is Florida Design Contractors, Inc., and the subcontractor is Aquifer Maintenance and Performance Systems, Inc. (AMPS). The bid tabulation from the above referenced contractor shows that the total contract value is $349,543.10 for a period of two years. The Town of Jupiter is currently at the one year anniversary of the two year contract and the City has spent $262,273.00 with change orders. Of that amount, $11,669.00 was spent on two Floridan Aquifer wells (of 13 Floridan wells total) and the balance was spent on 14 of Jupiter's 45 surficial aquifer wells and pumps.

The Town of Jupiter's raw water withdrawals are as follows:

- Current Average Daily Withdrawal from Surficial Aquifer is 11.7 mgd.
- Current Average Daily Withdrawal from Floridan Aquifer is 9.3 mgd.
- Annual Withdrawal from Surficial Aquifer is 4287 MGY.
- Annual Withdrawal from Floridan Aquifer is 3382 MGY.

Based on the Town of Jupiter well rehabilitation contract and data above:

- Rehabilitation Cost per 1000 gallons of water from surficial aquifer wells = $ 0.059
- Rehabilitation Cost per 1000 gallons of water from Floridan Aquifer wells = $ 0.003

According to Mr. Paul Jurzcak, superintendent for the Town of Jupiter Water Department, the electricity cost for pumping both Floridan and surficial aquifer wells was estimated to be approximately $30,000.00 on an average month. Based on this value and a withdrawal of 357 MG per month from the surficial aquifer and 282 MG per month from the Floridan Aquifer, the electricity cost per thousand gallons is estimated to be $0.047 per thousand gallons for wells completed in each aquifer. Total O&M Costs for the Town of Jupiter wells is shown in **Table 4-9**.

Table 4-9 Town of Jupiter O&M Costs for Surficial and Floridan Aquifer Wells

Surficial aquifer		Dollars ($)/1000 gallons
	Well Rehab	0.059
	Power	0.047
	Total	0.106
Floridan aquifer		
	Well Rehab	0.003
	Power	0.047
	Total	0.050

Well rehabilitation costs were obtained for Palm Beach County Water Utilities Department (PBCWUD) for a bid tab opened July 2006 (**Appendix E**). PBCWUD is rehabilitating 40 Biscayne aquifer wells over a two year period at a cost of $1,176,000 or $588,000/year. At an average day pumpage of about 60 million gallons per day, the cost of rehabilitation is about $0.03/1000 gallons. Assuming energy costs of $0.10 Kw-hr, an average flow rate of 700 gpm, a total dynamic head of 170 feet and pump and motor efficiencies of 70 percent and 90 percent respectively, and continuous operation, a monthly power cost of $2,500 is calculated per well. This is approximately $0.08/1000 gallons. Total O&M for PBCWUD wells is therefore about $0.11/1000 gallons.

4.4 Kissimmee Basin

Table 4-10 describes wells that have recently been constructed in the Kissimmee Basin. For well construction in the upper Floridan aquifer, utilities include Orange County Utilities, Eastern Regional Water Supply Facility (ERWSF); Altamonte Springs in Seminole County; and Eatonville in Orange County. Total depth on these wells is about 600 feet and the inner casing varies from 205 feet deep to 250 feet deep. Well costs range from $94,847 for 18-inch diameter wells that are currently under construction to $295,280 for 24-inch diameter wells are also currently under construction. ERWSF is currently installing 6 upper Floridan wells (24-in diameter cased to 250 feet and open to 600 ft) and has the most representative costs equal to $295,280 per well or $491/ft. The cost of wellheads appears to vary from $150,442 to $63,000 for wells at Altamonte Springs and Eatonville. The wellheads for the wells at ERWSF have not yet been bid. The total cost adjusted to August 2006 for Altamonte Springs for both construction of a 24-inch diameter well in the upper Floridan aquifer and the wellhead is $344,156.

Table 4-10 also describes well construction in the lower Floridan aquifer. Wells in this aquifer range in total depth from 1,350 feet to 1,462 feet, with casing depths from 850 feet to 1,060 feet. Wells were constructed by Orlando Utilities Commission and the City of Maitland and the completion date for these wells ranges from 1997 to 2002; thus there are no recent data for wells constructed into this aquifer. Costs adjusted using ENR CCI to August 2006 for well construction range as high as $658,093.

Table 4-10 Cost of Well Construction and Wellheads for Wells in the Kissimmee Basin in Both the Upper and Lower Floridan Aquifer

County	Utility Name	Water Plant	Production Aquifer	Well Type	Well ID	Completion Date	ENR CCI Value	Inner Casing Dia. - Inches	Inner Casing Depth - Feet	Total Depth Feet	Open Interval Feet	Pump Horsepower	Pump Capacity - GPM	Operating TDH - Feet	Well Const. Cost	Well Const. Cost Adjusted to Aug-06 Dollars[1]	Wellhead Cost	Wellhead Cost Adjusted to Aug-06 Dollars[1]	Notes
Orange	Orange Co. Util.	ERWSF	Upper Floridan	Municipal Supply	7	**In Progress**	--	24	250	600	350				$295,280	$295,280	NA		
Orange	Orange Co. Util.	CR 535	Upper Floridan	Municipal Supply	1	Nov-03	6794	24	230	602	372				$99,168	$112,713	NA		
					2	Feb-04	6862	24	205	702	497				$122,569	$137,930	NA		
					3	Nov-03	6794	24	225	602	377				$192,006	$218,232	NA		
Seminole	Altamonte Spgs.	WTP-4	Upper Floridan	Municipal Supply	17	Jun-04	7109	24	215	600	385	100	2500	132	$178,337	$193,715	$138,500	$150,443	2
Orange	Eatonville		Upper Floridan	Municipal Supply	1A	**In Progress**	--	18	205	601	396	40	1000	100	$94,847	$94,847	$63,000	$63,000	3
					2A	**In Progress**	--	18	207	601	394	40	1000	100	$94,847	$94,847	$63,000	$63,000	3
Orange	Maitland	WTP-6	Lower Floridan	Municipal Supply	6A	Sep-99	6128	24	850	1350	500	200	4200	142	$445,766	$519,003	$138,600	$174,652	4
Orange	OUC	Southwest	Lower Floridan	Municipal Supply	2	Mar-00	6202	24	1048	1450	402								
					7	Aug-00	6233	24	840	1450	610								
Orange	OUC	Sky Lake	Lower Floridan	Municipal Supply	3	Aug-02	6592	24	1000	1450	450				$326,779	$382,795			
Orange	OUC	Navy	Lower Floridan	Municipal Supply	2	Dec-01	6390	24	876	1357	481				$544,576	$658,093			
Orange	OUC	Southeast	Lower Floridan	Municipal Supply	1	Apr-99	6008	18	1045	1450	405				$402,879	$517,815			
					2	Apr-99	6008	18	1045	1441	396				$362,751	$466,239			
Orange	OUC	Conway	Lower Floridan	Municipal Supply	4	Sep-97	5851	24	1060	1462	402				$393,252	$519,003			
					5	Jul-97	5863	16	1054	1445	391				$404,796	$519,003			

ENR CCI = 7722 for August 1, 2006

Notes:
1) Costs adjusted to August 2006 dollars using the Engineering News Record (ENR) Construction Cost Index (CCI). ENR CCI = 7722 for August 2006.
2) Wellhead cost includes a 100 horsepower pump, piping, valves, and a 24-inch diameter butterfly valve
3) Wellhead costs for each well includes a 40 horsepower pump, piping, valves, fittings, and site work.
4) Wellhead costs include test pumping; temporary well cover and access port; electrical power, control conduit and wire; and well motor control center and control panel modifications.

Section 5
Capital and O&M Costs for Water Treatment Technologies

CDM has developed opinions of probable capital, operation and maintenance (O&M), and total production costs for various potable water treatment technologies, treatment process and plant components, and disinfection technologies. In addition to general opinions of cost for these components, which are provided for plant capacity increments of 5, 10, 15, and 20 million gallons per day (mgd) on a maximum day demand (MDD) basis, specific recent Florida project case studies are summarized for reference, as noted below.

Within this Section, the assembled cost data are broken up into the following four general groups of tables:

- General Water Treatment Technologies. This cost data set may be viewed as comprising costs for developing "grass roots" plants of various capacity ranges and various treatment technologies (although costs for finished water storage and high service pumping costs are not included). Treatment technologies examined include various membrane processes, as well as a case study of a fresh surface water supply (i.e., the Tampa Bay Actiflo Surface Water project). The cost tables under this category include development of the raw water supply, either groundwater wells or surface water intake, as appropriate for the specific technology and indicated in the respective table. This data set is reflected in Tables 5-2 through 5-8, presented later in this section.

- Water Treatment Technology Process Components. This cost data set may be viewed as comprising costs for adding incremental treatment process capacity to an existing water treatment plant (not including raw water supply or other ancillary equipment that is likely to already be available on an existing water treatment plant site). Treatment technologies examined include nanofiltration and reverse osmosis membrane processes. This data set is reflected in Tables 5-9 and 5-10.

- Water Distribution Plant Components. This cost data set may be viewed as comprising costs for components that are likely to be common among the various treatment technologies for each capacity increment examined (e.g., sizing, design, and cost for the finished water storage tank for a 5 mgd nanofiltration plant will be the same as for a 5 mgd seawater reverse osmosis plant). Plant components examined include finished water storage and high service pumping (components which were not included in the first group of tables). This data set is reflected in Tables 5-11 and 5-12.

- Disinfection Plant Components. This cost data set is similar to the third group, except that various technologies for the disinfection process component are examined. Again, the different process technologies may utilize any of the

following disinfection technologies, as long as the capacity rating is consistent. The disinfection technologies examined include on-site generation of sodium hypochlorite, ozone, and ultraviolet light (UV). This data set is reflected in Tables 5-13 through 5-15.

Opinions of probable capital, O&M, and total production cost are presented for the following treatment technologies, process components, and plant components:

General Water Treatment Technologies

- Microfiltration/ultrafiltration (MF/UF)
- Nanofiltration (NF)
- Brackish ground water reverse osmosis (low pressure), (LPRO) with deep injection well disposal of concentrate
- Brackish surface water reverse osmosis (low pressure), (LPRO) with deep injection well disposal of concentrate
- Seawater reverse osmosis (SWRO), surface intake co-located with a power plant

Water Treatment Technologies - Case Studies

- SWRO surface water case study - 29 mgd Tampa Bay Seawater Water Treatment Plant co-located with Tampa Electric power plant with concentrate discharge to the cooling water outfall from the power plant.
- Fresh surface water case study - 66 mgd Tampa Bay Surface Water Project

Water Treatment Technology Process Components

- NF process units.
- RO process units

Water Distribution Plant Components

- Finished water storage plant component.
- High service pumping plant component

Disinfection Plant Components

- On-site generation sodium hypochlorite disinfection
- Ozone disinfection
- Ultraviolet light (UV) disinfection

Table 5-1 summarizes the cost items that are included under each of the four groups of tables described above.

The majority of the water treatment technologies addressed in the cost tables utilize membranes. Application of a particular membrane technology in a specific case is dependent on the source water quality and characteristics and desired treated water quality. **Figure 5-1** shows the filtration capabilities of various membrane technologies with respect to aqueous salts, viruses, bacteria, Cryptosporidium cysts, Giardia cysts, some microconstituents, and a range of particle sizes.

MF membranes generally have pore sizes of 0.1 to 0.2 micron range. UF membranes generally have smaller pore sizes, in the 0.01 to 0.04 micron range. Common contaminant particle size ranges vary from 5 to 15 micron for Giardia, 3 to 5 micron for Crypto, and 0.01 to 0.1 micron for viruses. The pore sizes for MF/UF membranes are much smaller than the typical particle size for Giardia and Crypto, so theoretically, MF/UF should provide essentially 100 percent removal of these contaminants. Due to their smaller size, MF is not as effective in removing viruses, while a higher level of removal could be expected from with UF membranes.

NF membranes are generally effective in the 10 to 100 micron particle size range. This makes them effective at removing high molecular weight molecules (e.g., dissolved organics such as disinfection by-product precursors) and hardness ions. This is the reason NF membranes are commonly applied in softening applications, and the technology is sometimes referred to as "membrane softening".

RO membranes are effective at removing dissolved ions (aqueous salts), and are therefore effective in desalination of brackish and sea water raw water supplies. Due to the level of removal efficiency, a typical RO application may require a raw water blend stream (bypassing the RO process) with the finished water, and/or the post-treatment addition of calcium hardness, alkalinity, and corrosion inhibitor to produce a stable finished water that does not present corrosion concerns with the downstream distribution system.

Microconstituents comprise a new group of compounds found in very low concentrations whose health effects are unknown and currently without standards but whose removal may become a performance standard in the future. Microconstituents may be found in either ground or surface water serving as a source for drinking water. They may also be found in wastewater and reclaimed water. On their website (http://www.dep.state.fl.us/water/microfact.htm) the Florida Department of Environmental Protection defines microconstituents as follows:

"Microconstituents, sometimes known as "emerging pollutants of concern," are chemicals found in a wide array of consumer goods, including pharmaceuticals and personal care products. Some of the microconstituents are considered to be "endocrine disrupters" (compounds such as synthetic estrogen, PCBs, dioxin, and some pesticides that may interfere with or modify hormone processes within an organism)."

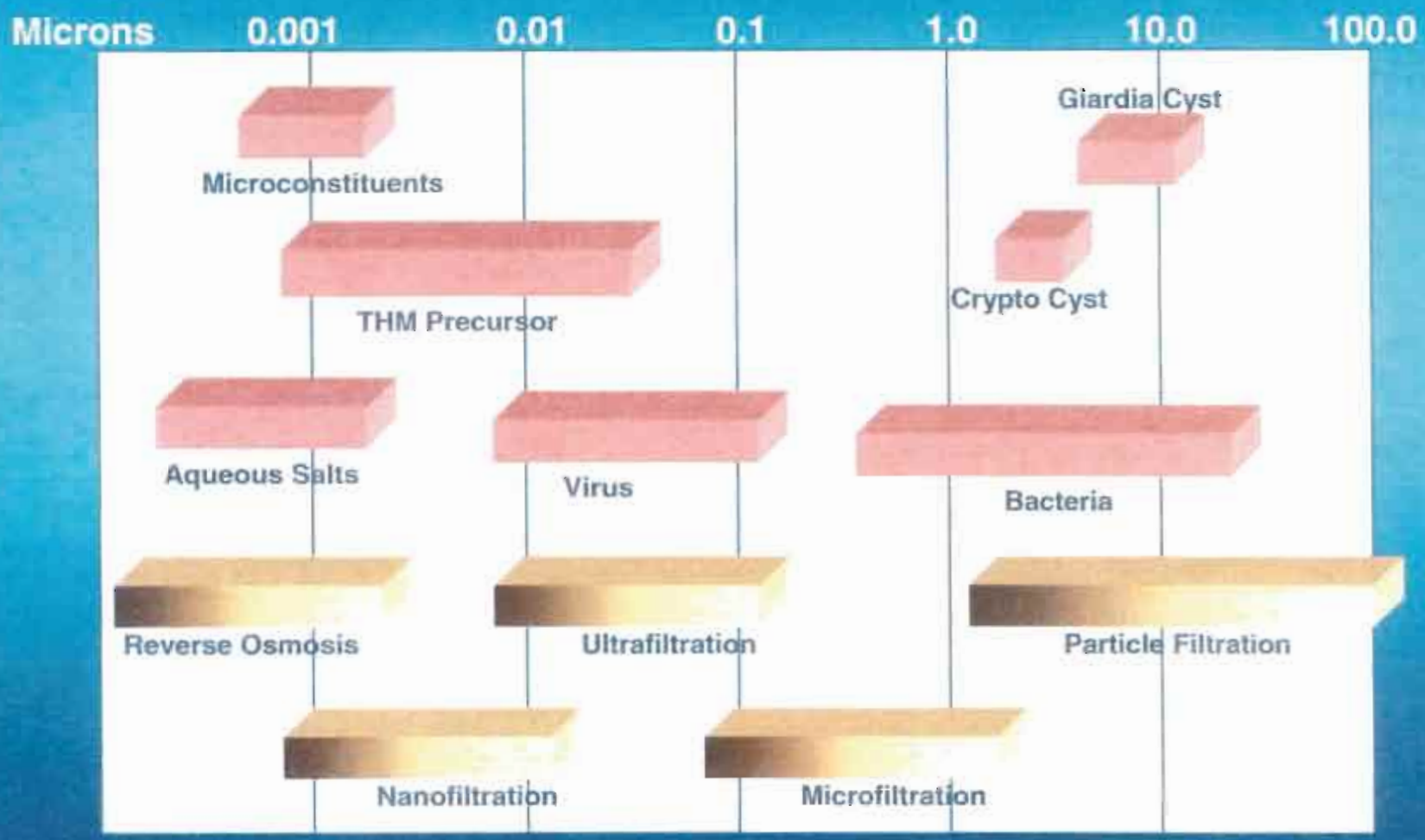
Table 5-1

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Opinions of Probable Capital Tables

Item	General Water Treatment Technologies							Process Components		Distribution Components		Disinfection Components		
	MF/UF	NF	GW LPRO	SW LPRO	SW SWRO	SW SWRO Case Study	Fresh SW Case Study	NF Process Units	RO Process Units	FW Storage	HS Pumping	OSG Hypochlorite Disinfection	Ozone Disinfection	UV Disinfection
No. Description	5-2	5-3	5-4	5-5	5-6	5-7	5-8	5-9	5-10	5-11	5-12	5-13	5-14	5-15
1. Raw water supply	X	X	X	X	X	X	X							
2. Pretreatment	X	X	X	X	X	X	X	X						
3. Process equipment	X	X	X	X	X	X	X	X	X			X	X	X
4. Post treatment	X	X	X	X	X	X	X	X	X					
5. Intermediate storage (clearwell)	X	X	X	X	X	X		X	X					
6. Transfer pumping		X	X	X	X		X	X	X					
7. Finished water storage						X	X			X				
8. High service pumping						X	X				X			
9. Plant infrastructure	X	X	X	X	X	X	X	X	X			X	X	
10. Concentrate disposal	X	X	X	X	X	X	X	X	X					
11. Yard piping	X	X	X	X	X	X	X	X	X	X	X		X	X
12. Electrical	X	X	X	X	X	X	X	X	X		X	X	X	X
13. Instrumentation and controls	X	X	X	X	X	X	X	X	X		X	X	X	X
14. Site work	X	X	X	X	X	X	X	X	X	X	X	X	X	X
15. General Requirements	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16. Contractor overhead and profit	X	X	X	X	X	X	X	X	X	X	X	X	X	X
17. Construction contingency	X	X	X	X	X	X	X	X	X	X	X	X	X	X
18. Technical Services	X	X	X	X	X	X	X	X	X	X	X	X	X	X
19. Owner administration and legal	X	X	X	X	X	X	X	X	X	X	X	X	X	X
20. Project contingency	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Figure 5-1 Filtration Regimes



The U.S. Geological Survey has done a national water quality survey of microconstituents and this can be found at http://toxics.usgs.gov/pubs/OFR-02-94/index.html.

The term microconstituents refers to a vast array of constituents ranging from pesticides to pharmaceuticals and personal care products. The number of constituents that would fall within this definition is well beyond the number of contaminants that are currently monitored in drinking water. As technology has advanced to the point that the trace quantities of these chemicals can now be detected, there is a significant amount of research activity being devoted to determining the distribution and occurrence of these substances in drinking water, the associated health implications, and methods of treatment for contaminants that may be considered a health risk.

In an effort to quantify the size range of microconstituents and to determine the effectiveness of membranes in removing these contaminants, several studies where reviewed. The "Filtration Spectrum" published by GE-Osmonics (http://www.osmonics.com/library/filspcold.html) indicates that the size range for pesticides and herbicides are generally in a molecular weight range of 150 to 1000. A special report entitled "Pharmaceuticals and Personal Care Products in the Environment: Agents of Subtle Change?" (Daughton and Ternes, 1999) includes a representative list of pharmaceuticals and personal care products (PPCP's) that have been found in the environment. While this list is by no means exhaustive, it does include information on the chemical formulas and molecular weights of these constituents. The PPCP's in this list are generally in the molecular weight range of 150 to 1600. From the GE-Osmonics chart, the molecular weight range of 150 to 1600 translates to about 0.0007 to 0.0025 microns. While this review is not comprehensive, considering that the scope of microconstituents is not clearly defined, CDM considered that this molecular weight range would be representative of a wide range of pesticides, pharmaceuticals and personal care products of interest. Figure 5-1 has been revised to reflect this size range for microconstituents.

It should be noted that in Figure 5-1, that treatment technologies such as particle filtration, microfiltration (MF) and ultrafiltration (UF) remove suspended particles by a sieving type of filtration process. For example the small pore sizes in MF and UF membranes, which are on the order of 0.1 and 0.01 microns respectively, represent a physical barrier to larger sized contaminants such as bacteria, cryptosporidium, giardia cysts, etc. In these cases, if the physical size of a contaminant is larger than the pore size of the membrane, the contaminant will be well removed. With nanofiltration and reverse osmosis the pore sizes of the membranes are much smaller and these membranes are capable of removing dissolved solids. However, it is important to note that for dissolved solids, the removal mechanism of ions in solution by NF and RO membranes is much more complex than the sieving model for MF and UF membranes. Several theories of removal mechanisms have been proposed; however, no single uniform model that is applicable for the entire range of inorganic and organic compounds has been developed. While the rejection of many inorganic

compounds by NF and RO membranes is well documented, the rejection of small organics molecules in the range included in the microconstituent category is much more complex.

A recent AWWA and Kiwa Water Research Paper (Hofman, et al., 2007) reports that a literature review was done to build a database on rejection data of nanofiltration membranes. The review of 20 scientific papers resulted in a database with more than 1000 rejection numbers determined on 30 different types of membranes with information on 120 compounds. A statistical analysis of the reported rejections showed that 60 percent of the data had rejection values above 80 percent.

It is not possible to generalize and say that all organic molecules over a specific molecular weight will be highly rejected by a given RO or NF membrane. The best method to determine the actual rejection rate of a particular microconstituent or group of microconstituents (for example, in a wastewater) by a particular membrane is by coupon, bench scale or pilot testing.

5.1 Description of Opinions of Cost and Discussion of Assumptions

Cost estimates are considered to be "order-of-magnitude estimates", as defined by the American Association of Cost Engineers. This is an approximate estimate made without detailed engineering data. An order-of-magnitude estimate is considered to be accurate within +50% or -30%, and is typically used for planning purposes. Plots of construction and total production cost curves are provided for each treatment technology, with the +50%/-30% envelope plotted in addition to the estimated cost curve.

For each technology, costs are broken up into three tables (designated A, B, and C, refer to Tables 5-2A through 5-2C as an example).

Table A - Opinions of Capital Cost

The first table (Table A) presents the opinion of probable capital cost. Individual process and plant component cost items are listed first, followed by general plant improvements (e.g., yard piping, electrical, instrumentation and controls), which are estimated by a factor applied to the process/plant component subtotal. The contractor's administrative costs follow (i.e., general requirements, overhead and profit, and construction contingency). The opinion of probable construction cost is presented as a subtotal. This cost may be considered to be comparable to a general contractor's "bid" cost for a traditional design-bid-build project delivery method.

The "owner's costs" are presented following the opinion of probable construction cost. These include technical services (e.g., engineering design, permitting, surveying, geotechnical engineering, engineering services during construction, etc.), owner administration and legal (e.g., internal expenses associated with project management

and administration), and project contingency (for unknowns related to design conditions, water quality, etc.).

The total opinion of probable capital cost is presented as the sum of the above items. The opinion of equivalent annual capital cost is then presented below in Table A, which is the annual amortized cost based on an annual interest rate of 7 percent and 20-year amortization period.

Table B - Opinions of Operation and Maintenance Cost
Table B in each series presents the annual O&M cost for each technology. Within this table, these costs are broken up into variable and fixed costs. Variable costs include items such as power, chemicals, and replacement parts and materials. These costs vary in proportion to the amount of finished water produced by the plant over the study year.

Fixed costs include labor (plant staffing) and administration/regulatory compliance, which are independent of the water production rate.

Within Table B, total annual O&M costs are presented for two cases. In the first case, variable costs are based on the plant capacity rating (i.e., for the 5 mgd capacity plant, variable costs are based on a 5 mgd production rate 24 hours per day, 365 days per year). Essentially, this case assumes that the plant is operating at capacity all of the time.

In the second case, the variable costs are based on the plant meeting an annual average day demand (AADD), which is estimated as a factor of the plant capacity rating. It should be noted that the typical plant capacity rating is based on meeting a maximum day demand (MDD). The methodology for estimating the AADD based on the MDD utilizes an assumed MDD/AADD peaking factor. This peaking factor is a characteristic of the distribution system served by a plant, and is related to the size of the system (i.e., the plant capacity rating). The MDD/AADD factor generally decreases as the size of the system increases. Assumptions for MDD/AADD are based on CDM experience and are listed in Table B for each technology. The AADD for a given plant capacity is calculated as follows:

AADD = [Plant Capacity (mgd)] / [MDD/AADD].

For the 5 mgd plant capacity rating, the estimated AADD is

AADD = 5 mgd / 1.50

= 3.33 mgd or 1,217 million gallons per year (mgy).

The above calculation is summarized for each case in each table, and defines the basis for the variable costs for the AADD case.

Total unit O&M costs for each case are summarized in Table B, and also appear in Table C.

Table C - Opinions of Total Production Costs
Table C presents a summary of the total production cost for each technology, including the annualized capital cost from Table A, the annual O&M costs for each production rate case presented in Table B, and an annual renewal and replacement (R&R) fund deposit (which is not included under O&M costs). The annual R&R fund deposit is equal to 10 percent of the equivalent annual capital cost and is for replacement of major equipment that is expected to wear out over the 20-year service life of the plant.

As with the O&M costs, annual production costs are given for two cases, production equal to the plant capacity rating, and production equal to the AADD estimated as discussed above for the O&M cost tables.

5.1.1 General Water Treatment Technologies

As noted above, this group of cost tables may be viewed as comprising costs for developing new, "grass roots" plants of various capacity ranges and various treatment technologies. These cost tables include all components for a complete, functioning facility, including raw water supply, pretreatment, all typical process components for each treatment technology, post-treatment, finished water stabilization, intermediate (in-plant) storage, transfer pumping, back-up power generation, general plant infrastructure, etc.

For the purpose of this study, finished water storage and high service pumping are considered to be part of the transmission/distribution system, and are not included under these tables. These components are addressed in a separate group of cost tables, as discussed later.

The following general assumptions are applicable to the general water treatment technology costs (Tables 5-2 through 5-8).

General Assumptions

1. It is assumed that the new plant is built on a virgin site, with no unusual issues requiring unusual sitework or foundation preparation such as wetland mitigation, substantial site filling, demucking, pilings, etc.
2. It is assumed that plants are either located directly adjacent to surface raw water sources, or that raw water supply wells are located on the plant site such that raw water transmission piping is considered to be included in the yard piping line item cost.
3. It is assumed that plants are located directly adjacent to a power supply such that the power transmission system to the plant is considered to be included in the electrical cost allowance.

4. Project implementation is assumed to be a traditional design-bid-build approach, with owner operation. Capital cost estimates are based on similar projects completed within the last ten years in Florida, the Bahamas, and California.
5. Capital costs do not include the cost for acquisition of land, rights-of-way, transmission mains, and utilities.
6. Operation and maintenance costs are based on an assumed unit electrical power cost of $0.10 per kilowatt-hour, with typical chemical costs prevailing in the South Florida area in August 2006. Operator labor is based on estimated staffing levels and prevailing wage rates in the South Florida area.
7. The equivalent annual capital cost is based on an annual interest rate of 7 percent.
8. An annual deposit equal to 10 percent of the equivalent annual capital cost is budgeted for a renewal and replacement (R&R) account.

Assumptions Associated with Individual Cost Line Items Common to Tables 5-2 through 5-8

1. Raw Water Supply. Except where the treatment technology designation specifies a surface water raw water supply, all scenarios assume groundwater wells as the raw water supply. As noted above, it is assumed that the raw water supply wells are either on the water treatment plant site or directly adjacent to the site such that the raw water transmission piping is included in the yard piping allowance. Costs for raw water supply wells include drilling, installation of casing, and development of the well, installation of a pump of appropriate design and materials selection, and above-ground wellhead piping, valves, and fittings, and a concrete well pad. A building housing the well is not included. Electrical, instrumentation and controls, sitework, and underground piping are assumed to be included in the general plant allowances for these items.
2. Pretreatment. Includes treatment typically needed for successful operation of the technology in South Florida (e.g., cartridge filtration and chemical pretreatment for NF and RO processes), but not processes that may be needed if the supply has unusually high levels of sand or silt, such as sand strainers, multimedia pressure filters, etc.
3. Process Equipment. Includes all process equipment typically needed for successful operation of the technology with a "typical" South Florida raw water supply, including pumps, interior piping, pressure vessels, valves, membrane elements, process tanks, etc.
4. Post Treatment. Includes all process equipment typically needed for successful operation of the technology. For most membrane systems, this equipment would include packed-tower, forced-draft type degasification, odor control scrubbers, and chemical storage and feed systems for pH adjustment, stabilization, and corrosion control.
5. Intermediate Storage. Includes construction of a below-grade, poured-in-place concrete clearwell sized for approximately fifteen (15) minutes of disinfectant contact time and for proper intake design conforming to Hydraulic Institute Standards for a vertical turbine transfer pumping system. The intermediate storage requirements (and associated costs) are assumed to be the same for

various treatment technologies for each plant capacity (i.e., the clearwell design for a 5 mgd RO system is the same as the clearwell design for a 5 mgd NF system).

6. Transfer Pumping. Includes a transfer pumping system consisting of two constant speed vertical turbine transfer pumps, each pump sized for 100 percent of the rated plant capacity (assuming the provision of one standby pump), and above-ground piping, fittings, and valves. As with intermediate storage, the transfer pumping requirements and associated costs are assumed to be the same for various treatment technologies for each plant capacity.
7. Plant Infrastructure. Plant infrastructure includes improvements such as buildings to house process equipment, equipment pads, and awning structures as appropriate, etc. Costs are based on previous actual project costs.
8. Concentrate disposal. Membrane process concentrate disposal will be through an on-site deep injection well. Concentrate transmission piping is considered to be included in the yard piping line item cost. Injection pressure will be provided through residual pressure from the membrane system (i.e., a separate concentrate injection pump station is not provided). Based on bids received in mid- to late-2005, the cost of a deep injection well is assumed to be $5.5 million, regardless of the concentrate flow rate. Plants that generate greater than 10 mgd of concentrate are assumed to require two injection wells.
9. Yard Piping. Includes underground raw, process, and finished water piping, sanitary sewer, plant water, and concentrate transmission piping.
10. Mechanical. Includes HVAC, plumbing, and fire protection systems.
11. Electrical. Includes electrical service, underground yard electrical, transformers, switchgear, motor control centers, variable frequency drives, control panels, etc.
12. Instrumentation and Controls. Includes field instrumentation, control system architecture, process control software and hardware, process control programming, testing, and startup.
13. Site Work. Includes typical site preparation, paving, grading, and drainage, fill, compaction, site restoration, landscaping, etc.
14. General Requirements. Includes mobilization, demobilization, bonds, insurance, construction trailers, temporary facilities, contractor permits, etc.
15. Contractor Overhead and Profit. Assumed to be 15 percent of the equipment and installation cost.
16. Construction Contingency. Assumed to be 15 percent of the equipment and installation cost.
17. Technical Services. Includes a "traditional" level of surveying and geotechnical services, engineering and hydrogeological preliminary and final design, permitting, bidding services, construction contract administration, limited resident project representative (RPR) services, shop drawing reviews, etc. for a design-bid-build project delivery method using standard contract document format, as endorsed by the Engineer's Joint Contract Document Committee (EJCDC) and the Construction Specifications Institute (CSI).
18. Owner Administration and Legal. Includes owner's expenses for project administration and permitting.
19. Project Contingency. Assumed to be 15 percent of the construction cost.

The following sections present the cost tables for each water treatment technology, and discuss the assumptions associated with each technology.

Within each of the following subsections for the general water treatment technologies, the recent actual projects that were used to develop the opinions of cost are listed, including the name of the project, plant capacity, and the bid date. It should be noted that, in order to develop the opinion of cost curves and cost data for each capacity increment from the available project cost data, it was necessary to make adjustments to the "as-bid" cost for each of the projects to "normalize" the project scope to the assumed scope in the cost table. This was necessary to account for the sometimes substantial differences between the individual (and unique) project scopes versus the "standardized" scope reflected in the cost tables.

5.1.1.1 Microfiltration/Ultrafiltration

The opinion of probable cost for MF/UF is shown in **Tables 5-2A, 5-2B,** and **5-2C**. Cost curves for MF/UF are shown on **Figures 5-2** and **5-3** for construction costs and production costs.

The raw water supply for the MF/UF treatment is assumed to be from a surface water source such as a river or lake. The intake includes slotted intake screens, pump basin, and vertical turbine intake pumps and assumes that the intake is located on the plant site. The pretreatment considered includes automatic backwashing 300 micron screens and the addition of a coagulant aid. The MF/UF units include the membrane equipment, membrane basins, permeate pumps, backwash, cleaning, and integrity test systems. The MF/UF systems are assumed to operate at 90% recovery. The post-treatment system includes caustic soda, sodium hypochlorite, ammonia, and fluoride systems. The clearwell for the MF/UF system is designed to include a similar product storage capacity as for the other membrane treatment options. Plant infrastructure includes the membrane building and miscellaneous structures. The residuals treatment system includes an equalization basin, residuals thickener, and centrifuge.

In preparation of the opinions of cost, project cost data were compiled from the following projects, which are plotted on the construction and production cost curves:

- City of Boise, 6 mgd.
- City of Weatherford, 6 mgd.
- City of Jackson, 25 mgd.
- City of Racine, 50 mgd.
- City of Georgetown, 3.24 mgd.
- City of Pflugerville, 12 mgd.

Table 5-2A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Treatment Technology : Microfiltration/Ultrafiltration
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	Raw water supply		$548,000	$922,000	$1,249,000	$1,550,000
2.	Pretreatment		$147,000	$248,000	$336,000	$416,000
3.	Process equipment		$2,079,000	$3,496,000	$4,738,000	$5,879,000
4.	Post treatment		$272,000	$458,000	$621,000	$770,000
5.	Intermediate storage (clearwell)		$754,000	$1,365,000	$1,850,000	$2,296,000
6.	Transfer pumping		$0	$0	$0	$0
7.	Plant infrastructure		$579,000	$1,050,000	$1,423,000	$1,766,000
8.	Residuals disposal		$284,000	$477,000	$647,000	$803,000
Subtotal:			$4,663,000	$8,016,000	$10,864,000	$13,480,000
9.	Yard piping	11%	$513,000	$882,000	$1,195,000	$1,483,000
10.	Electrical	18%	$839,000	$1,443,000	$1,956,000	$2,426,000
11.	Instrumentation and controls	11%	$513,000	$882,000	$1,195,000	$1,483,000
13.	Site work	11%	$513,000	$882,000	$1,195,000	$1,483,000
Subtotal:			$7,041,000	$12,105,000	$16,405,000	$20,355,000
14.	General Requirements	9%	$633,690	$1,089,450	$1,476,450	$1,831,950
15.	Contractor overhead and profit	15%	$1,056,150	$1,815,750	$2,460,750	$3,053,250
16.	Construction contingency	15%	$1,056,150	$1,815,750	$2,460,750	$3,053,250
Opinion of Probable Construction Cost::			**$9,786,990**	**$16,825,950**	**$22,802,950**	**$28,293,450**
17.	Technical Services	25%	$2,447,000	$4,206,000	$5,701,000	$7,073,000
18.	Owner administration and legal	5%	$489,000	$841,000	$1,140,000	$1,415,000
19.	Project contingency	15%	$1,468,000	$2,524,000	$3,420,000	$4,244,000
Opinion of Probable Capital Cost:			**$14,191,000**	**$24,397,000**	**$33,064,000**	**$41,025,000**
Opinion of Equivalent Annual Capital Cost:			$1,339,530	$2,302,904	$3,121,008	$3,872,470
Plant service life =		20 years				
Annual interest rate =		7%				
Unit Probable Construction Cost ($/gpd)			$1.96	$1.68	$1.52	$1.41
Unit Probable Total Capital Cost ($/gpd)			$2.84	$2.44	$2.20	$2.05

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Table 5-2B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Treatment Technology : Microfiltration/Ultrafiltration
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Variable Costs				
1.	Power	$140,000	$281,000	$421,000	$562,000
2.	Chemicals	$59,000	$119,000	$178,000	$237,000
3.	Replacement parts and materials	$230,000	$387,000	$525,000	$651,000
	Replacement Membranes	$32,000	$64,000	$97,000	$129,000
	Fixed				
4.	Operation and maintenance labor	$459,000	$565,000	$638,000	$695,000
5.	Administration/regulatory compliance	$312,000	$525,000	$712,000	$883,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual O&M Cost at Rated Capacity	**$1,232,000**	**$1,941,000**	**$2,571,000**	**$3,157,000**
	Unit Cost at Rated Capacity, $/kgal	$0.68	$0.53	$0.47	$0.43
	Annual Production at Avg Day Demand, (mgy)	1,217	2,704	4,212	5,840
	Annual O&M Cost at ADD Capacity	**$1,078,000**	**$1,720,000**	**$2,289,000**	**$2,841,000**
	Unit Cost at Rated Capacity, $/kgal	$0.89	$0.64	$0.54	$0.49

Table 5-2C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Treatment Technology : Microfiltration/Ultrafiltration
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Production Costs at Rated Capacity				
1.	Equivalent annual capital cost	$1,340,000	$2,303,000	$3,121,000	$3,872,000
2.	Annual O&M Cost - Variable	$461,000	$851,000	$1,221,000	$1,579,000
2.	Annual O&M Cost - Fixed	$771,000	$1,090,000	$1,350,000	$1,578,000
3.	Annual R&R fund deposit(1):	$134,000	$230,000	$312,000	$387,000
	Total Annual Cost:	$2,706,000	$4,474,000	$6,004,000	$7,416,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual Production Cost at Rated Cap. ($/kgal):	**$1.48**	**$1.23**	**$1.10**	**$1.02**
	Production Costs at Average Day Demand (ADD)				
	MDD/AADD factor(2):	1.50	1.35	1.30	1.25
1.	Equivalent annual capital cost	$1,340,000	$2,303,000	$3,121,000	$3,872,000
2.	Annual O&M Cost - Variable	$307,000	$630,000	$939,000	$1,263,000
2.	Annual O&M Cost - Fixed	$771,000	$1,090,000	$1,350,000	$1,578,000
3.	Annual R&R fund deposit(1):	$134,000	$230,000	$312,000	$387,000
	Total Annual Cost:	$2,552,000	$4,253,000	$5,722,000	$7,100,000
	Annual finished water production rate (mgy)(3):	1,217	2,704	4,212	5,840
	Annual Production Cost at ADD ($/kgal):	**$2.10**	**$1.57**	**$1.36**	**$1.22**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.
(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.
(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Figure 5-2 MF/UF Construction Cost

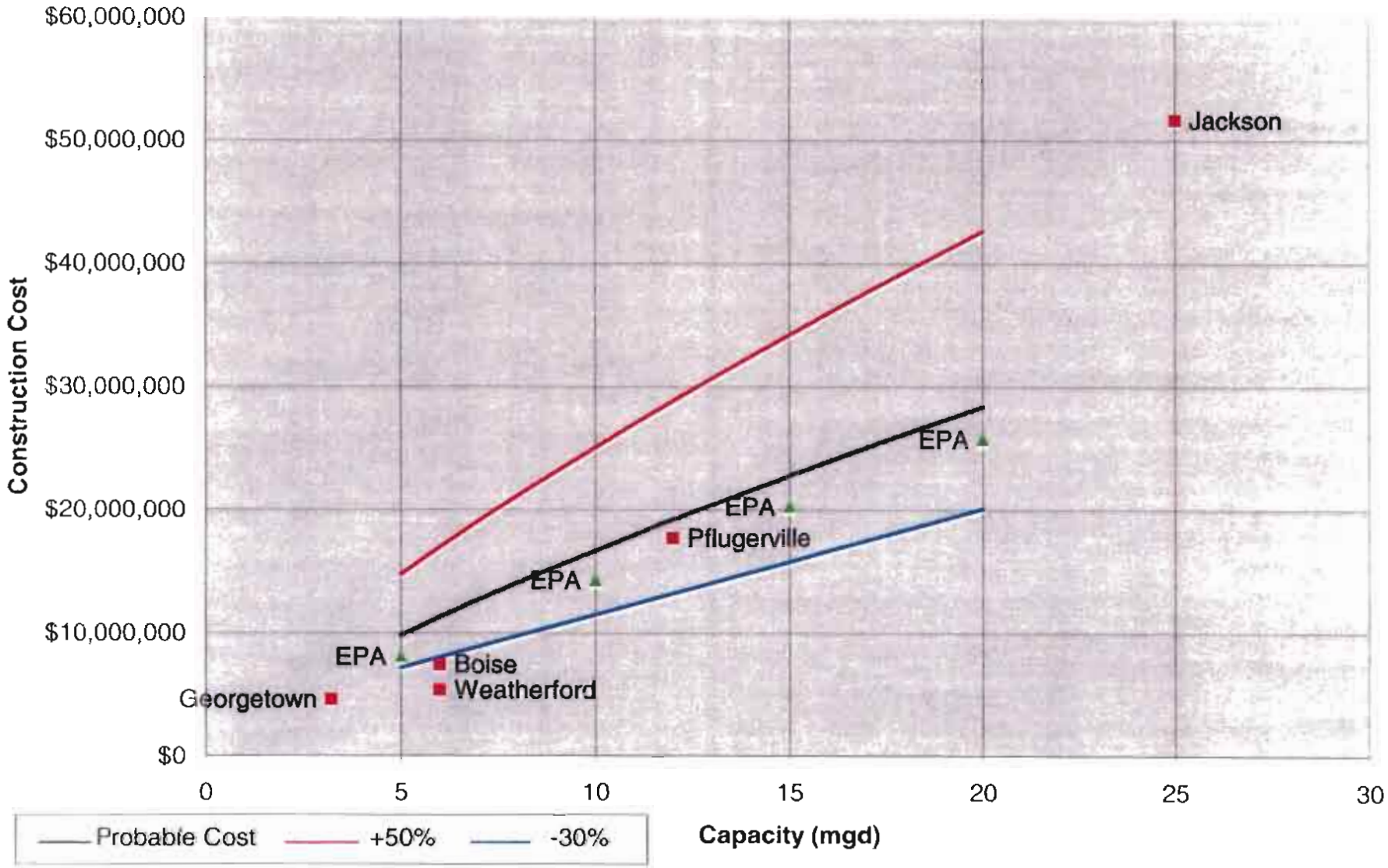
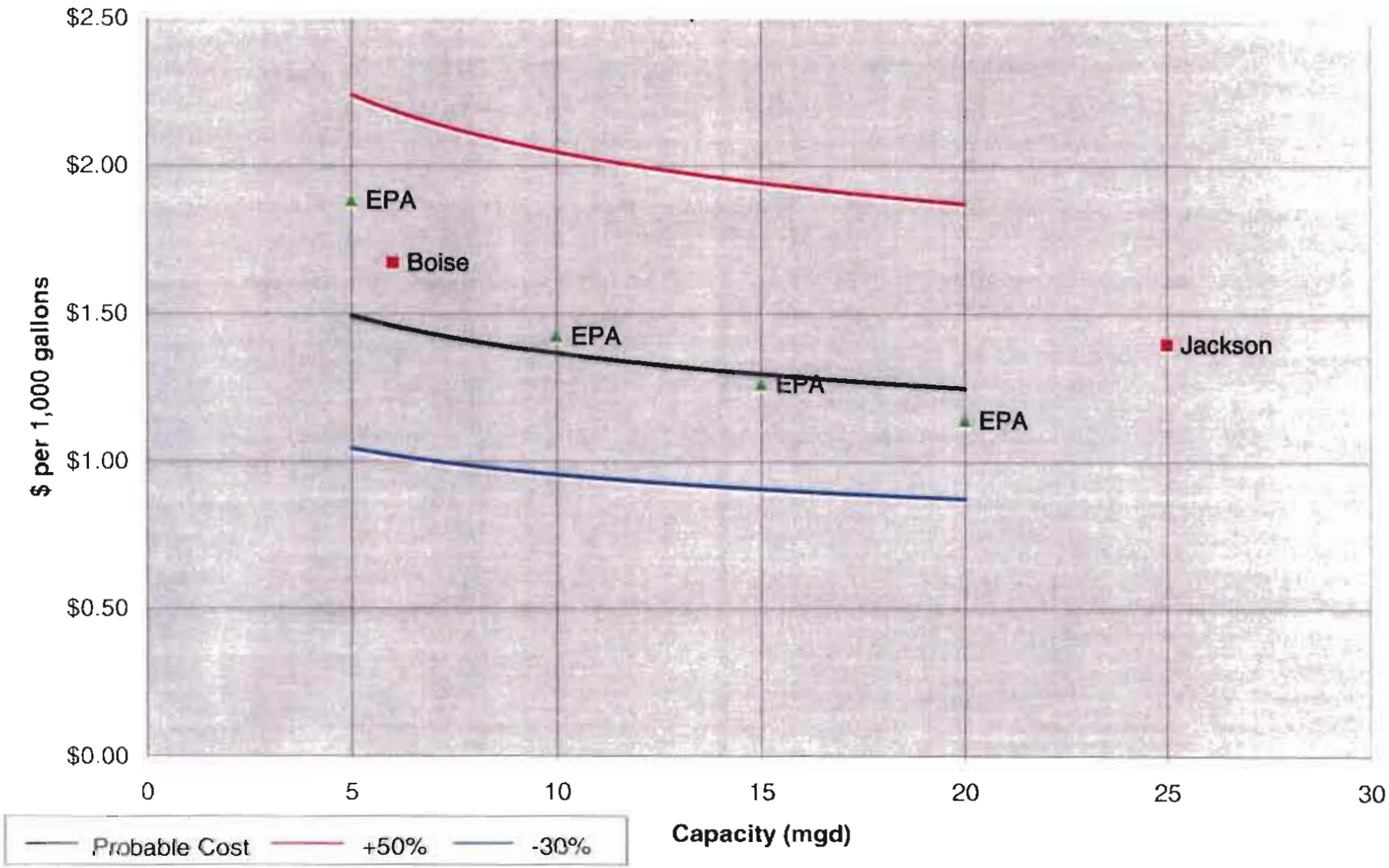


Figure 5-3 MF/UF Production Cost



5.1.1.2 Nanofiltration

The opinion of probable cost for NF is shown in **Tables 5-3A, 5-3B,** and **5-3C**. Cost curves for NF are shown on **Figures 5-4** and **5-5** for construction costs and production costs.

The raw water supply for the NF treatment technology is assumed to be shallow Biscayne Aquifer wells. The design capacity for each well is approximately 2 mgd of raw water per well. The NF process is assumed to operate at an 85 percent recovery rate, with no raw water blend. The number of wells required is that necessary to provide the raw water feed to the plant at the rated capacity and assuming 20 percent standby wells.

Pretreatment includes raw water acidification, antiscalant feed, and micron cartridge filtration. The membrane system includes stainless steel membrane feed pumps and feed piping, membrane skids (pressure vessels, skid piping, membrane elements, control valves, and instrumentation), a membrane cleaning system, and process piping. Post-treatment includes packed-tower type degasification, a caustic (NaOH) feed system for pH adjustment, and application of a corrosion inhibitor. It is assumed that application of post-treatment chemicals will be performed in the clearwell (provided under the "intermediate storage" cost item). Pre-treatment and post-treatment chemical systems include bulk storage tanks and containment basins, day tanks, metering pumps, chemical piping, and chemical injection quills and/or diffusers.

In preparation of the opinions of cost, project cost data were compiled from the following projects, which are plotted on the construction and production cost curves:

- City of Deerfield Beach West Water Treatment Plant Expansion Phase II, 10.5 mgd, bid April 1999.
- City of Boca Raton Membrane Softening Process Addition, 40 mgd, bid May 2001.
- Palm Beach County Water Treatment Plant No. 9, 25 mgd, bid January 1999.
- City of North Miami, 6.5 mgd.

Table 5-3A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Treatment Technology : Nanofiltration
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	Raw water supply		$1,200,000	$2,400,000	$3,300,000	$4,500,000
2.	Pretreatment		$87,000	$146,000	$213,000	$268,000
3.	Process equipment		$1,919,000	$3,227,000	$4,396,000	$5,534,000
4.	Post treatment		$224,000	$377,000	$513,000	$646,000
5.	Intermediate storage (clearwell)		$110,000	$208,000	$305,000	$400,000
6.	Transfer pumping		$105,000	$160,000	$194,000	$248,000
7.	Plant infrastructure		$1,371,000	$2,306,000	$3,142,000	$3,955,000
8.	Concentrate disposal		$5,500,000	$5,500,000	$5,500,000	$5,500,000
Subtotal:			$10,516,000	$14,324,000	$17,563,000	$21,051,000
9.	Yard piping	7%	$736,000	$1,003,000	$1,229,000	$1,474,000
10.	Electrical(1)	10%	$502,000	$882,000	$1,206,000	$1,555,000
11.	Instrumentation and controls(1)	7%	$351,000	$618,000	$844,000	$1,089,000
12.	Site work	5%	$526,000	$716,000	$878,000	$1,053,000
Subtotal:			$12,631,000	$17,543,000	$21,720,000	$26,222,000
13.	General Requirements	2%	$253,000	$351,000	$434,000	$524,000
14.	Contractor overhead and profit	15%	$1,895,000	$2,631,000	$3,258,000	$3,933,000
15.	Construction contingency	15%	$1,895,000	$2,631,000	$3,258,000	$3,933,000
Opinion of Probable Construction Cost:			**$16,674,000**	**$23,156,000**	**$28,670,000**	**$34,612,000**
16.	Technical Services	25%	$4,169,000	$5,789,000	$7,168,000	$8,653,000
17.	Owner administration and legal	5%	$834,000	$1,158,000	$1,434,000	$1,731,000
18.	Project contingency	15%	$2,501,000	$3,473,000	$4,301,000	$5,192,000
Opinion of Probable Capital Cost:			**$24,178,000**	**$33,576,000**	**$41,573,000**	**$50,188,000**
Opinion of Equivalent Annual Capital Cost:			**$2,282,232**	**$3,169,337**	**$3,924,197**	**$4,737,392**
Plant service life =		20 years				
Annual interest rate =		7%				
Unit Probable Construction Cost ($/gpd)			$3.33	$2.32	$1.91	$1.73
Unit Probable Total Capital Cost ($/gpd)			$4.84	$3.36	$2.77	$2.51

Notes:

(1) "Electrical" and "Instrumentation and controls" cost items are estimated as 10% and 7%, respectively, of the subtotal of the preceding cost components minus the cost for concentrate disposal. This is due to the fact that a concentrate disposal deep injection well (DIW) has negligible electrical and instrumentation and controls costs relative to other plant components, while the construction cost for a DIW is typically a substantial portion of the total facility cost.

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Table 5-3B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Treatment Technology : Nanofiltration
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Variable Costs				
1.	Power	$477,000	$954,000	$1,431,000	$1,908,000
2.	Chemicals	$293,000	$492,000	$667,000	$828,000
3.	Replacement parts and materials	$432,000	$726,000	$984,000	$1,221,000
	a. Replacement membranes:	$110,000	$185,000	$250,000	$311,000
	Fixed				
4.	Operation and maintenance labor	$459,000	$565,000	$638,000	$695,000
5.	Administration/regulatory compliance	$312,000	$525,000	$712,000	$883,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual O&M Cost at Rated Capacity	**$2,083,000**	**$3,447,000**	**$4,682,000**	**$5,846,000**
	Unit Cost at Rated Capacity, $/kgal	$1.14	$0.94	$0.86	$0.80
	Annual Production at Avg Day Demand, (mgy)	1,217	2,704	4,212	5,840
	Annual O&M Cost at ADD Capacity	**$1,646,000**	**$2,836,000**	**$3,913,000**	**$4,992,000**
	Unit Cost at Rated Capacity, $/kgal	$1.35	$1.05	$0.93	$0.85

Table 5-3C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Treatment Technology : Nanofiltration
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Production Costs at Rated Capacity				
1.	Equivalent annual capital cost	$2,282,000	$3,169,000	$3,924,000	$4,737,000
2.	Annual O&M Cost - Variable	$1,312,000	$2,357,000	$3,332,000	$4,268,000
2.	Annual O&M Cost - Fixed	$771,000	$1,090,000	$1,350,000	$1,578,000
3.	Annual R&R fund deposit(1):	$228,000	$317,000	$392,000	$474,000
	Total Annual Cost:	$4,593,000	$6,933,000	$8,998,000	$11,057,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual Production Cost at Rated Cap. ($/kgal):	**$2.52**	**$1.90**	**$1.64**	**$1.51**
	Production Costs at Average Day Demand (ADD)				
	MDD/AADD factor(2):	1.50	1.35	1.30	1.25
1.	Equivalent annual capital cost	$2,282,000	$3,169,000	$3,924,000	$4,737,000
2.	Annual O&M Cost - Variable	$875,000	$1,746,000	$2,563,000	$3,414,000
2.	Annual O&M Cost - Fixed	$771,000	$1,090,000	$1,350,000	$1,578,000
3.	Annual R&R fund deposit(1):	$228,000	$317,000	$392,000	$474,000
	Total Annual Cost:	$4,156,000	$6,322,000	$8,229,000	$10,203,000
	Annual finished water production rate (mgy)(3):	1,217	2,704	4,212	5,840
	Annual Production Cost at ADD ($/kgal):	**$3.42**	**$2.34**	**$1.95**	**$1.75**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.

(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.

(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Figure 5-4 Nanofiltration Construction Cost

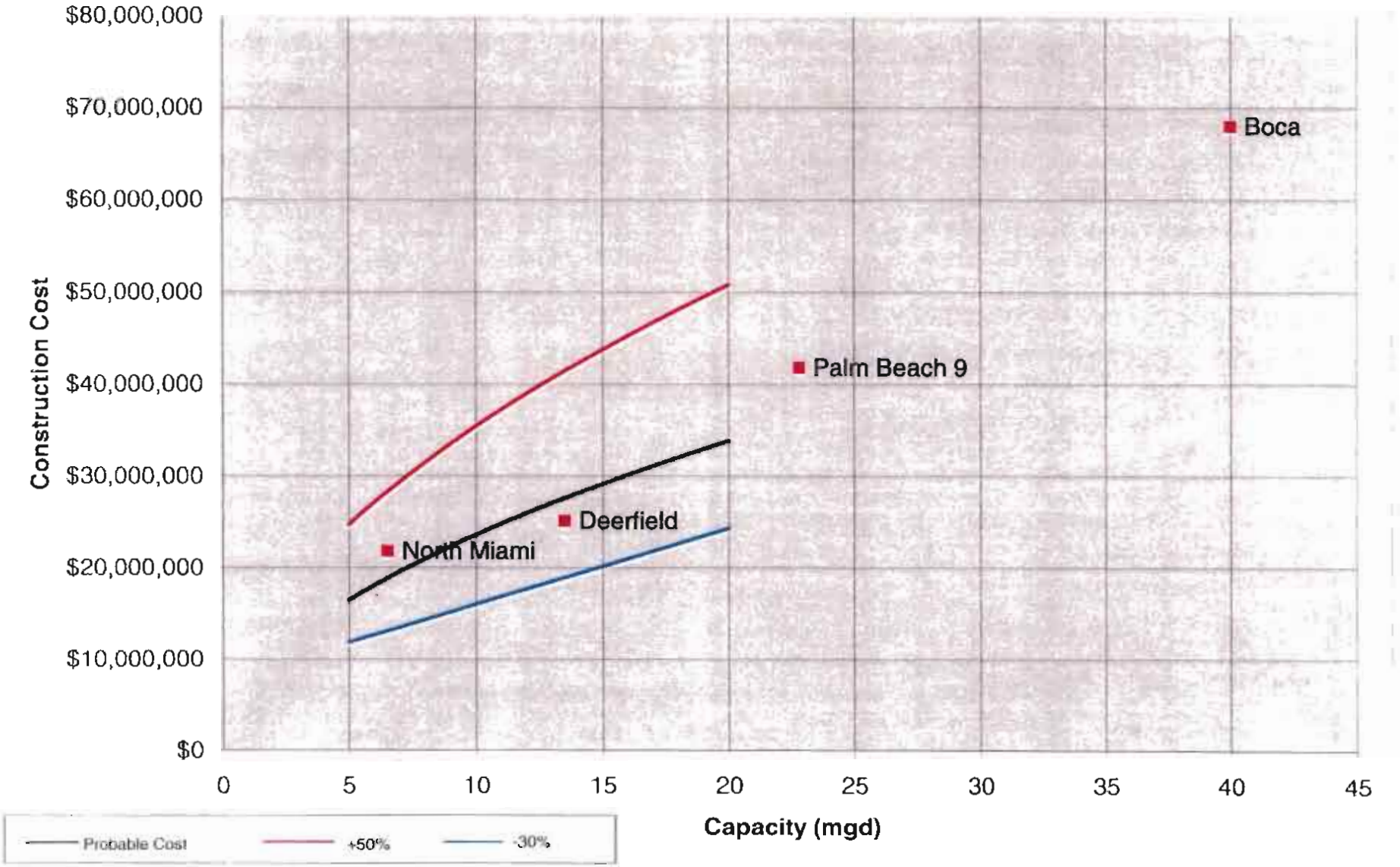
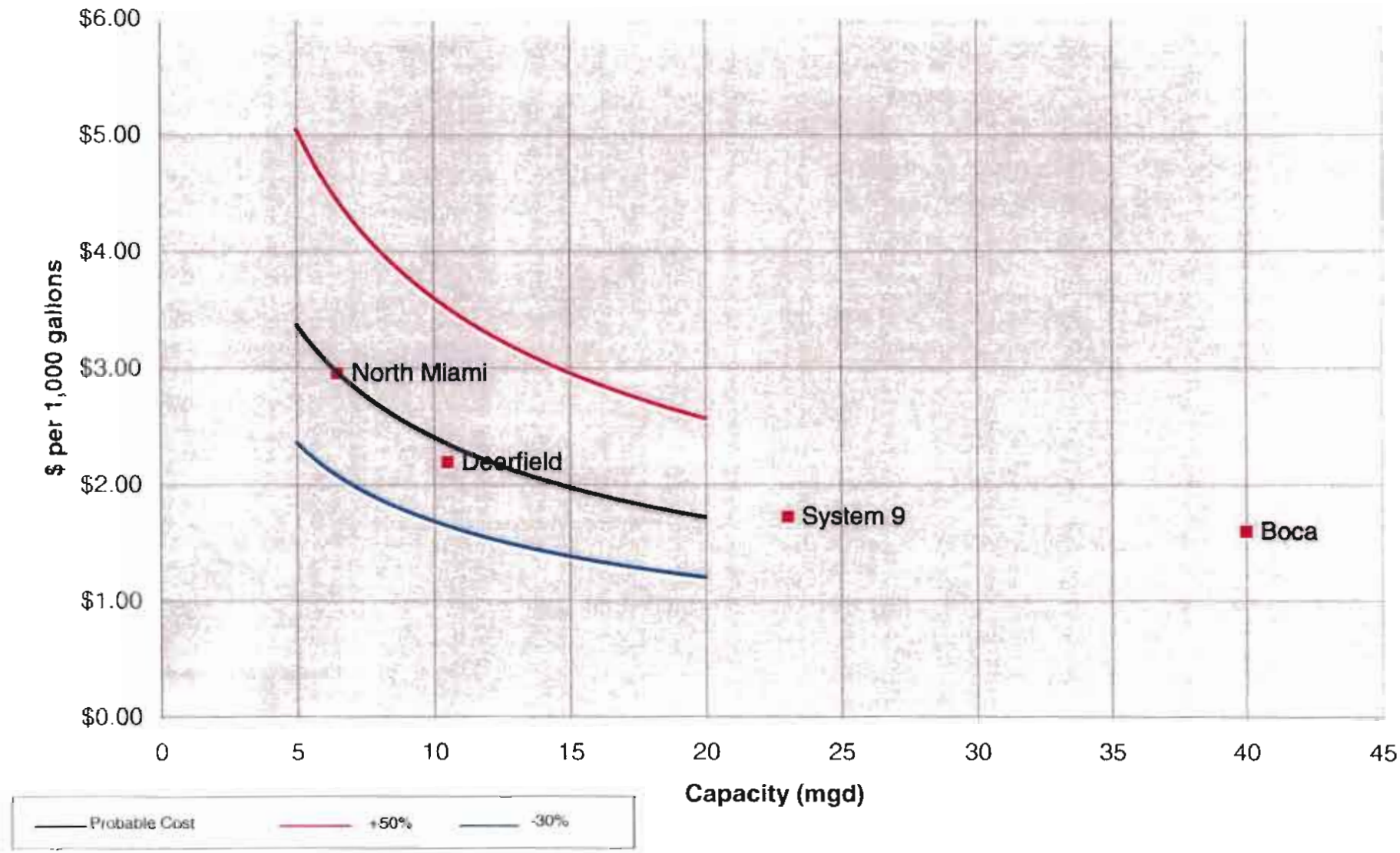


Figure 5-5 Nanofiltration Production Cost



5.1.1.3 Brackish Groundwater RO

The opinion of probable cost for brackish groundwater RO is shown in **Tables 5-4A, 5-4B,** and **5-4C**. Cost curves for brackish groundwater RO are shown on **Figures 5-6** and **5-7** for construction costs and production costs.

The raw water supply for the brackish groundwater RO treatment technology is assumed to be upper Floridan Aquifer wells. The design capacity for each well is approximately 2 mgd of raw water per well. The LPRO process is assumed to operate at a 75 percent recovery rate, with no raw water blend. The number of wells required is that necessary to provide the raw water feed to the plant at the rated capacity and assuming 20 percent standby wells.

The pretreatment, process, and post-treatment components provided are essentially the same as described above for the NF system (with minor differences in items such as pipe pressure ratings due to the difference in operating pressures).

In preparation of the opinions of cost, project cost data were compiled from the following projects, which are plotted on the construction and production cost curves:

- City of Clewiston Low Pressure Reverse Osmosis Water Treatment Plant, 3.0 mgd, bid December 2005.
- Lake Region Water Treatment Plant, Palm Beach County, 10 mgd, bid July 2005.
- Collier County, 12 mgd.
- El Paso, Texas, 28 mgd, bid February 2005.
- Cape Coral, 3.1 mgd.
- Lake Worth, 4.5 mgd.
- Lee County Pine Woods, 2.3 mgd.
- North Miami Beach, 6.5 mgd.
- Alameda County Water, 6 mgd, February 2003.

Table 5-4A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Treatment Technology : Brackish Reverse Osmosis
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	Raw water supply		$3,400,000	$6,800,000	$10,200,000	$13,600,000
2.	Pretreatment		$128,000	$175,000	$237,000	$293,000
3.	Process equipment		$2,219,000	$3,032,000	$4,109,000	$5,099,000
4.	Post treatment		$1,765,000	$2,411,000	$3,269,000	$4,056,000
5.	Intermediate storage (clearwell)		$110,000	$208,000	$305,000	$400,000
6.	Transfer pumping		$105,000	$160,000	$194,000	$248,000
7.	Plant infrastructure		$1,548,000	$2,114,000	$2,866,000	$3,556,000
8.	Concentrate disposal		$5,500,000	$5,500,000	$5,500,000	$5,500,000
Subtotal:			$14,775,000	$20,400,000	$26,680,000	$32,752,000
9.	Yard piping	7%	$1,034,000	$1,428,000	$1,868,000	$2,293,000
10.	Electrical(1)	10%	$928,000	$1,490,000	$2,118,000	$2,725,000
11.	Instrumentation and controls(1)	7%	$649,000	$1,043,000	$1,483,000	$1,908,000
12.	Site work	5%	$739,000	$1,020,000	$1,334,000	$1,638,000
Subtotal:			$18,125,000	$25,381,000	$33,483,000	$41,316,000
13.	General Requirements	2%	$363,000	$508,000	$670,000	$826,000
14.	Contractor overhead and profit	15%	$2,719,000	$3,807,000	$5,022,000	$6,197,000
15.	Construction contingency	15%	$2,719,000	$3,807,000	$5,022,000	$6,197,000
Opinion of Probable Construction Cost::			**$23,926,000**	**$33,503,000**	**$44,197,000**	**$54,536,000**
16.	Technical Services	25%	$5,982,000	$8,376,000	$11,049,000	$13,634,000
17.	Owner administration and legal	5%	$1,196,000	$1,675,000	$2,210,000	$2,727,000
18.	Project contingency	15%	$3,589,000	$5,025,000	$6,630,000	$8,180,000
Opinion of Probable Capital Cost:			**$34,693,000**	**$48,579,000**	**$64,086,000**	**$79,077,000**
Opinion of Equivalent Annual Capital Cost:			**$3,274,774**	**$4,585,514**	**$6,049,265**	**$7,464,309**
Plant service life =		20 years				
Annual interest rate =		7%				
Unit Probable Construction Cost ($/gpd)			$4.79	$3.35	$2.95	$2.73
Unit Probable Total Capital Cost ($/gpd)			$6.94	$4.86	$4.27	$3.95

Notes:

(1) "Electrical" and "Instrumentation and controls" cost items are estimated as 10% and 7%, respectively, of the subtotal of the preceding cost components minus the cost for concentrate disposal. This is due to the fact that a concentrate disposal deep injection well (DIW) has negligible electrical and instrumentation and controls costs relative to other plant components, while the construction cost for a DIW is typically a substantial portion of the total facility cost.

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Table 5-4B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Treatment Technology : Brackish Reverse Osmosis
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Variable Costs				
1.	Power	$710,000	$1,420,000	$2,130,000	$2,839,000
2.	Chemicals	$246,000	$492,000	$738,000	$985,000
3.	Replacement parts and materials	$432,000	$726,000	$984,000	$1,221,000
	a. Replacement membranes:	$92,000	$185,000	$277,000	$370,000
	Fixed				
4.	Operation and maintenance labor	$459,000	$565,000	$638,000	$695,000
5.	Administration/regulatory compliance	$312,000	$525,000	$712,000	$883,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual O&M Cost at Rated Capacity	**$2,251,000**	**$3,913,000**	**$5,479,000**	**$6,993,000**
	Unit Cost at Rated Capacity, $/kgal	$1.23	$1.07	$1.00	$0.96
	Annual Production at Avg Day Demand, (mgy)	1,217	2,704	4,212	5,840
	Annual O&M Cost at ADD Capacity	**$1,758,000**	**$3,181,000**	**$4,526,000**	**$5,910,000**
	Unit Cost at Rated Capacity, $/kgal	$1.44	$1.18	$1.07	$1.01

Table 5-4C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Treatment Technology : Brackish Reverse Osmosis
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Production Costs at Rated Capacity				
1.	Equivalent annual capital cost	$3,275,000	$4,586,000	$6,049,000	$7,464,000
2.	Annual O&M Cost - Variable	$1,480,000	$2,823,000	$4,129,000	$5,415,000
2.	Annual O&M Cost - Fixed	$771,000	$1,090,000	$1,350,000	$1,578,000
3.	Annual R&R fund deposit(1):	$328,000	$459,000	$605,000	$746,000
	Total Annual Cost:	$5,854,000	$8,958,000	$12,133,000	$15,203,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual Production Cost at Rated Cap. ($/kgal):	**$3.21**	**$2.45**	**$2.22**	**$2.08**
	Production Costs at Average Day Demand (ADD)				
	MDD/AADD factor(2):	1.50	1.35	1.30	1.25
1.	Equivalent annual capital cost	$3,275,000	$4,586,000	$6,049,000	$7,464,000
2.	Annual O&M Cost - Variable	$987,000	$2,091,000	$3,176,000	$4,332,000
2.	Annual O&M Cost - Fixed	$771,000	$1,090,000	$1,350,000	$1,578,000
3.	Annual R&R fund deposit(1):	$328,000	$459,000	$605,000	$746,000
	Total Annual Cost:	$5,361,000	$8,226,000	$11,180,000	$14,120,000
	Annual finished water production rate (mgy)(3):	1,217	2,704	4,212	5,840
	Annual Production Cost at ADD ($/kgal):	**$4.41**	**$3.04**	**$2.65**	**$2.42**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.

(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.

(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Figure 5-6 Brackish RO Construction Cost

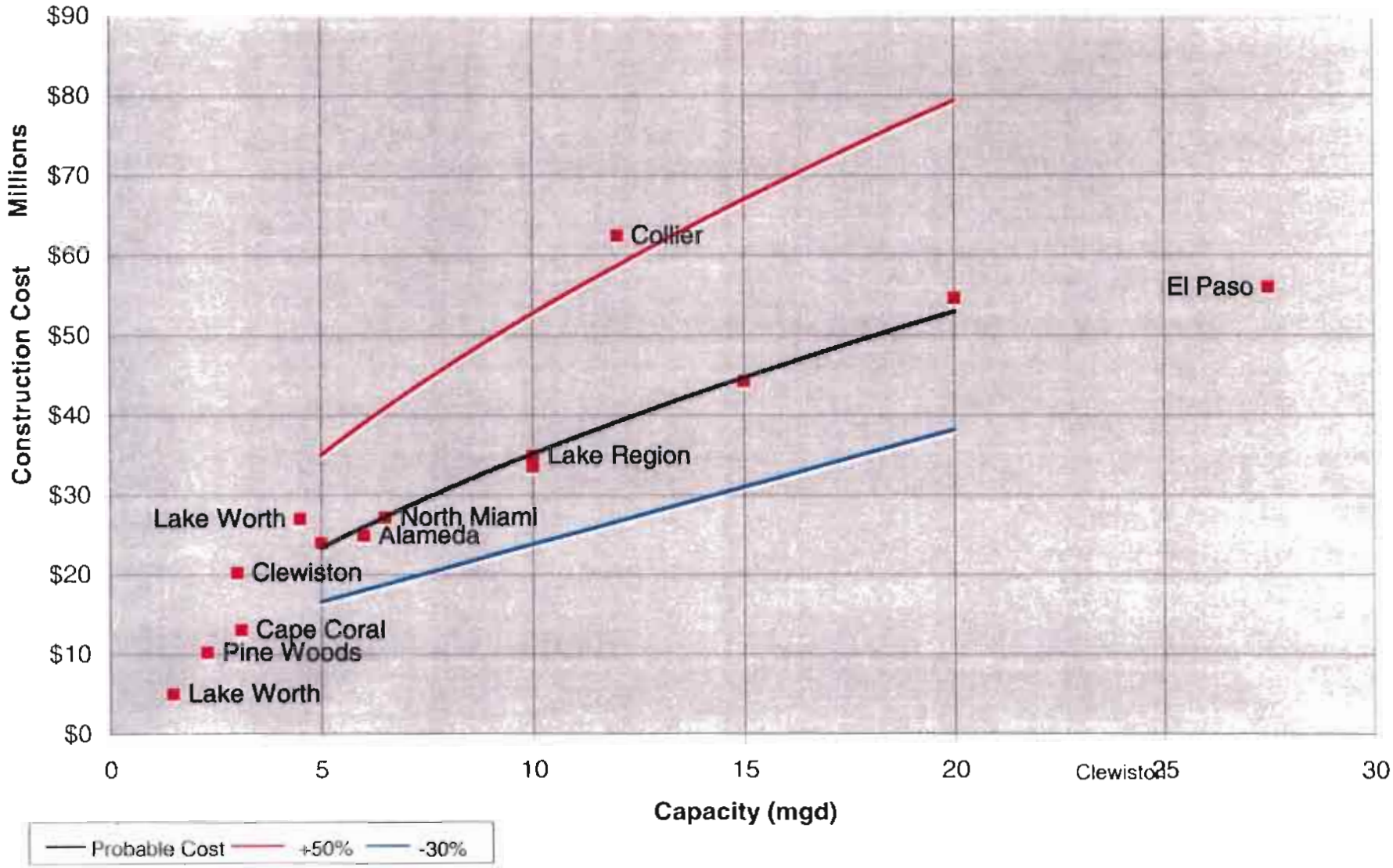
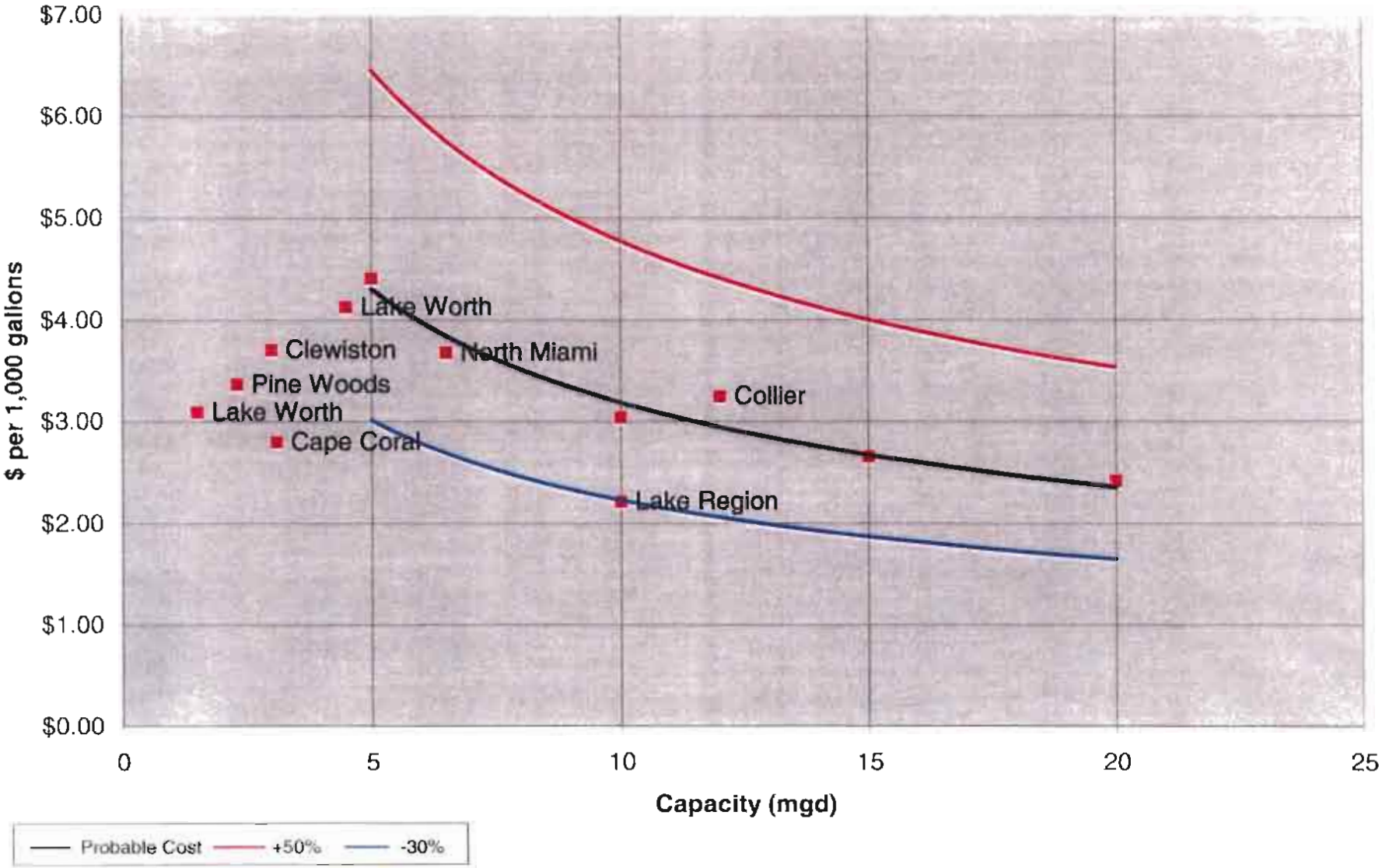


Figure 5-7 Brackish RO Production Cost



5.1.1.4 Brackish Surface Water RO

The opinion of probable cost for brackish surface water RO is shown in **Tables 5-5A, 5-5B,** and **5-5C**. Cost curves for brackish surface water RO are shown on **Figure 5-8** and **5-9** for construction costs and production costs.

The raw water supply for the brackish surface water RO treatment technology is assumed to be from a surface water source such as a brackish river or estuary. The intake includes slotted intake screens, pump basin, and vertical turbine intake pumps and assumes that the intake is located on the plant site. The brackish surface water RO process is assumed to operate at a 75 percent recovery rate, with no raw water blend.

The "base" pretreatment, process, and post-treatment components provided are essentially the same as described above for the NF and groundwater RO systems. However, an additional pretreatment step of media filters would be provided upstream of the cartridge filters due to higher levels of suspended particulate contaminants present in a surface water supply.

To prepare the opinions of cost, the opinions of cost for the brackish groundwater RO technology (based on the projects noted above) were adjusted to include the additional pretreatment step discussed above.

5.1.1.5 Seawater RO – Surface Intake Co-Located with a Power Plant

The opinion of probable cost for seawater RO (surface intake co-located with a power plant) is shown in **Tables 5-6A, 5-6B,** and **5-6C**. Cost curves for seawater RO (surface intake co-located with a power plant) are shown on **Figures 5-10** and **5-11** for construction costs and production costs.

The raw water supply is assumed to be taken from a saltwater bay or intercoastal waterway. The intake would utilize the existing cooling water intake for the power plant, and concentrate would be discharged to the cooling water outfall (similar to the system described below for the Tampa Bay Seawater RO case study). The sea water RO process is assumed to operate at a 50 percent recovery rate.

The pretreatment, process, and post-treatment components provided are essentially the same as described above for the brackish surface water RO system, including media filter pretreatment. There would also be some differences in equipment, pipe pressure ratings, etc. due to the increased operating pressure of sea water RO systems versus brackish water RO systems.

Table 5-5A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Treatment Technology : Brackish RO Surface Water
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	Raw water supply		$1,794,000	$2,451,000	$3,322,000	$4,121,000
2.	Pretreatment		$2,155,000	$2,943,000	$3,989,000	$4,950,000
3.	Process equipment		$2,237,000	$3,762,000	$5,100,000	$6,328,000
4.	Post treatment		$1,765,000	$2,411,000	$3,269,000	$4,056,000
5.	Intermediate storage (clearwell)		$110,000	$208,000	$305,000	$400,000
6.	Transfer pumping		$105,000	$160,000	$194,000	$248,000
7.	Plant infrastructure		$2,284,000	$3,120,000	$4,229,000	$5,932,000
8.	Concentrate disposal		$5,500,000	$5,500,000	$5,500,000	$5,500,000
Subtotal:			$15,950,000	$20,555,000	$25,908,000	$31,535,000
9.	Yard piping	7%	$1,117,000	$1,439,000	$1,814,000	$2,207,000
10.	Electrical(1)	10%	$1,045,000	$1,506,000	$2,041,000	$2,604,000
11.	Instrumentation and controls(1)	7%	$732,000	$1,054,000	$1,429,000	$1,822,000
12.	Site work	5%	$798,000	$1,028,000	$1,295,000	$1,577,000
Subtotal:			$19,642,000	$25,582,000	$32,487,000	$39,745,000
13.	General Requirements	2%	$393,000	$512,000	$650,000	$795,000
14.	Contractor overhead and profit	15%	$2,946,000	$3,837,000	$4,873,000	$5,962,000
15.	Construction contingency	15%	$2,946,000	$3,837,000	$4,873,000	$5,962,000
Opinion of Probable Construction Cost::			**$25,927,000**	**$33,768,000**	**$42,883,000**	**$52,464,000**
16.	Technical Services	25%	$6,482,000	$8,442,000	$10,721,000	$13,116,000
17.	Owner administration and legal	5%	$1,296,000	$1,688,000	$2,144,000	$2,623,000
18.	Project contingency	15%	$3,889,000	$5,065,000	$6,432,000	$7,870,000
Opinion of Probable Capital Cost:			**$37,594,000**	**$48,963,000**	**$62,180,000**	**$76,073,000**
Opinion of Equivalent Annual Capital Cost:			**$3,548,608**	**$4,621,761**	**$5,869,352**	**$7,180,753**
Plant service life =		20 years				
Annual interest rate =		7%				
Unit Probable Construction Cost ($/gpd)			$5.19	$3.38	$2.86	$2.62
Unit Probable Total Capital Cost ($/gpd)			$7.52	$4.90	$4.15	$3.80

Notes:

(1) "Electrical" and "Instrumentation and controls" cost items are estimated as 10% and 7%, respectively, of the subtotal of the preceding cost components minus the cost for concentrate disposal. This is due to the fact that a concentrate disposal deep injection well (DIW) has negligible electrical and instrumentation and controls costs relative to other plant components, while the construction cost for a DIW is typically a substantial portion of the total facility cost.

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Table 5-5B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Treatment Technology : Brackish RO Surface Water
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Variable Costs				
1.	Power	$710,000	$1,420,000	$2,130,000	$2,839,000
2.	Chemicals	$331,000	$661,000	$992,000	$1,323,000
3.	Replacement parts and materials	$456,000	$767,000	$1,040,000	$1,291,000
	a. Replacement membranes:	$116,000	$231,000	$347,000	$462,000
	Fixed				
4.	Operation and maintenance labor	$459,000	$565,000	$638,000	$695,000
5.	Administration/regulatory compliance	$312,000	$525,000	$712,000	$883,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual O&M Cost at Rated Capacity	**$2,384,000**	**$4,169,000**	**$5,859,000**	**$7,493,000**
	Unit Cost at Rated Capacity, $/kgal	$1.31	$1.14	$1.07	$1.03
	Annual Production at Avg Day Demand, (mgy)	1,217	2,704	4,212	5,840
	Annual O&M Cost at ADD Capacity	**$1,846,000**	**$3,371,000**	**$4,818,000**	**$6,310,000**
	Unit Cost at Rated Capacity, $/kgal	$1.52	$1.25	$1.14	$1.08

Table 5-5C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Treatment Technology : Brackish RO Surface Water
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Production Costs at Rated Capacity				
1.	Equivalent annual capital cost	$3,549,000	$4,622,000	$5,869,000	$7,181,000
2.	Annual O&M Cost - Variable	$1,613,000	$3,079,000	$4,509,000	$5,915,000
2.	Annual O&M Cost - Fixed	$771,000	$1,090,000	$1,350,000	$1,578,000
3.	Annual R&R fund deposit(1):	$355,000	$462,000	$587,000	$718,000
	Total Annual Cost:	$6,288,000	$9,253,000	$12,315,000	$15,392,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual Production Cost at Rated Cap. ($/kgal):	**$3.45**	**$2.54**	**$2.25**	**$2.11**
	Production Costs at Average Day Demand (ADD)				
	MDD/AADD factor(2):	1.50	1.35	1.30	1.25
1.	Equivalent annual capital cost	$3,549,000	$4,622,000	$5,869,000	$7,181,000
2.	Annual O&M Cost - Variable	$1,075,000	$2,281,000	$3,468,000	$4,732,000
2.	Annual O&M Cost - Fixed	$771,000	$1,090,000	$1,350,000	$1,578,000
3.	Annual R&R fund deposit(1):	$355,000	$462,000	$587,000	$718,000
	Total Annual Cost:	$5,750,000	$8,455,000	$11,274,000	$14,209,000
	Annual finished water production rate (mgy)(3):	1,217	2,704	4,212	5,840
	Annual Production Cost at ADD ($/kgal):	**$4.73**	**$3.13**	**$2.68**	**$2.43**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.

(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.

(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Figure 5-8 Brackish Surface Water RO Construction Cost

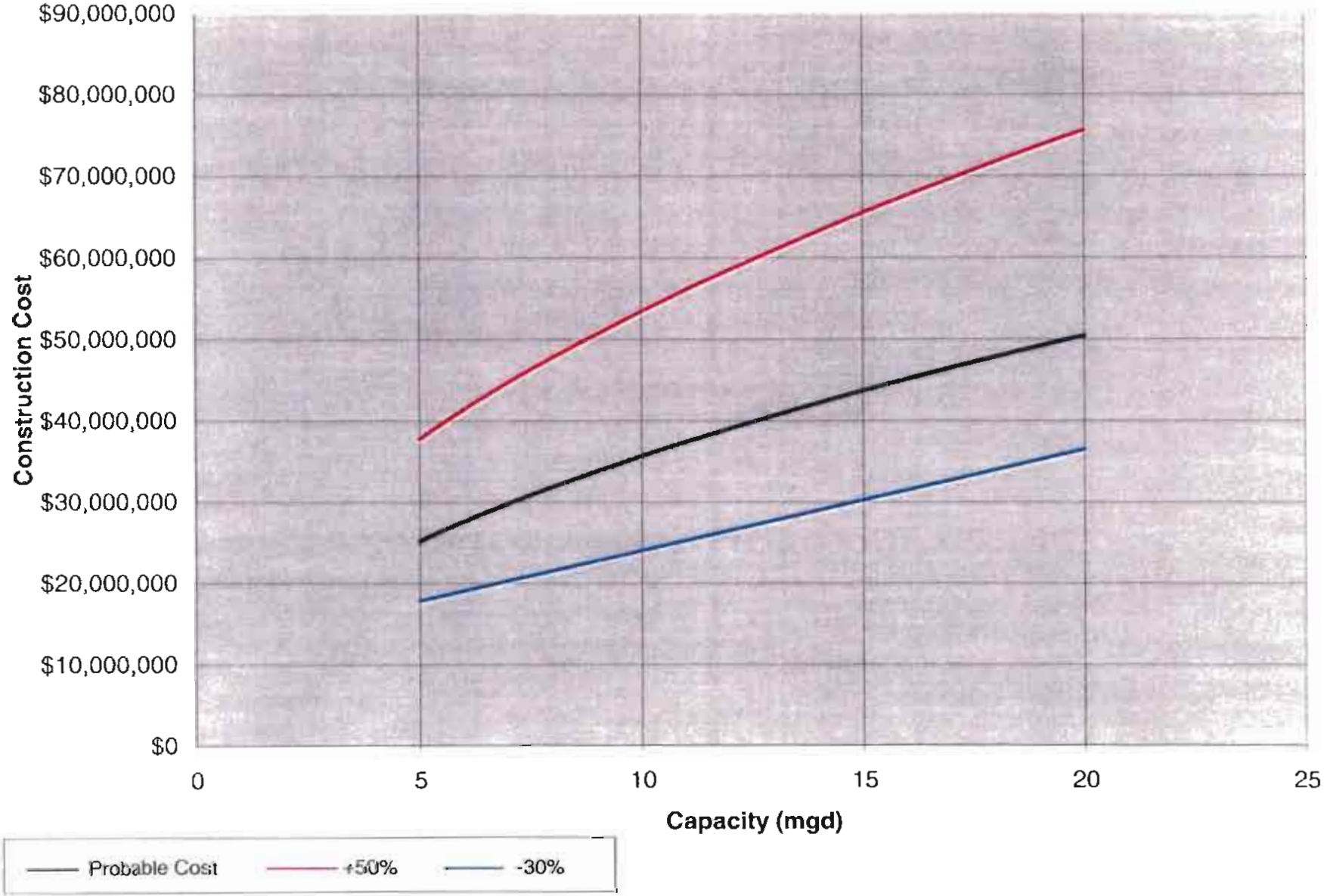

Figure 5-9 Brackish Surface Water RO Production Cost

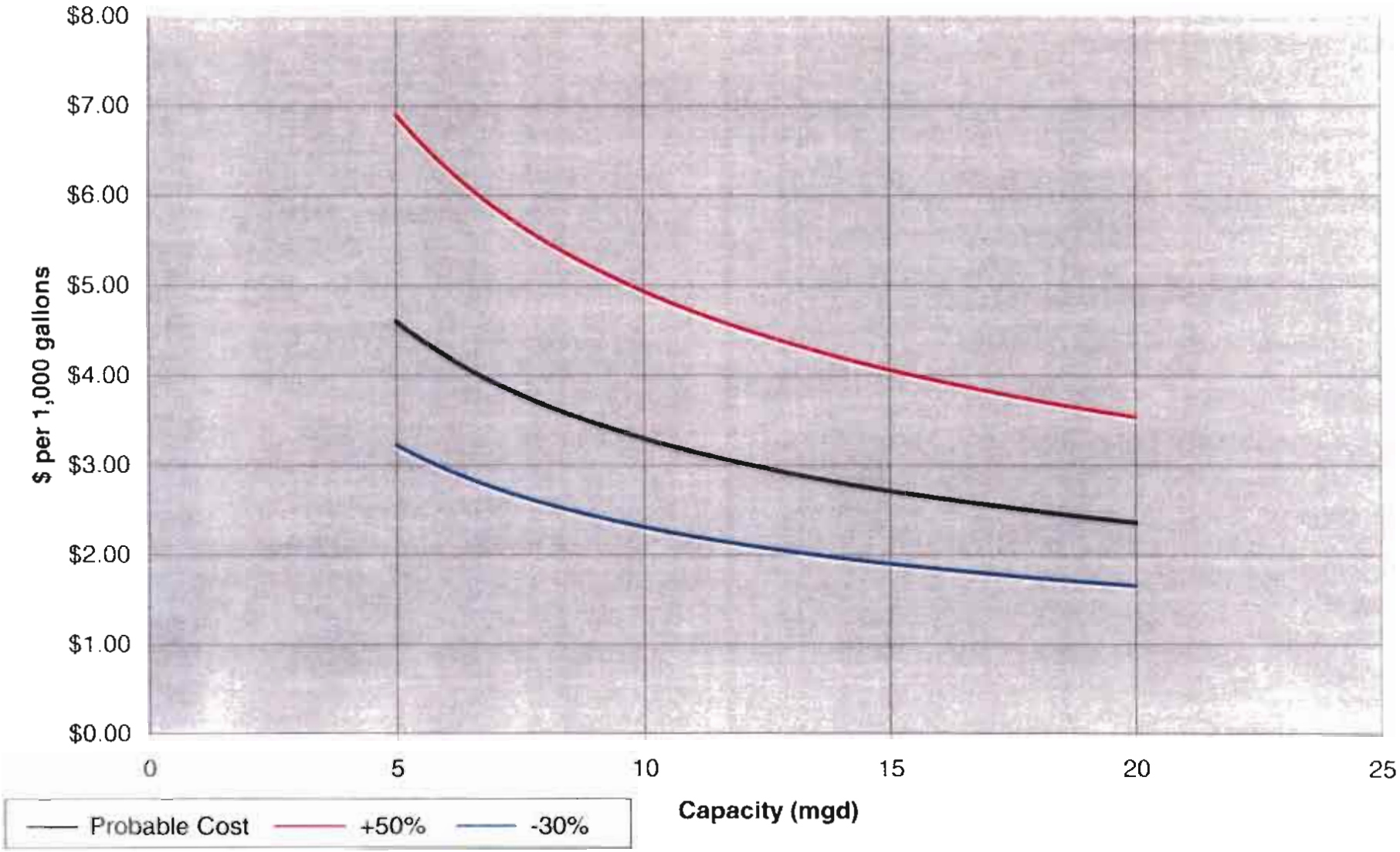

Table 5-6A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Treatment Technology : Seawater RO (Surface Intake, Co-located With a Power Plant)
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	Raw water supply		$2,263,000	$3,676,000	$4,982,000	$6,182,000
2.	Pretreatment		$2,718,000	$4,415,000	$6,583,000	$8,242,000
3.	Process equipment		$8,229,000	$13,368,000	$19,930,000	$24,730,000
4.	Post treatment		$561,000	$912,000	$1,236,000	$1,534,000
5.	Intermediate storage (clearwell)		$110,000	$208,000	$305,000	$400,000
6.	Transfer pumping		$105,000	$160,000	$194,000	$248,000
7.	Plant infrastructure		$1,921,000	$3,120,000	$4,229,000	$5,247,000
8.	Concentrate disposal		$62,000	$100,000	$136,000	$168,000
Subtotal:			$15,969,000	$25,959,000	$37,595,000	$46,751,000
9.	Yard piping	7%	$1,118,000	$1,817,000	$2,632,000	$3,273,000
10.	Electrical	10%	$1,597,000	$2,596,000	$3,760,000	$4,675,000
11.	Instrumentation and controls	7%	$1,118,000	$1,817,000	$2,632,000	$3,273,000
12.	Site work	5%	$798,000	$1,298,000	$1,880,000	$2,338,000
Subtotal:			$20,600,000	$33,487,000	$48,499,000	$60,310,000
13.	General Requirements	2%	$412,000	$670,000	$970,000	$1,206,000
14.	Contractor overhead and profit	15%	$3,090,000	$5,023,000	$7,275,000	$9,047,000
15.	Construction contingency	15%	$3,090,000	$5,023,000	$7,275,000	$9,047,000
Opinion of Probable Construction Cost::			**$27,192,000**	**$44,203,000**	**$64,019,000**	**$79,610,000**
16.	Technical Services	25%	$6,798,000	$11,051,000	$16,005,000	$19,903,000
17.	Owner administration and legal	5%	$1,360,000	$2,210,000	$3,201,000	$3,981,000
18.	Project contingency	15%	$4,079,000	$6,630,000	$9,603,000	$11,942,000
Opinion of Probable Capital Cost:			**$39,429,000**	**$64,094,000**	**$92,828,000**	**$115,436,000**
Opinion of Equivalent Annual Capital Cost:			**$3,721,819**	**$6,050,020**	**$8,762,307**	**$10,896,342**
Plant service life =		20 years				
Annual interest rate =		7%				
Unit Probable Construction Cost ($/gpd)			$5.44	$4.42	$4.27	$3.98
Unit Probable Total Capital Cost ($/gpd)			$7.89	$6.41	$6.19	$5.77

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Table 5-6B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Treatment Technology : Seawater RO (Surface Intake, Co-located With a Power Plant)
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Variable Costs				
1.	Power	$2,537,000	$5,073,000	$7,610,000	$10,146,000
2.	Chemicals	$338,000	$676,000	$1,014,000	$1,352,000
3.	Replacement parts and materials	$597,000	$1,005,000	$1,362,000	$1,690,000
	a. Replacement membranes:	$92,000	$185,000	$277,000	$370,000
	Fixed				
4.	Operation and maintenance labor	$459,000	$565,000	$638,000	$695,000
5.	Administration/regulatory compliance	$310,000	$525,000	$715,000	$891,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual O&M Cost at Rated Capacity	**$4,333,000**	**$8,029,000**	**$11,616,000**	**$15,144,000**
	Unit Cost at Rated Capacity, $/kgal	$2.37	$2.20	$2.12	$2.07
	Annual Production at Avg Day Demand, (mgy)	1,217	2,704	4,212	5,840
	Annual O&M Cost at ADD Capacity	**$3,145,000**	**$6,230,000**	**$9,248,000**	**$12,432,000**
	Unit Cost at Rated Capacity, $/kgal	$2.58	$2.30	$2.20	$2.13

Table 5-6C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Treatment Technology : Seawater RO (Surface Intake, Co-located With a Power Plant)
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Production Costs at Rated Capacity				
1.	Equivalent annual capital cost	$3,722,000	$6,050,000	$8,762,000	$10,896,000
2.	Annual O&M Cost - Variable	$3,564,000	$6,939,000	$10,263,000	$13,558,000
2.	Annual O&M Cost - Fixed	$769,000	$1,090,000	$1,353,000	$1,586,000
3.	Annual R&R fund deposit(1):	$372,000	$605,000	$876,000	$1,090,000
	Total Annual Cost:	$8,427,000	$14,684,000	$21,254,000	$27,130,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual Production Cost at Rated Cap. ($/kgal):	**$4.62**	**$4.02**	**$3.88**	**$3.72**
	Production Costs at Average Day Demand (ADD)				
	MDD/AADD factor(2):	1.50	1.35	1.30	1.25
1.	Equivalent annual capital cost	$3,722,000	$6,050,000	$8,762,000	$10,896,000
2.	Annual O&M Cost - Variable	$2,376,000	$5,140,000	$7,895,000	$10,846,000
2.	Annual O&M Cost - Fixed	$769,000	$1,090,000	$1,353,000	$1,586,000
3.	Annual R&R fund deposit(1):	$372,000	$605,000	$876,000	$1,090,000
	Total Annual Cost:	$7,239,000	$12,885,000	$18,886,000	$24,418,000
	Annual finished water production rate (mgy)(3):	1,217	2,704	4,212	5,840
	Annual Production Cost at ADD ($/kgal):	**$5.95**	**$4.77**	**$4.48**	**$4.18**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.
(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.
(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd)

Figure 5-10 Seawater RO Construction Cost

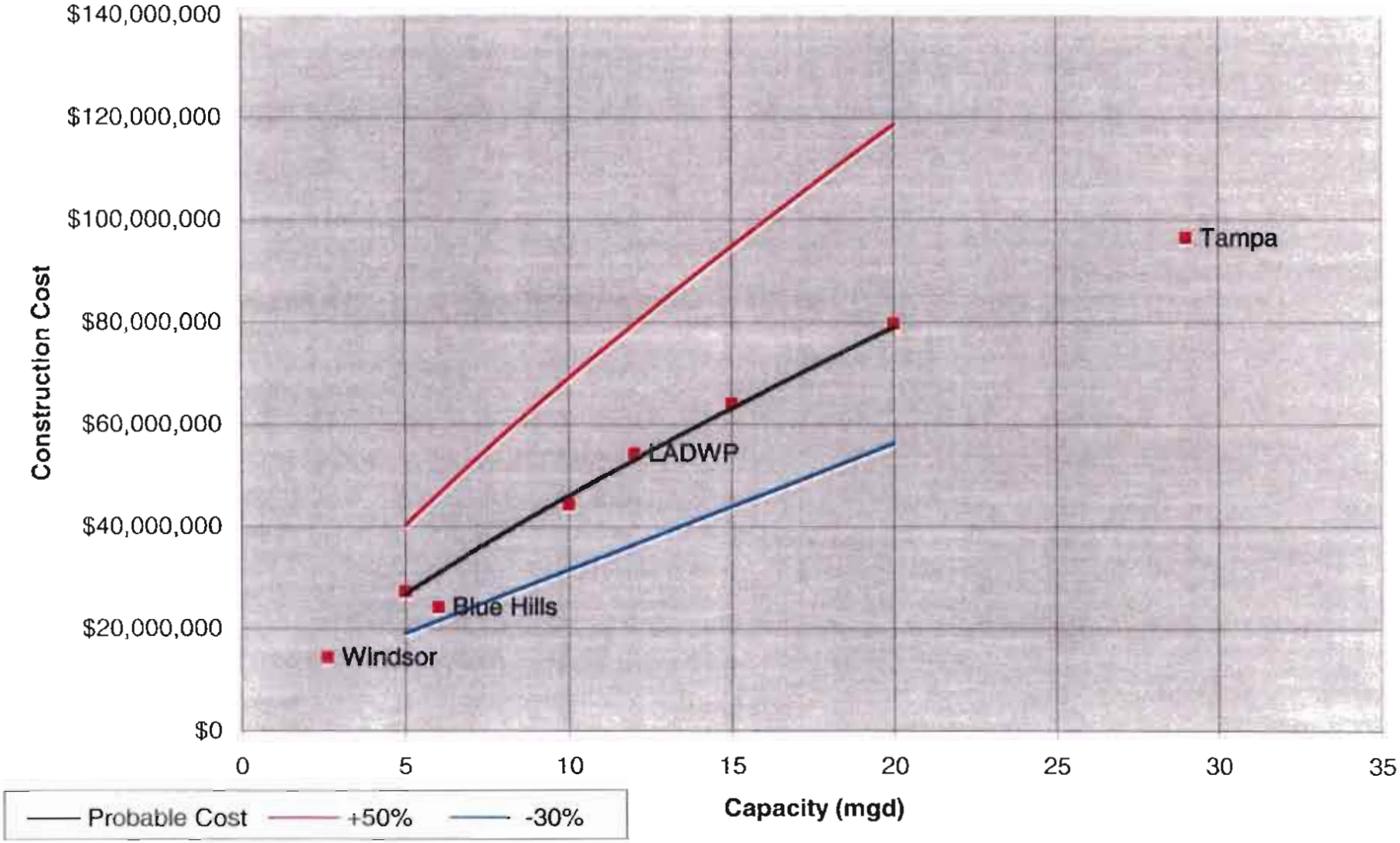
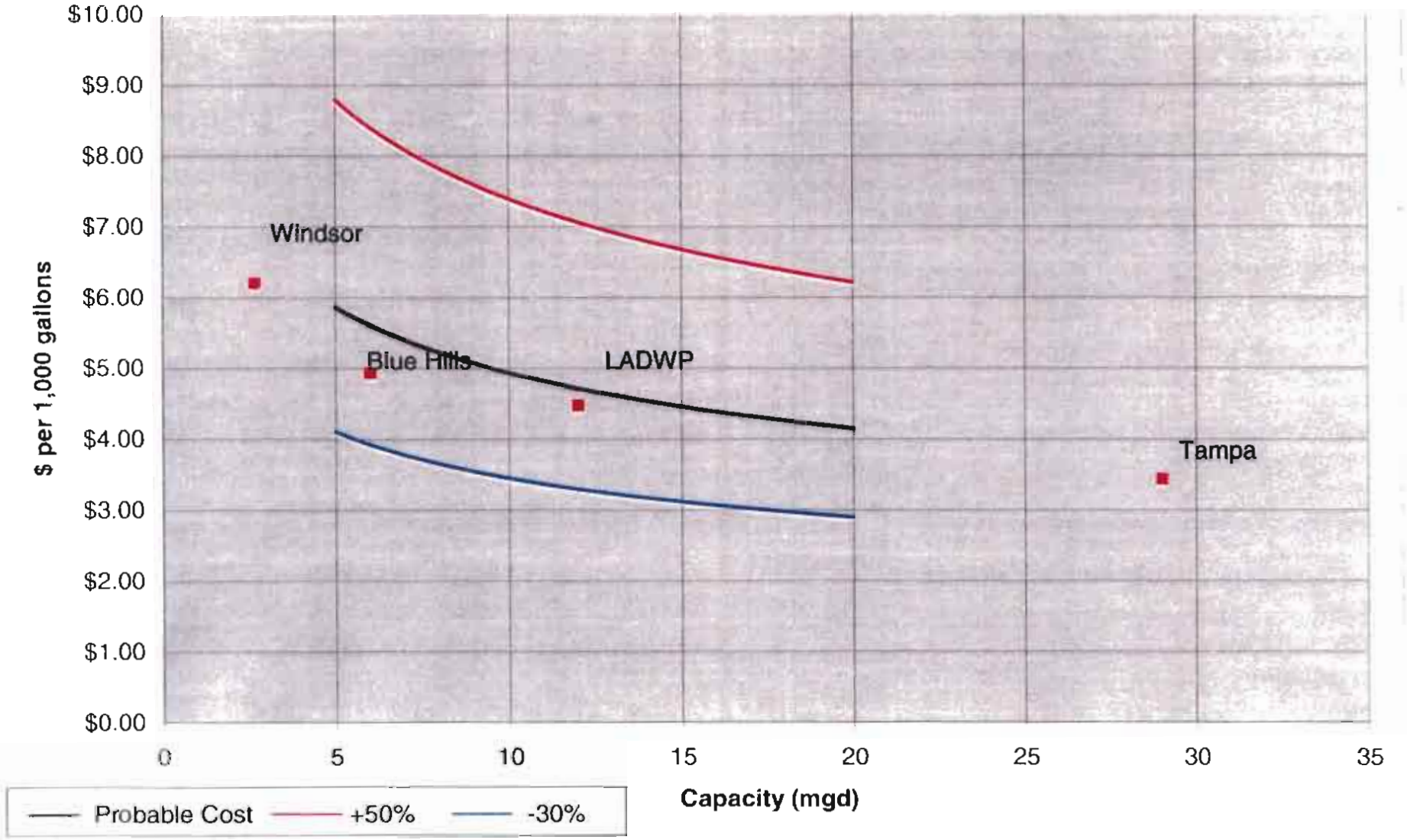


Figure 5-11 Seawater RO Production Cost



In preparation of the opinions of cost, project cost data were compiled from the following projects, which are plotted on the construction and production cost curves:

- Bahamas Water and Sewerage Corporation Windsor Plant, 2.64 mgd, bid February 1997.
- Bahamas Water and Sewerage Corporation Blue Hills Seawater RO Plant, 6 mgd, bid May 2004.
- LADWP, 12 mgd, bid June 2002.
- Tampa Bay Water, 29 mgd, February 1999.

5.1.2 Water Treatment Technologies - Case Studies

5.1.2.1 Seawater RO Surface Water Case Study

The contract for this facility was originally awarded by Tampa Bay Water (TBW) to a consortium consisting of Poseidon Resources and Stone and Webster Engineering on a design, build, operate, and finance (DBFO) basis in July of 1999. Under this contract, the Developer, Poseidon Resources, guaranteed to produce and sell 25 mgd of desalinated water for a contract term of 30 years. Due to financial considerations unrelated to this project, Stone and Webster was replaced by Covanta in 2000. The original scheduled completion date for construction of the project was December of 2002.

The Facility is located north of the cooling water inlet canal for the Tampa Electric Company Big Bend Power Station. An agreement was reached that allowed the Developer to lease this industrial zoned site from Tampa Electric for the duration of the Project. The site is adequate to allow future expansion of the Facility to produce up to 35 mgd of Product Water.

The desalination plant is designed to produce a guaranteed water quality having finished water chlorides of less than 100 mg/l. To accomplish this stringent water quality objective, the treatment process includes a first pass of seawater reverse osmosis (RO) membranes and a partial second pass of brackish RO membranes. The percentage of the flow stream directed to the second pass is varied to meet the specified product water quality. The seawater reverse osmosis system consists of seven seawater reverse osmosis membrane units. The units are sized such that six units are capable of producing the plant rated capacity of 25 mgd. The seventh unit is essentially an installed spare and the total installed membrane capacity of the facility is approximately 29 mgd. The seawater RO units include multistage split case centrifugal high pressure membrane feed pumps with Pelton wheel turbines for energy recovery.

The source water for the Facility is taken from the cooling water discharge conduits of the power station and the Facility essentially reuses the water withdrawn by Tampa

Electric. The cooling water (greater than 1,350 mgd) flows to the power plant through an inlet canal, is drawn into two intake structures, is screened, pumped through the main condensers of the plant, and is discharged through outfalls into another canal for transport back to the bay. The concentrate and filter backwash water discharged from the desalination plant are discharged into the cooling water outfalls along with the discharge from the power plant.

The intake structure consists of a sump located between the cooling water discharge conduits from Units 3 and 4 of the power plant. The seawater supply pumps are located in the intake sump and pump seawater to the pretreatment system.

The original pretreatment system utilizes two-stage Dyna-Sand type gravity filtration with chemical addition. This pretreatment system has experienced operational problems and is currently in the process of being upgraded. Water from the pretreatment system is pumped by vertical turbine pumps from the pretreatment clearwell through the cartridge filter to the first pass seawater RO units described above.

A lime storage facility and feed system is provided for lime addition to the permeate from the RO system to add hardness and improve the stability of the product water prior to pumping to storage.

The product water is pumped approximately fourteen miles to the Tampa Bay Water regional water plant. The total product storage capacity for this system is 12.5 million gallons. One 5-MG ground storage tank was provided at the Big Bend site in the seawater desalination contract. Another 7.5 million gallons of storage was to be provided by TBW at the Tampa Bay Regional Facility Site.

The initial 25-mgd Facility was sized for expansion to 35 mgd in the following areas:

- Intake structure and pipeline;
- Plant headworks and stub-outs;
- Concentrate discharge pipeline;
- Product water delivery pipeline; and
- Stub-outs for pipeline pump and storage tanks.

Space was provided to accommodate expansion of the membrane treatment building to the 35-mgd capacity if authorized by Tampa Bay Water.

The summary of probable cost for seawater reverse osmosis surface water case study is shown in **Tables 5-7A, 5-7B,** and **5-7C**.

Table 5-7A

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Capital Cost

Treatment Technology : Seawater RO Surface Water Case Study

Item No.	Description	Allowance Factor	Original Plant Capacity (mgd) 29	Escalated Aug-06 Plant Capacity (mgd) 29
1.	Raw water supply		$921,000	$1,183,000
2.	Pretreatment		$7,747,000	$9,949,000
3.	Process equipment		$17,604,000	$22,607,000
4.	Post treatment		$357,000	$458,000
5.	Intermediate storage (clearwell)		$470,000	$604,000
6.	Transfer pumping		$0	$0
7.	Finished water storage		$2,431,000	$3,122,000
8.	High service pumping		$403,000	$518,000
9.	Plant infrastructure		$5,542,000	$7,117,000
10.	Concentrate disposal		$802,000	$1,030,000
Subtotal:			$36,277,000	$46,588,000
11.	Yard piping		$4,723,000	$6,065,000
12.	Mechanical		$14,000,000	$17,979,000
13.	Electrical		$3,724,000	$4,782,000
14.	Instrumentation and controls		$1,486,000	$1,908,000
15.	Site work		$1,785,000	$2,292,000
Subtotal:			$61,995,000	$79,614,000
16.	General Requirements		$1,952,000	$2,507,000
17.	Contractor overhead and profit		$5,785,000	$7,429,000
18.	Construction contingency		$1,882,000	$2,417,000
Opinion of Probable Construction Cost::			**$71,614,000**	**$91,967,000**
19.	Developer's Costs		$10,631,000	$13,652,000
20.	Bonds, Insurance, Capitalized Construction Interest		$8,081,000	$10,378,000
21.	Controlled Insurance Program		$4,500,000	$5,779,000
Opinion of Probable Capital Cost:			**$94,826,000**	**$121,776,000**
Opinion of Equivalent Annual Capital Cost:			**$8,950,904**	**$11,494,793**
Plant service life =		20 years		
Annual interest rate =		7%		
Unit Probable Construction Cost ($/gpd)			$2.47	$3.17
Unit Probable Total Capital Cost ($/gpd)			$3.27	$4.20

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Table 5-7B

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Annual Operation and Maintenance Cost
Treatment Technology : Seawater RO Surface Water Case Study
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 25
	Variable Costs	
1.	Power	$22,813,000
2.	Chemicals	$1,036,000
3.	Replacement parts and materials	$1,260,000
	a. Replacement membranes:	$1,004,000
	Fixed	
4.	Operation and maintenance labor	$953,000
5.	Administration/regulatory compliance	$1,120,000
	Annual Production at Rated Capacity, (mgy)	9,125
	Annual O&M Cost at Rated Capacity	**$28,186,000**
	Unit Cost at Rated Capacity, $/kgal	$3.09
	Annual Production at Avg Day Demand, (mgy)	7,300
	Annual O&M Cost at ADD Capacity	**$22,963,000**
	Unit Cost at Rated Capacity, $/kgal	$3.15

Table 5-7C

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Total Production Cost
Treatment Technology : Seawater RO Surface Water Case Study
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 25
	Production Costs at Rated Capacity	
1.	Equivalent annual capital cost	$11,495,000
2.	Annual O&M Cost - Variable	$26,113,000
2.	Annual O&M Cost - Fixed	$2,073,000
3.	Annual R&R fund deposit(1):	$1,150,000
	Total Annual Cost:	$40,831,000
	Annual Production at Rated Capacity, (mgy)	9,125
	Annual Production Cost at Rated Cap. ($/kgal):	**$4.47**
	Production Costs at Average Day Demand (ADD)	
	MDD/AADD factor(2):	1.25
1.	Equivalent annual capital cost	$11,495,000
2.	Annual O&M Cost - Variable	$20,890,000
2.	Annual O&M Cost - Fixed	$2,073,000
3.	Annual R&R fund deposit(1):	$1,150,000
	Total Annual Cost:	$35,608,000
	Annual finished water production rate (mgy)(3):	7,300
	Annual Production Cost at ADD ($/kgal):	**$4.88**

5.1.2.2 Fresh Surface Water Case Study – Tampa Bay Surface Water Project

This section presents a case study of a 66-million-gallon per day (mgd), state-of-the-art regional surface water treatment plant for Tampa Bay Water. The design was one component of a 15-year design/build/operate (DBO) contract awarded to USFilter for the project. Tampa Bay Water owns and financed the facility. Tampa Bay Water provides high-quality drinking water to its members that in turn supply water to nearly 2 million residents of the Tampa Bay area. Tampa Bay Water member governments include the cities of New Port Richey, St. Petersburg and Tampa, and the counties of Hillsborough, Pasco and Pinellas. Plant construction was completed in September 2002 on a 435-acre tract of land located in an industrial area near Broadway and U.S. 301 in the Brandon area.

The surface water treatment plant uses a high-rate ballasted flocculation/ sedimentation process consisting of a proprietary system provided by Veolia Water North America Kruger Products with the trade name "ACTIFLO". This system replaces a traditional rapid mix coagulation, flocculation, and sedimentation process. This process is particularly advantageous when treating large flow rates with variable raw water quality, the conditions anticipated for the regional water treatment plant. The facility treats water from the Hillsborough and Alafia rivers and Tampa Bypass Canal to standards that exceed the current EPA Safe Drinking Water Act requirements for potable water.

The ACTIFLO Process operates similarly to a conventional flocculation-sedimentation design, with the exception that 130-150 micron sand (microsand) is added to the water during the flocculation process in order to enhance both coagulation and settling. The microsand adds surface area in the coagulation process, which significantly improves the frequency of collision of dispersed or colloidal particles in the raw water with oppositely charged coagulated floc. This action accelerates the coagulation and flocculation processes. The microsand also provides "ballast" to the floc, resulting in floc settling velocities that are 25 to 35 times faster than floc produced in conventional floc-sed processes. When compared to conventional flocculation-sedimentation or "sludge blanket" processes, this combination of improved coagulation efficiency and rapid floc settling characteristics provides:

- Significantly better quality settled water (as measured via particle counts in the 2 to 4 micron range);
- More stable performance during raw water upset conditions;
- Reduced coagulant demand (particularly under high algae conditions); and
- Lower construction costs (reduced process footprint).

The ACTIFLO treatment process is immediately followed by ozonation and dual-media biologically active filtration.

A large-scale pilot testing program executed by USFilter and CDM at the Lake Manatee water treatment plant demonstrated that the process design using ACTIFLO offered better finished water quality, improved process reliability, reduced treatment costs and reduced space requirements over the conventional flocculation-sedimentation design specified in the base bid requirements for the project.

The new 66-mgd water treatment plant treats water at a rate of 40 cents per thousand gallons, significantly lower than earlier estimates, and guarantees higher water quality than originally specified.

Additional information on the current O&M for the Surface Treatment Plant is contained in **Appendix F**.

The summary of probable cost for the fresh surface water case study for the Tampa Bay surface water project is shown in **Tables 5-8A, 5-8B,** and **5-8C**.

5.1.3 Water Treatment Technology Process Components

As noted previously, this group of cost tables may be viewed as comprising costs for adding incremental treatment process capacity to an existing water treatment plant.

5.1.3.1 Nanofiltration Process Units

The opinion of probable cost for cartridge filters, membrane feed pumps, pretreatment chemicals (acid and antiscalant), the membrane units (membrane pressure vessels, frames and piping), piping inside the membrane building, cleaning system, instruments and controls, and electrical equipment is shown in **Tables 5-9A, 5-9B,** and **5-9C**. Cost curves for membrane units are shown on **Figures 5-12** and **5-13** for construction costs and production costs.

5.1.3.2 Reverse Osmosis Process Units

The opinion of probable cost for cartridge filters, membrane feed pumps, pretreatment chemicals (acid and antiscalant), the membrane units (membrane pressure vessels, frames and piping), piping inside the membrane building, cleaning system, instruments and controls, and electrical equipment is shown in **Tables 5-10A, 5-10B,** and **5-10C**. Cost curves for membrane units are shown on **Figures 5-14** and **5-15** for construction costs and production costs.

5.1.4 Water Distribution Plant Components

As noted above, this group of cost tables may be viewed as comprising costs for components that are likely to be common among the various treatment technologies for each capacity increment examined. Plant components addressed include finished water storage and high service pumping. These tables should be considered to represent the cost of incorporating the selected components for a particular plant capacity rating into a new "grass roots" water treatment plant (e.g., as an add-on to the first group of water treatment technology cost tables).

Table 5-8A

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Capital Cost
Treatment Technology : Fresh Surface Water Case Study
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 66
1.	Raw water supply		$8,950,000
2.	Pretreatment		$2,204,000
3.	Process equipment		$21,211,000
4.	Post treatment		$13,183,000
5.	Intermediate storage (clearwell)		$0
6.	Transfer pumping		$707,000
7.	Finished water storage		$0
8.	High service pumping		$2,877,000
9.	Plant infrastructure		$5,066,000
10.	Concentrate disposal		$9,825,000
Subtotal:			$64,023,000
11.	Yard piping		$4,293,000
12.	Electrical		$4,213,000
13.	Instrumentation and controls		$0
14.	Site work		$2,571,000
Subtotal:			$75,100,000
15.	General Requirements		$1,754,000
16.	Contractor overhead and profit		$14,611,000
17.	Construction contingency		$2,114,000
Opinion of Probable Construction Cost:			**$93,579,000**
18.	Technical Services		$0
19.	Owner administration and legal		$0
20.	Project contingency		$0
Opinion of Probable Capital Cost:			**$93,579,000**
Opinion of Equivalent Annual Capital Cost:			**$8,833,196**
Plant service life =		20 years	
Annual interest rate =		7%	

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Table 5-8B

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Annual Operation and Maintenance Cost
Treatment Technology : Fresh Surface Water Case Study
August 2006 Dollars

Assumptions
Unit power cost = $0.0715 per kW-hr

Item No.	Description	Plant Capacity (mgd) 66
	Variable Costs	
1.	Power	$1,008,000
2.	Chemicals	$3,132,000
3.	Replacement parts and materials	$675,000
	a. Replacement membranes:	
	Fixed	
4.	Operation and maintenance labor	$4,159,000
5.	Administration/regulatory compliance	$707,000
	Annual Production at Rated Capacity, (mgy)	24,090
	Annual O&M Cost at Rated Capacity	**$9,681,000**
	Unit Cost at Rated Capacity, $/kgal	$0.40
	Annual Production at Avg Day Demand, (mgy)	15,586
	Annual O&M Cost at ADD Capacity	**$7,981,000**
	Unit Cost at Rated Capacity, $/kgal	$0.51

Table 5-8C

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Total Production Cost
Treatment Technology : Fresh Surface Water Case Study
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 66
	Production Costs at Rated Capacity	
1.	Equivalent annual capital cost	$8,833,000
2.	Annual O&M Cost - Variable	$4,815,000
2.	Annual O&M Cost - Fixed	$4,866,000
3.	Annual R&R fund deposit(1):	$883,000
	Total Annual Cost:	$19,397,000
	Annual Production at Rated Capacity, (mgy)	24,090
	Annual Production Cost at Rated Cap. ($/kgal):	**$0.81**
	Production Costs at Average Day Demand (ADD)	
	MDD/AADD factor(2):	1.55
1.	Equivalent annual capital cost	$8,833,000
2.	Annual O&M Cost - Variable	$3,115,000
2.	Annual O&M Cost - Fixed	$4,866,000
3.	Annual R&R fund deposit(1):	$883,000
	Total Annual Cost:	$17,697,000
	Annual finished water production rate (mgy)(3):	15,586
	Annual Production Cost at ADD ($/kgal):	**$1.14**

Table 5-9A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Treatment Technology : Nanofiltration - Process Addition
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	Pretreatment		$87,000	$146,000	$213,000	$268,000
2.	Process equipment		$1,793,000	$3,015,000	$4,396,000	$5,534,000
3.	Post treatment		$209,000	$352,000	$513,000	$646,000
4.	Intermediate storage (clearwell)		$110,000	$208,000	$305,000	$400,000
5.	Transfer pumping		$105,000	$160,000	$194,000	$248,000
6.	Plant infrastructure		$1,371,000	$2,306,000	$3,142,000	$3,955,000
7.	Concentrate disposal		$5,500,000	$5,500,000	$5,500,000	$5,500,000
Subtotal:			$9,175,000	$11,687,000	$14,263,000	$16,551,000
8.	Yard piping	7%	$642,000	$818,000	$998,000	$1,159,000
11.	Electrical(1)	10%	$368,000	$619,000	$876,000	$1,105,000
12.	Instrumentation and controls(1)	7%	$257,000	$433,000	$613,000	$774,000
13.	Site work	5%	$459,000	$584,000	$713,000	$828,000
Subtotal:			$10,901,000	$14,141,000	$17,463,000	$20,417,000
14.	General Requirements	2%	$218,000	$283,000	$349,000	$408,000
15.	Contractor overhead and profit	15%	$1,635,000	$2,121,000	$2,619,000	$3,063,000
16.	Construction contingency	15%	$1,635,000	$2,121,000	$2,619,000	$3,063,000
Opinion of Probable Construction Cost:			**$14,389,000**	**$18,666,000**	**$23,050,000**	**$26,951,000**
17.	Technical Services	25%	$3,597,000	$4,667,000	$5,763,000	$6,738,000
18.	Owner administration and legal	5%	$719,000	$933,000	$1,153,000	$1,348,000
19.	Project contingency	15%	$2,158,000	$2,800,000	$3,458,000	$4,043,000
Opinion of Probable Capital Cost:			**$20,863,000**	**$27,066,000**	**$33,424,000**	**$39,080,000**
Opinion of Equivalent Annual Capital Cost:			**$1,969,320**	**$2,554,839**	**$3,154,989**	**$3,688,876**
Plant service life =		20 years				
Annual interest rate =		7%				
Unit Probable Construction Cost ($/gpd)			$2.88	$1.87	$1.54	$1.35
Unit Probable Total Capital Cost ($/gpd)			$4.17	$2.71	$2.23	$1.95

Notes:

(1) "Electrical" and "Instrumentation and controls" cost items are estimated as 10% and 7%, respectively, of the subtotal of the preceding cost components minus the cost for concentrate disposal. This is due to the fact that a concentrate disposal deep injection well (DIW) has negligible electrical and instrumentation and controls costs relative to other plant components, while the construction cost for a DIW is typically a substantial portion of the total facility cost.

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Table 5-9B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Treatment Technology : Nanofiltration - Process Addition
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Variable Costs				
1.	Power	$477,000	$954,000	$1,431,000	$1,908,000
2.	Chemicals	$293,000	$492,000	$667,000	$828,000
3.	Replacement parts and materials	$432,000	$726,000	$984,000	$1,221,000
	a. Replacement membranes:	$110,000	$185,000	$250,000	$311,000
	Fixed				
4.	Operation and maintenance labor	$459,000	$565,000	$638,000	$695,000
5.	Administration/regulatory compliance	$312,000	$525,000	$712,000	$883,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual O&M Cost at Rated Capacity	**$2,083,000**	**$3,447,000**	**$4,682,000**	**$5,846,000**
	Unit Cost at Rated Capacity, $/kgal	$1.14	$0.94	$0.86	$0.80
	Annual Production at Avg Day Demand, (mgy)	1,217	2,704	4,212	5,840
	Annual O&M Cost at ADD Capacity	**$1,646,000**	**$2,836,000**	**$3,913,000**	**$4,992,000**
	Unit Cost at Rated Capacity, $/kgal	$1.35	$1.05	$0.93	$0.85

Table 5-9C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Treatment Technology : Nanofiltration - Process Addition
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Production Costs at Rated Capacity				
1.	Equivalent annual capital cost	$1,969,000	$2,555,000	$3,155,000	$3,689,000
2.	Annual O&M Cost - Variable	$1,312,000	$2,357,000	$3,332,000	$4,268,000
2.	Annual O&M Cost - Fixed	$771,000	$1,090,000	$1,350,000	$1,578,000
3.	Annual R&R fund deposit(1):	$197,000	$256,000	$316,000	$369,000
	Total Annual Cost:	$4,249,000	$6,258,000	$8,153,000	$9,904,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual Production Cost at Rated Cap. ($/kgal):	**$2.33**	**$1.71**	**$1.49**	**$1.36**
	Production Costs at Average Day Demand (ADD)				
	MDD/AADD factor(2):	1.50	1.35	1.30	1.25
1.	Equivalent annual capital cost	$1,969,000	$2,555,000	$3,155,000	$3,689,000
2.	Annual O&M Cost - Variable	$875,000	$1,746,000	$2,563,000	$3,414,000
2.	Annual O&M Cost - Fixed	$771,000	$1,090,000	$1,350,000	$1,578,000
3.	Annual R&R fund deposit(1):	$197,000	$256,000	$316,000	$369,000
	Total Annual Cost:	$3,812,000	$5,647,000	$7,384,000	$9,050,000
	Annual finished water production rate (mgy)(3):	1,217	2,704	4,212	5,840
	Annual Production Cost at ADD ($/kgal):	**$3.13**	**$2.09**	**$1.75**	**$1.55**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.

(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.

(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Figure 5-12 Nanofiltration Process Addition Construction Cost

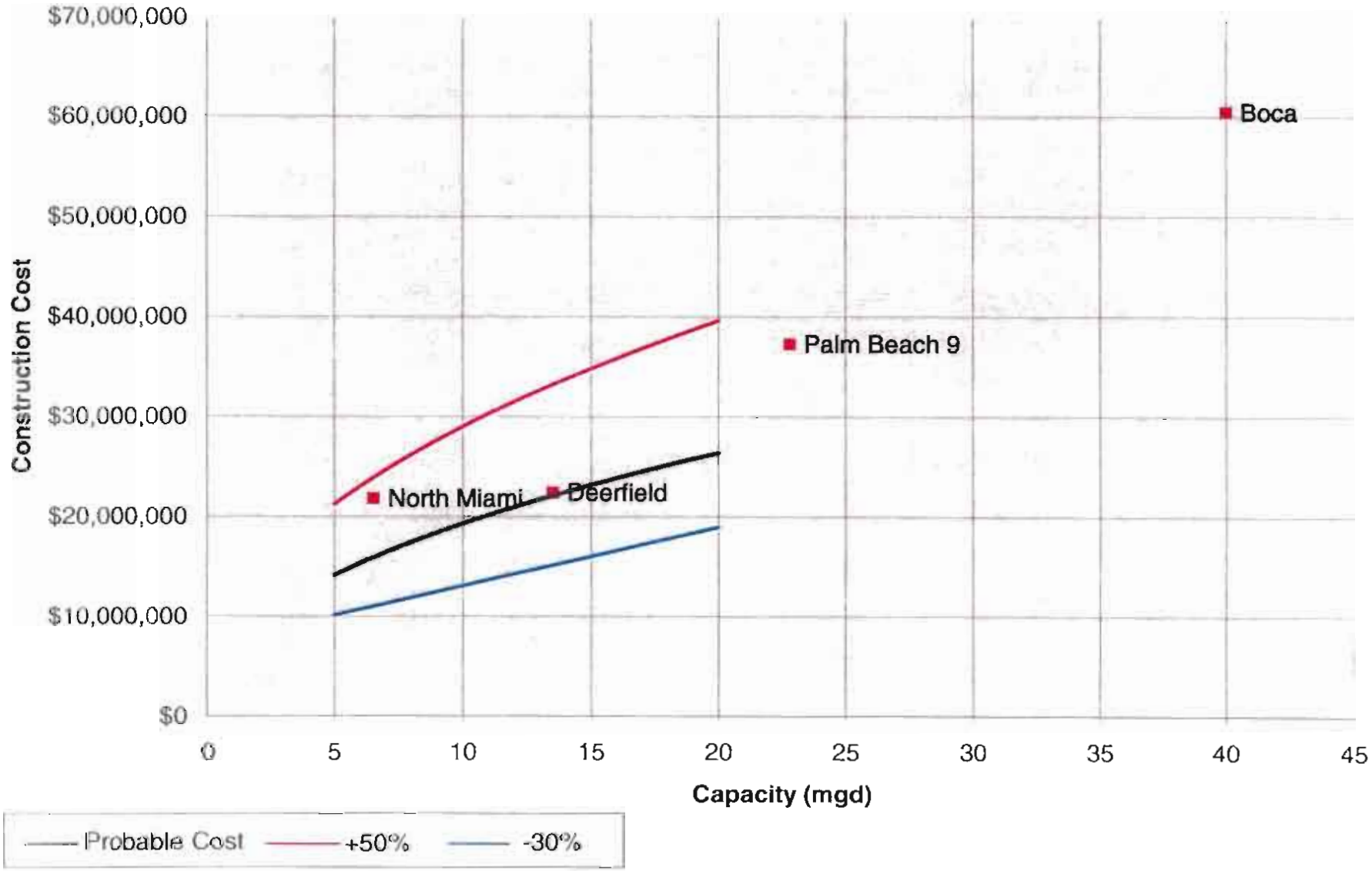

Figure 5-13 Nanofiltration Process Addition Production Cost

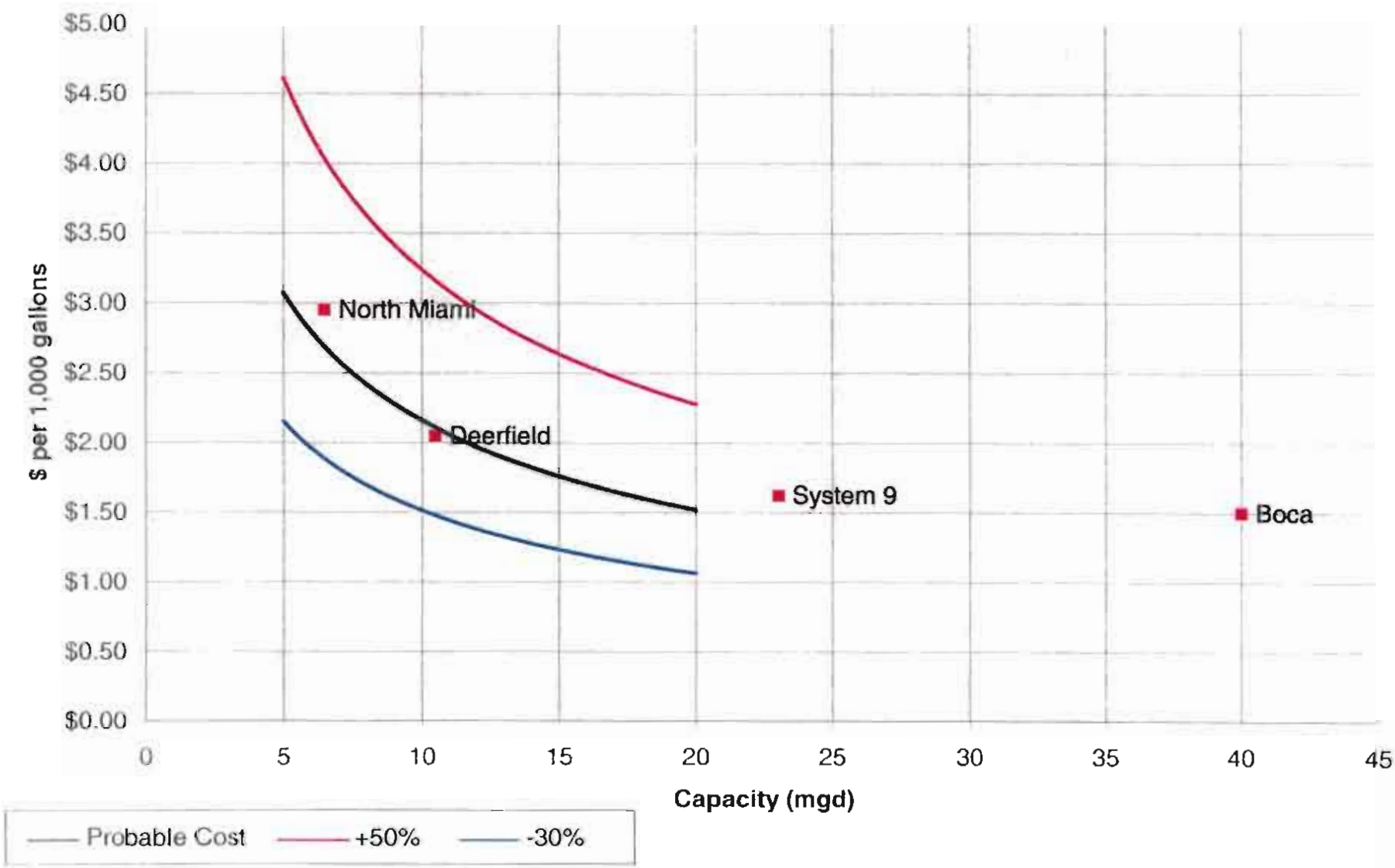

Table 5-10A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Treatment Technology : Brackish Reverse Osmosis Process Addition
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	Pretreatment		$0	$0	$0	$0
2.	Process equipment		$2,347,000	$3,206,000	$4,346,000	$5,392,000
3.	Post treatment		$1,765,000	$2,411,000	$3,269,000	$4,056,000
4.	Intermediate storage (clearwell)		$110,000	$208,000	$305,000	$400,000
5.	Transfer pumping		$105,000	$160,000	$194,000	$248,000
6.	Plant infrastructure		$1,548,000	$2,114,000	$2,866,000	$3,556,000
7.	Concentrate disposal		$5,500,000	$5,500,000	$5,500,000	$5,500,000
Subtotal:			$11,375,000	$13,599,000	$16,480,000	$19,152,000
8.	Yard piping	7%	$796,000	$952,000	$1,154,000	$1,341,000
9.	Electrical(1)	10%	$588,000	$810,000	$1,098,000	$1,365,000
10.	Instrumentation and controls(1)	7%	$411,000	$567,000	$769,000	$956,000
11.	Site work	5%	$569,000	$680,000	$824,000	$958,000
Subtotal:			$13,739,000	$16,608,000	$20,325,000	$23,772,000
12.	General Requirements	2%	$275,000	$332,000	$407,000	$475,000
13.	Contractor overhead and profit	15%	$2,061,000	$2,491,000	$3,049,000	$3,566,000
14.	Construction contingency	15%	$2,061,000	$2,491,000	$3,049,000	$3,566,000
Opinion of Probable Construction Cost::			**$18,136,000**	**$21,922,000**	**$26,830,000**	**$31,379,000**
15.	Technical Services	25%	$4,534,000	$5,481,000	$6,708,000	$7,845,000
16.	Owner administration and legal	5%	$907,000	$1,096,000	$1,342,000	$1,569,000
17.	Project contingency	15%	$2,720,000	$3,288,000	$4,025,000	$4,707,000
Opinion of Probable Capital Cost:			**$26,297,000**	**$31,787,000**	**$38,905,000**	**$45,500,000**
Opinion of Equivalent Annual Capital Cost:			**$2,482,251**	**$3,000,468**	**$3,672,357**	**$4,294,878**
Plant service life =		20 years				
Annual interest rate =		7%				
Unit Probable Construction Cost ($/gpd)			$3.63	$2.19	$1.79	$1.57
Unit Probable Total Capital Cost ($/gpd)			$5.26	$3.18	$2.59	$2.28

Notes:

(1) "Electrical" and "Instrumentation and controls" cost items are estimated as 10% and 7%, respectively, of the subtotal of the preceding cost components minus the cost for concentrate disposal. This is due to the fact that a concentrate disposal deep injection well (DIW) has negligible electrical and instrumentation and controls costs relative to other plant components, while the construction cost for a DIW is typically a substantial portion of the total facility cost.

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Table 5-10B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Treatment Technology : Brackish Reverse Osmosis Process Addition
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Variable Costs				
1.	Power	$709,848	$1,419,695	$2,129,543	$2,839,390
2.	Chemicals	$246,161	$492,322	$738,483	$984,644
3.	Replacement parts and materials	$431,550	$725,778	$983,721	$1,220,608
	a. Replacement membranes:	$92,400	$184,800	$277,200	$369,600
	Fixed				
4.	Operation and maintenance labor	$458,544	$564,534	$637,554	$695,022
5.	Administration/regulatory compliance	$312,167	$525,000	$711,587	$882,941
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual O&M Cost at Rated Capacity	**$2,251,000**	**$3,912,000**	**$5,478,000**	**$6,992,000**
	Unit Cost at Rated Capacity, $/kgal	$1.23	$1.07	$1.00	$0.96
	Annual Production at Avg Day Demand, (mgy)	1,217	2,704	4,212	5,840
	Annual O&M Cost at ADD Capacity	**$1,757,000**	**$3,180,000**	**$4,525,000**	**$5,909,000**
	Unit Cost at Rated Capacity, $/kgal	$1.44	$1.18	$1.07	$1.01

Table 5-10C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Treatment Technology : Brackish Reverse Osmosis Process Addition
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
	Production Costs at Rated Capacity				
1.	Equivalent annual capital cost	$2,482,251	$3,000,468	$3,672,357	$4,294,878
2.	Annual O&M Cost - Variable	$1,479,959	$2,822,595	$4,128,947	$5,414,242
2.	Annual O&M Cost - Fixed	$770,711	$1,089,534	$1,349,141	$1,577,964
3.	Annual R&R fund deposit(1):	$248,000	$300,000	$367,000	$429,000
	Total Annual Cost:	$4,981,000	$7,213,000	$9,517,000	$11,716,000
	Annual Production at Rated Capacity, (mgy)	1,825	3,650	5,475	7,300
	Annual Production Cost at Rated Cap. ($/kgal):	**$2.73**	**$1.98**	**$1.74**	**$1.60**
	Production Costs at Average Day Demand (ADD)				
	MDD/AADD factor(2):	1.50	1.35	1.30	1.25
1.	Equivalent annual capital cost	$2,482,251	$3,000,468	$3,672,357	$4,294,878
2.	Annual O&M Cost - Variable	$986,639	$2,090,811	$3,176,113	$4,331,394
2.	Annual O&M Cost - Fixed	$770,711	$1,089,534	$1,349,141	$1,577,964
3.	Annual R&R fund deposit(1):	$248,000	$300,000	$367,000	$429,000
	Total Annual Cost:	$4,488,000	$6,481,000	$8,565,000	$10,633,000
	Annual finished water production rate (mgy)(3):	1,217	2,704	4,212	5,840
	Annual Production Cost at ADD ($/kgal):	**$3.69**	**$2.40**	**$2.03**	**$1.82**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.

(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.

(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Figure 5-14 Brackish RO Process Addition Construction Cost

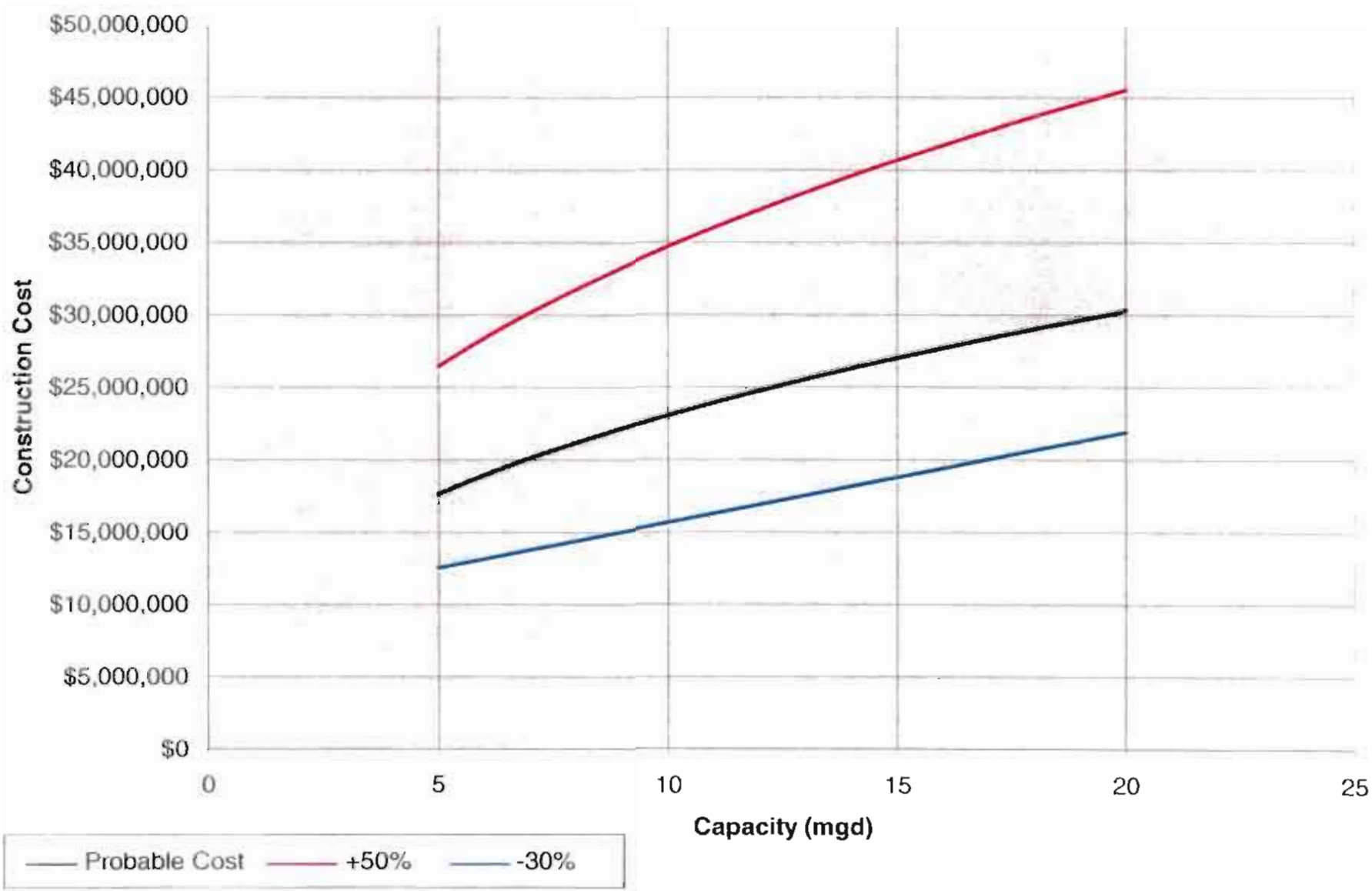
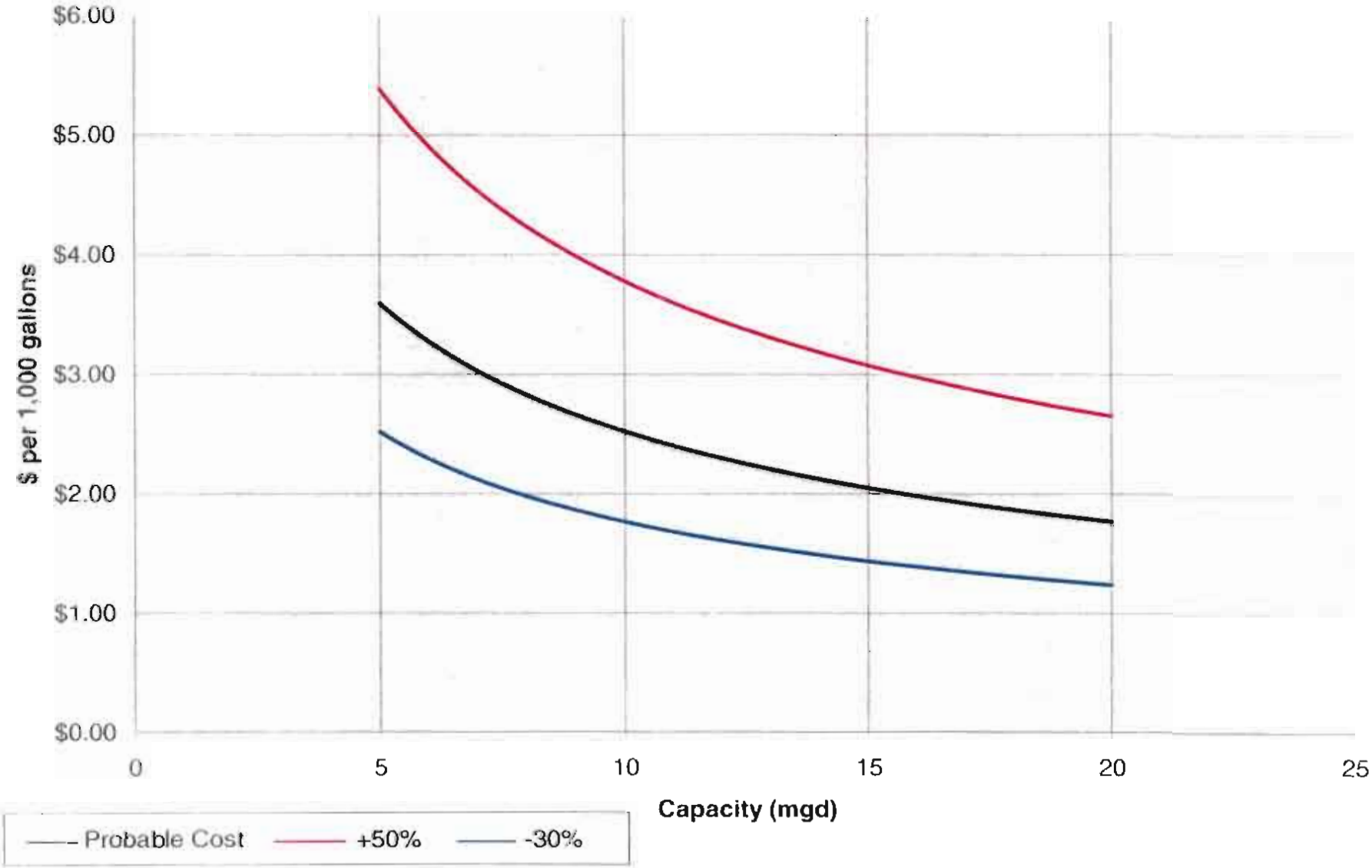


Figure 5-15 Brackish RO Process Addition Production Cost



5.1.4.1 Finished Water Storage

The opinion of probable cost for the finished water storage component is shown in **Tables 5-11A, 5-11B,** and **5-11C**. Cost curves for finished water storage are shown on **Figures 5-16** and **5-17** for construction costs and production costs.

Costs include a prestressed concrete (Crom-type) ground storage tank sized to provide approximately 50 percent of the rated plant capacity daily flow. For example, for a 10 mgd plant, a 5.0 million gallon (MG) storage tank is provided. The finished water storage requirements and associated costs are assumed to be the same for various treatment technologies for each plant capacity.

5.1.4.2 High Service Pumping

The opinion of probable cost for the high service pumping component is shown in **Tables 5-12A, 5-12B,** and **5-12C**. Cost curves for finished water storage are shown on **Figures 5-18** and **5-19** for construction costs and production costs.

Costs include a high service pumping system with a firm pumping capacity equal to 200 percent of the plant capacity rating to meet peak hour demands. This corresponds to a peak hour demand-to-maximum day demand (PHD/MDD) peaking factor of 2.0. The high service pumping requirements and associated costs are assumed to be the same for various treatment technologies for each plant capacity.

5.1.5 Disinfection Plant Components

Similarly to the finished water storage and high service pumping components, the costs for disinfection system components would be common among the various treatment technologies for each capacity increment examined. These tables should be considered to represent the cost of incorporating the selected disinfection system for a particular plant capacity rating into a new "grass roots" water treatment plant (e.g., as an add-on to the first group of water treatment technology cost tables).

5.1.5.1 On-Site Generation Sodium Hypochlorite Disinfection

The opinion of probable cost for on-site generation of sodium hypochlorite is shown in **Tables 5-13A, 5-13B,** and **5-13C**. Cost curves for on-site generation of sodium hypochlorite are shown on **Figures 5-20** and **5-21** for construction costs and production costs.

5.1.5.2 Ozone Disinfection

The opinion of probable cost for ozone disinfection is shown in **Tables 5-14A, 5-14B,** and **5-14C**. Cost curves for ozone disinfection are shown on **Figures 5-22** and **5-23** for construction costs and production costs.

Table 5-11A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Water Distribution Plant Component : Finished Water Storage
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	Finished water storage		$688,000	$1,250,000	$1,688,000	$2,000,000
Subtotal:			$688,000	$1,250,000	$1,688,000	$2,000,000
2.	Yard piping	8%	$55,000	$100,000	$135,000	$160,000
3.	Site work	7%	$48,000	$88,000	$118,000	$140,000
Subtotal:			$791,000	$1,438,000	$1,941,000	$2,300,000
4.	General Requirements	2%	$16,000	$29,000	$39,000	$46,000
5.	Contractor overhead and profit	15%	$119,000	$216,000	$291,000	$345,000
6.	Construction contingency	15%	$119,000	$216,000	$291,000	$345,000
Opinion of Probable Construction Cost:			**$1,045,000**	**$1,899,000**	**$2,562,000**	**$3,036,000**
7.	Technical Services	25%	$261,000	$475,000	$641,000	$759,000
8.	Owner administration and legal	5%	$52,000	$95,000	$128,000	$152,000
9.	Project contingency	15%	$157,000	$285,000	$384,000	$455,000
Opinion of Probable Capital Cost:			**$1,515,000**	**$2,754,000**	**$3,715,000**	**$4,402,000**
Opinion of Equivalent Annual Capital Cost:			**$143,005**	**$259,958**	**$350,670**	**$415,518**
Plant service life =		20 years				
Annual interest rate =		7%				

Table 5-11B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Water Distribution Plant Component : Finished Water Storage
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
1.	Operation and maintenance labor	Included in plant operation and maintenance labor.			
	Opinion of Annual O&M Cost:	$0	$0	$0	$0

Table 5-11C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Water Distribution Plant Component : Finished Water Storage
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
1.	Equivalent annual capital cost	$143,005	$259,958	$350,670	$415,518
2.	Annual operation and maintenance cost	$0	$0	$0	$0
3.	Annual R&R fund deposit(1):		Not applicable		
	Total Annual Cost:	$143,000	$260,000	$351,000	$416,000
	MDD/AADD factor(2):	1.50	1.35	1.30	1.25
	Annual finished water production rate (mgy)(3):	1,217	2,704	4,212	5,840
	Annual Production Cost ($/kgal):	**$0.12**	**$0.10**	**$0.08**	**$0.07**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.

(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.

(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Figure 5-16 Finished Water Storage Construction Cost

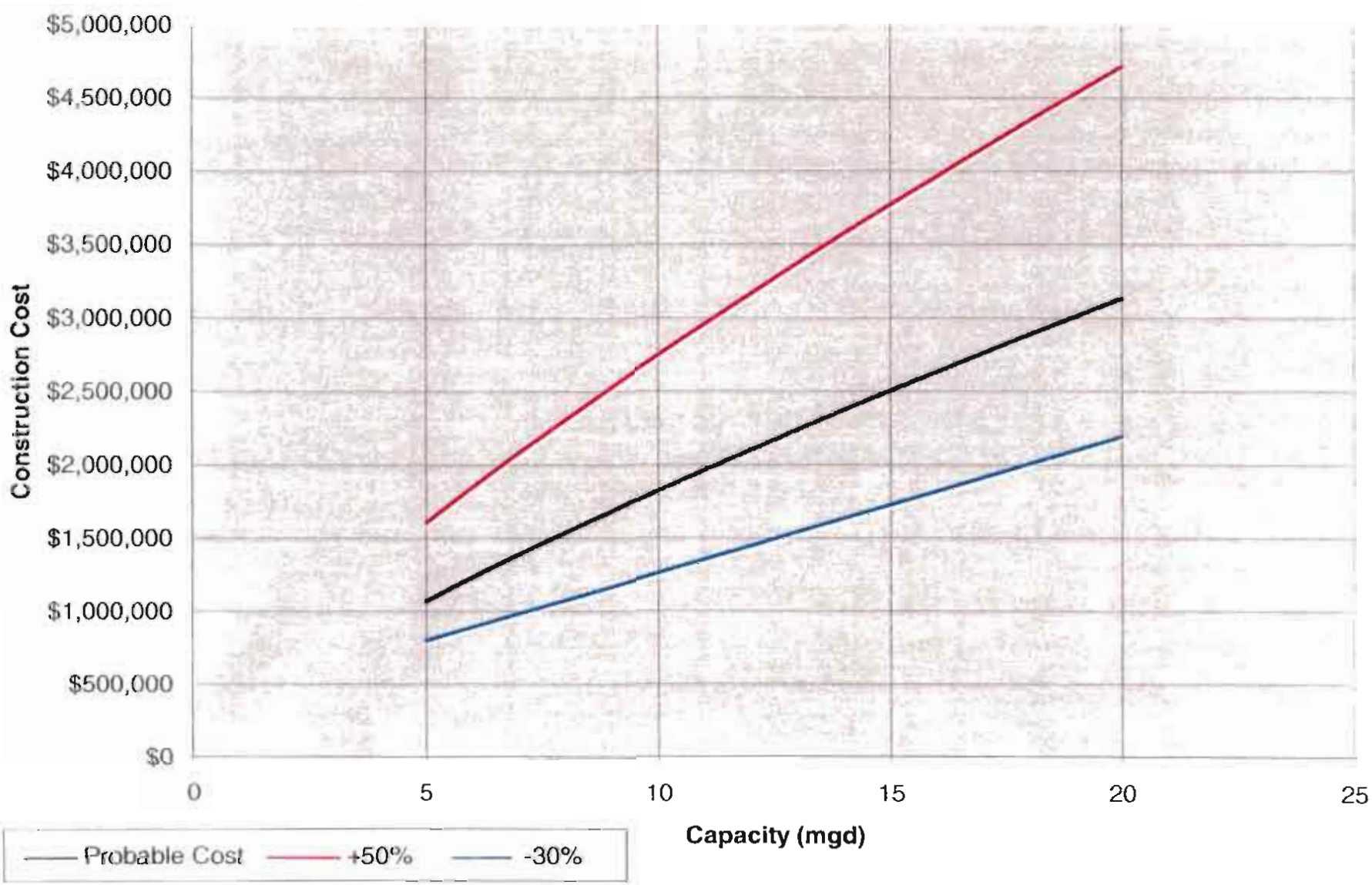


Figure 5-17 Finished Water Storage Production Cost

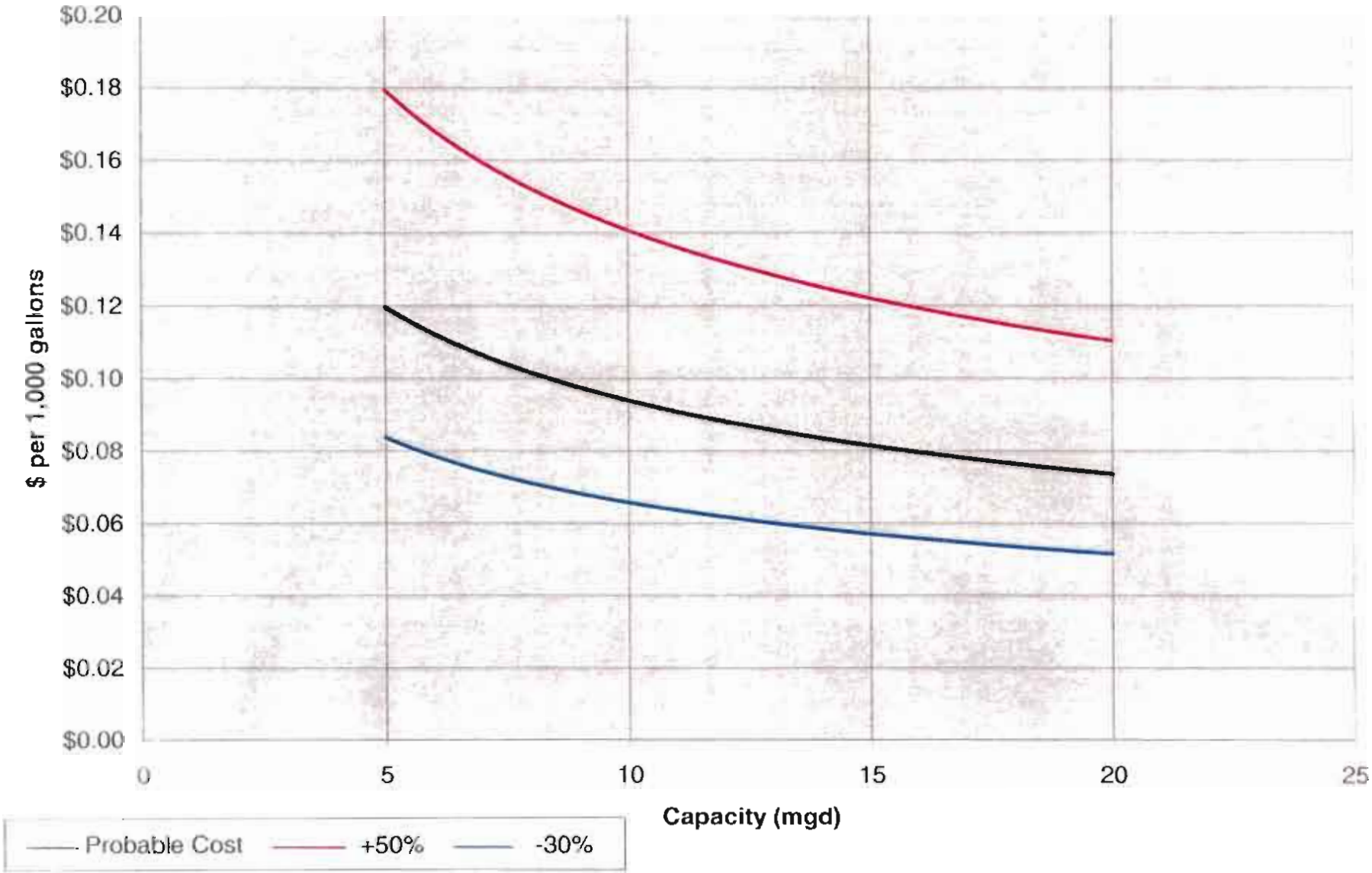


Table 5-12A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Water Distribution Plant Component : High Service Pumping
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	High service pumping		$360,000	$530,000	$625,000	$796,000
Subtotal:			$360,000	$530,000	$625,000	$796,000
2.	Yard piping	8%	$29,000	$42,000	$50,000	$64,000
3.	Electrical	11%	$40,000	$58,000	$69,000	$88,000
4.	Instrumentation and controls	7%	$25,000	$37,000	$44,000	$56,000
5.	Site work	7%	$25,000	$37,000	$44,000	$56,000
Subtotal:			$479,000	$704,000	$832,000	$1,060,000
6.	General Requirements	2%	$10,000	$14,000	$17,000	$21,000
7.	Contractor overhead and profit	15%	$72,000	$106,000	$125,000	$159,000
8.	Construction contingency	15%	$72,000	$106,000	$125,000	$159,000
Opinion of Probable Construction Cost:			**$633,000**	**$930,000**	**$1,099,000**	**$1,399,000**
9.	Technical Services	25%	$158,000	$233,000	$275,000	$350,000
10.	Owner administration and legal	5%	$32,000	$47,000	$55,000	$70,000
11.	Project contingency	15%	$95,000	$140,000	$165,000	$210,000
Opinion of Probable Capital Cost:			**$918,000**	**$1,350,000**	**$1,594,000**	**$2,029,000**
Opinion of Equivalent Annual Capital Cost:			**$86,653**	**$127,430**	**$150,462**	**$191,523**
Plant service life =		20 years				
Annual interest rate =		7%				

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Table 5-12B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Water Distribution Plant Component : High Service Pumping
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
1.	Power	$82,000	$182,000	$284,000	$393,000
3.	Operation and maintenance labor	Included in plant operation and maintenance labor.			
4.	Replacement parts and materials	$4,000	$5,000	$6,000	$8,000
Opinion of Annual O&M Cost:		**$86,000**	**$187,000**	**$290,000**	**$401,000**

Table 5-12C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Water Distribution Plant Component : High Service Pumping
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
1.	Equivalent annual capital cost	$86,653	$127,430	$150,462	$191,523
2.	Annual operation and maintenance cost	$86,000	$187,000	$290,000	$401,000
3.	Annual R&R fund deposit(1):	$9,000	$13,000	$15,000	$19,000
	Total Annual Cost:	$182,000	$327,000	$455,000	$612,000
	MDD/AADD factor(2):	1.50	1.35	1.30	1.25
	Annual finished water production rate (mgy)(3):	1,217	2,704	4,212	5,840
	Annual Production Cost ($/kgal):	**$0.15**	**$0.12**	**$0.11**	**$0.10**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.
(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.
(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Figure 5-18 High Service Pumping Construction Cost

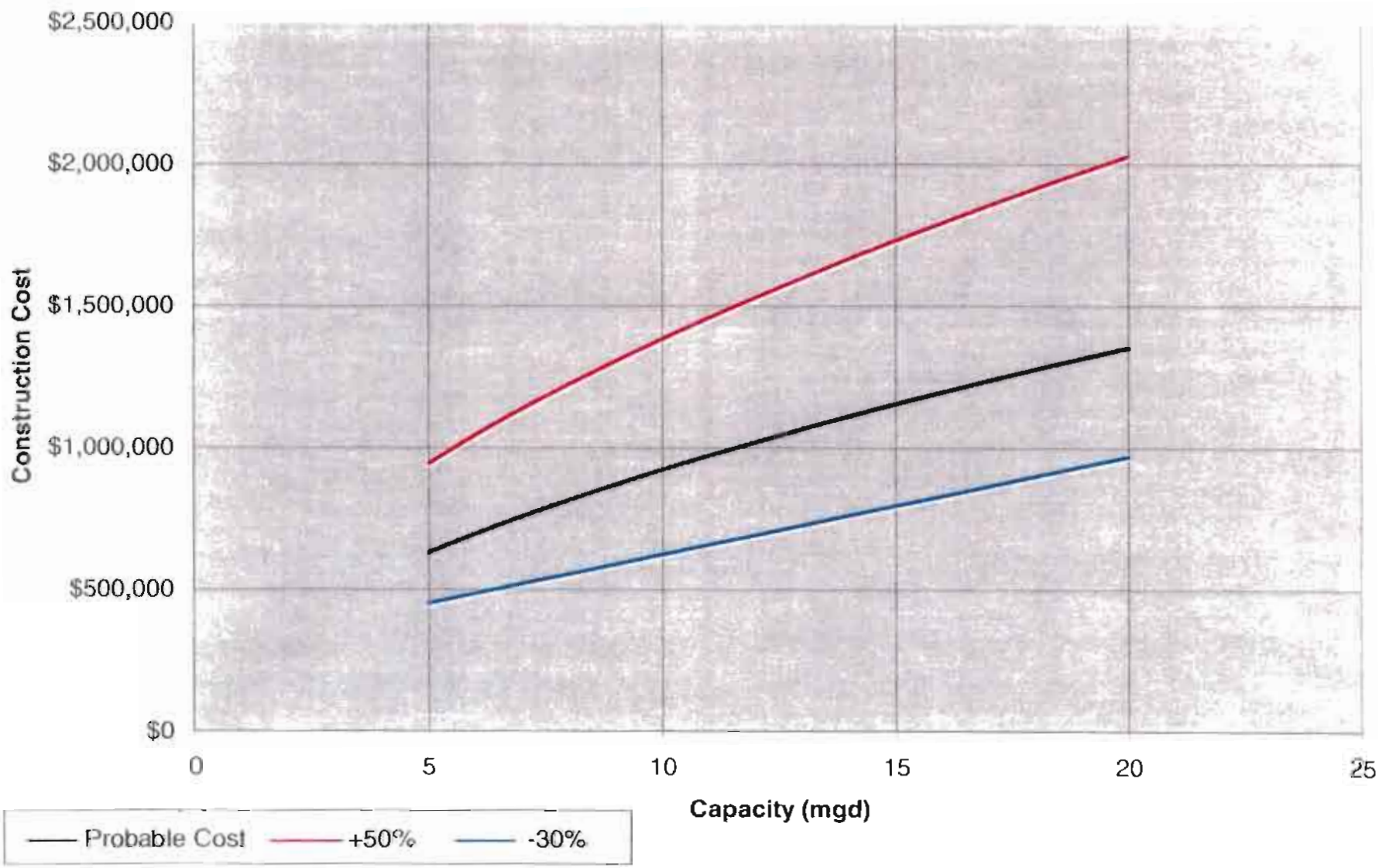

Figure 5-19 High Service Pumping Production Cost

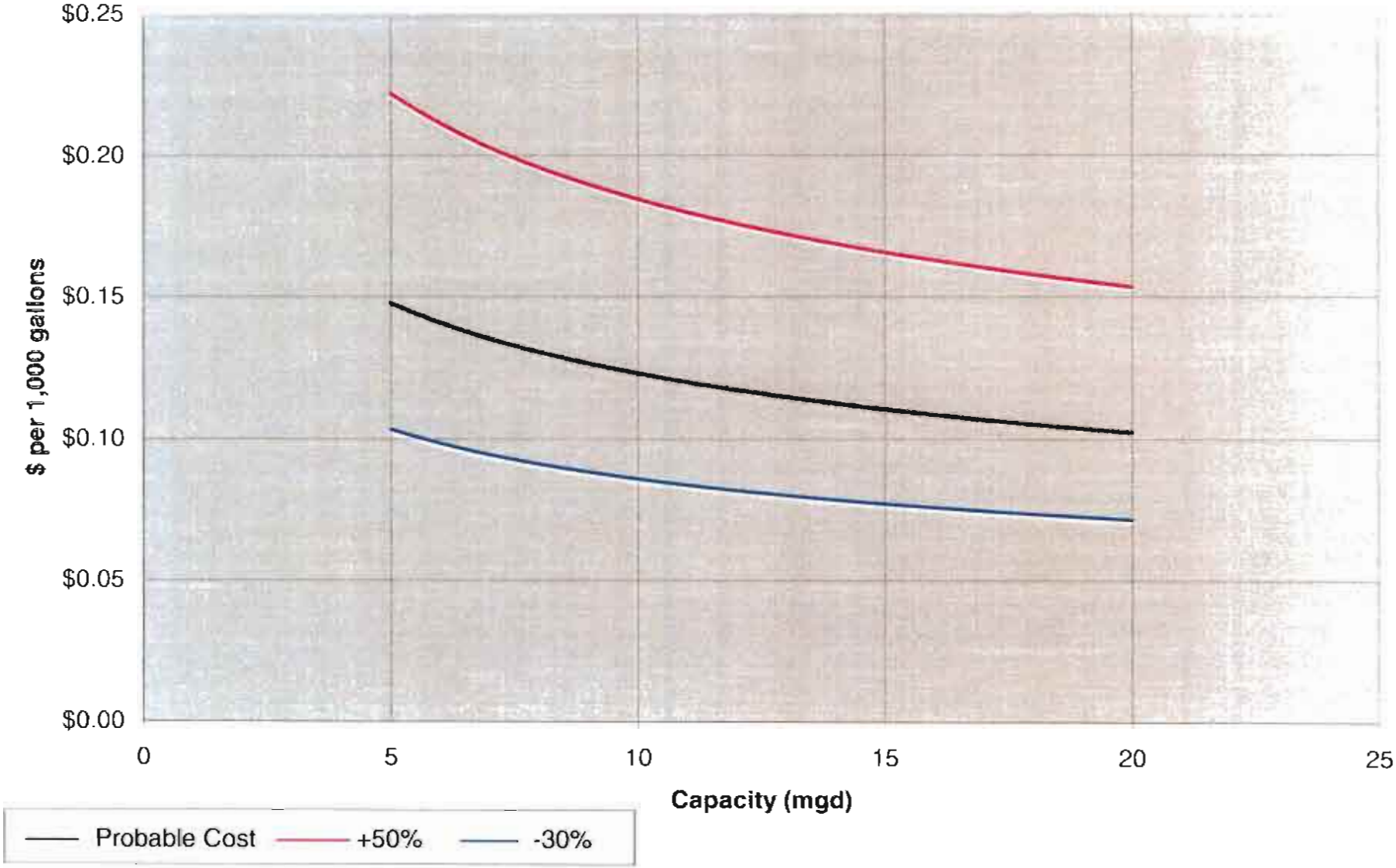

Table 5-13A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Disinfection Plant Component : On-site Generation Sodium Hypochlorite Disinfection

August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	OSG hypochlorite system		$529,000	$890,000	$1,206,000	$1,497,000
2.	Infrastructure		$530,000	$892,000	$1,209,000	$1,500,000
Subtotal:			$1,059,000	$1,782,000	$2,415,000	$2,997,000
13.	Electrical	11%	$116,000	$196,000	$266,000	$330,000
14.	Instrumentation and controls	7%	$74,000	$125,000	$169,000	$210,000
15.	Site work	7%	$74,000	$125,000	$169,000	$210,000
Subtotal:			$1,323,000	$2,228,000	$3,019,000	$3,747,000
16.	General Requirements	2%	$26,000	$45,000	$60,000	$75,000
17.	Contractor overhead and profit	15%	$198,000	$334,000	$453,000	$562,000
18.	Construction contingency	15%	$198,000	$334,000	$453,000	$562,000
Opinion of Probable Construction Cost:			**$1,745,000**	**$2,941,000**	**$3,985,000**	**$4,946,000**
19.	Technical Services	25%	$436,000	$735,000	$996,000	$1,237,000
20.	Owner administration and legal	5%	$87,000	$147,000	$199,000	$247,000
21.	Project contingency	15%	$262,000	$441,000	$598,000	$742,000
Opinion of Probable Capital Cost:			**$2,530,000**	**$4,264,000**	**$5,778,000**	**$7,172,000**
Opinion of Equivalent Annual Capital Cost:			**$238,814**	**$402,491**	**$545,402**	**$676,986**
Plant service life =		20 years				
Annual interest rate =		7%				

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Table 5-13B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Disinfection Plant Component : On-site Generation Sodium Hypochlorite Disinfection
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
1.	Power	$14,000	$28,000	$43,000	$57,000
2.	Chemicals (salt)	$4,000	$8,000	$11,000	$15,000
3.	Operation and maintenance labor	Included in plant operation and maintenance labor.			
4.	Replacement parts and materials	Covered under R/R fund deposit			
5.	Administration/regulatory compliance	Included in plant compliance cost.			
Opinion of Annual O&M Cost:		**$18,000**	**$36,000**	**$54,000**	**$72,000**

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Table 5-13C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Disinfection Plant Component : On-site Generation Sodium Hypochlorite Disinfection
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
1.	Equivalent annual capital cost	$238,814	$402,491	$545,402	$676,986
2.	Annual operation and maintenance cost	$18,000	$36,000	$54,000	$72,000
3.	Annual R&R fund deposit(1):	$24,000	$40,000	$55,000	$68,000
Total Annual Cost:		$281,000	$478,000	$654,000	$817,000
MDD/AADD factor(2):		1.50	1.35	1.30	1.25
Annual finished water production rate (mgy)(3):		1,217	2,704	4,212	5,840
Annual Production Cost ($/kgal):		**$0.23**	**$0.18**	**$0.16**	**$0.14**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.
(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.
(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Figure 5-20 On-site Generation Sodium Hypochlorite Disinfection Construction Cost

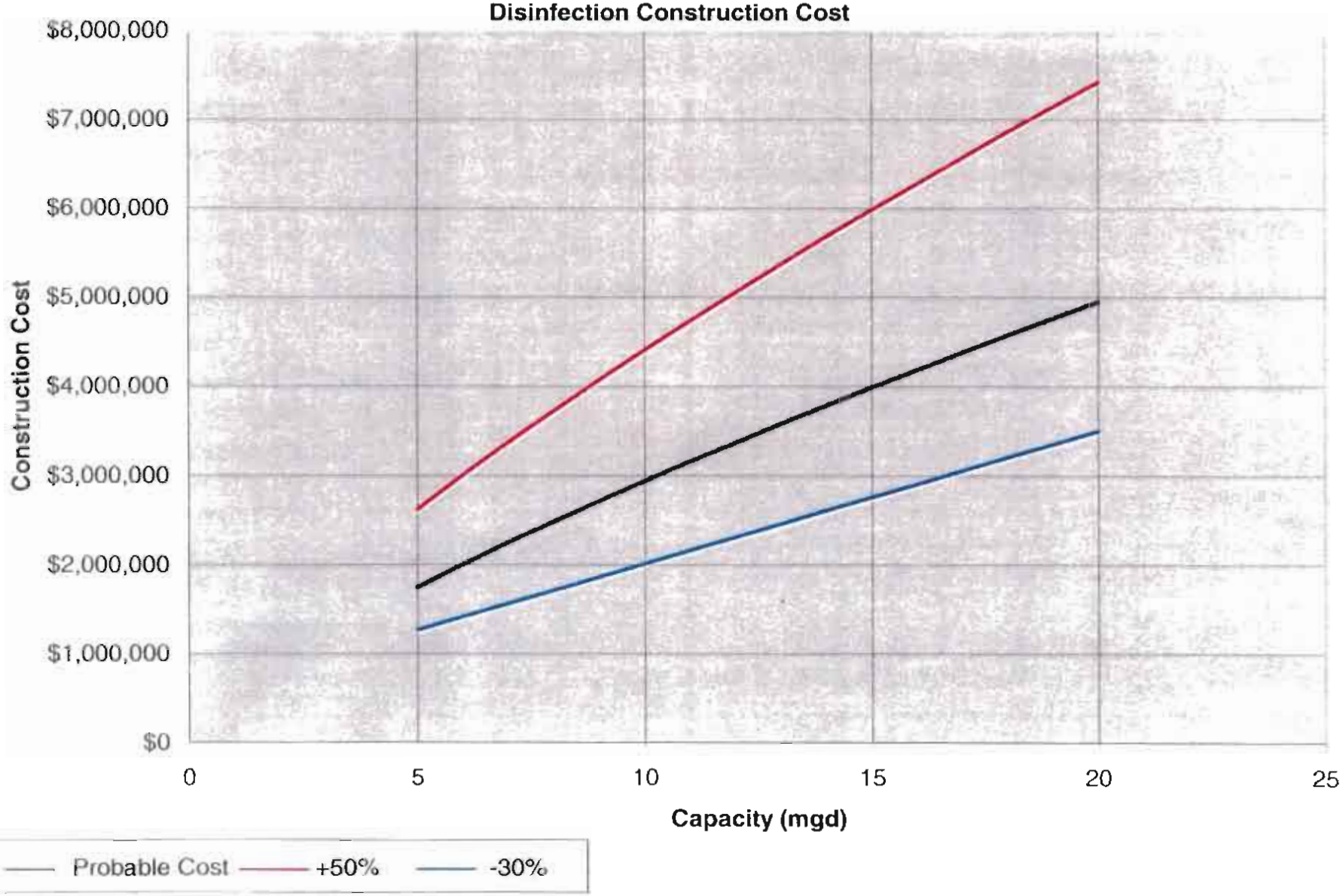

Figure 5-21 On-site Generation Sodium Hypochlorite Disinfection Production Cost

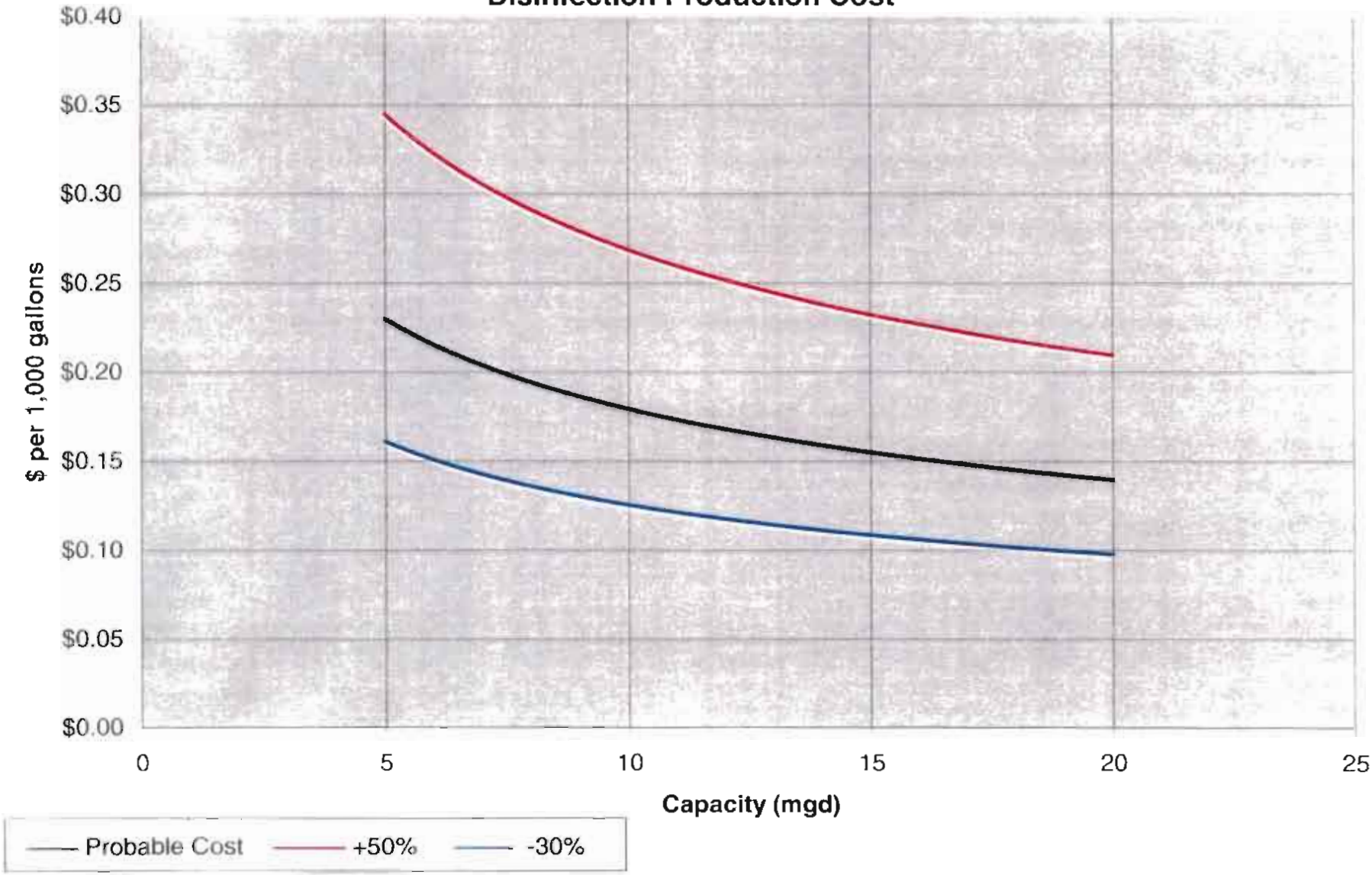

Table 5-14A

South Florida Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost

Treatment Technology: Ozone Disinfection

August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity			
			5	10	15	20
1	Ozone Generation System		408,000	572,000	712,000	822,000
2	Ozone Contactor		276,000	441,000	588,000	722,000
3	OffGas Destruction		59,000	84,000	105,000	121,000
4	Stainless Steel Piping, Valves and Ductwork		187,000	278,000	356,000	422,000
5	LOX Storage Pad		3,000	5,000	7,000	9,000
6	Ozone Generator Building		83,000	184,000	296,000	400,000
	Subtotal:		1,016,000	1,564,000	2,064,000	2,496,000
10	Yard Piping	8%	81,000	125,000	165,000	200,000
11	Mechanical	10%	0	0	0	0
12	Electrical	14%	142,000	219,000	289,000	349,000
13	Instrumentation and Controls	8%	81,000	125,000	165,000	200,000
14	Site Work	8%	81,000	125,000	165,000	200,000
	Subtotal:		1,401,000	2,158,000	2,848,000	3,445,000
15	General Requirements	9%	126,000	194,000	256,000	310,000
16	Contractor Overhead and Profit	15%	210,000	324,000	427,000	517,000
17	Construction Contingency	15%	210,000	324,000	427,000	517,000
	Opinion of Probable Construction Cost:		1,947,000	3,000,000	3,958,000	4,789,000
18	Technical Services	25%	487,000	750,000	990,000	1,197,000
19	Owner Administration and Legal	5%	97,000	150,000	198,000	239,000
20	Project Contingency	15%	292,000	450,000	594,000	718,000
	Opinion of Probable Capital Cost:		2,823,000	4,350,000	5,740,000	6,943,000
	Opinion of Equivalent Annual Capital Cost		$266,000	$411,000	$542,000	$655,000

Plant Service Life= 20 years

Annual Interest Rate= 7%

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Table 5-14B

South Florida Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost

Treatment Technology: Ozone Disinfection

August 2006 Dollars

Item No.	Description	Plant Capacity			
		5	10	15	20
1	Liquid Oxygen	$10,100	$22,500	$35,100	$48,700
2	Electricity	$13,200	$29,300	$45,700	$63,300
3	Operation and Maintenance Labor	$37,400	$37,400	$37,400	$37,400
4	Replacement Parts and Materials	$8,800	$12,400	$15,500	$17,900
	Opinion of Annual O&M Cost:	69,500	101,600	133,700	167,300

Table 5-14C
South Florida Management District Water Supply Cost Estimation Study
Opinion of Total Production Cost
Treatment Technology: Ozone Disinfection
August 2006 Dollars

Item No.	Description	Plant Capacity			
		5	10	15	20
1	Equivalent Annual Capital Cost	$266,000	$411,000	$542,000	$655,000
2	Annual Operation and Maintenance Cost	$69,500	$101,600	$133,700	$167,300
3	Annual R&R Fund Deposit	$26,600	$41,100	$54,200	$65,500
	Total Annual Cost:	$362,100	$553,700	$729,900	$887,800
	MDD/AADD Factor (2):	1.50	1.35	1.30	1.25
	Annual Finished Water Production Rate (mgy)(3):	1,217	2,704	4,212	5,840
	Annual Production Cost ($k/gal):	$0.30	$0.20	$0.17	$0.15

Figure 5-22 Ozone Disinfection Construction Cost

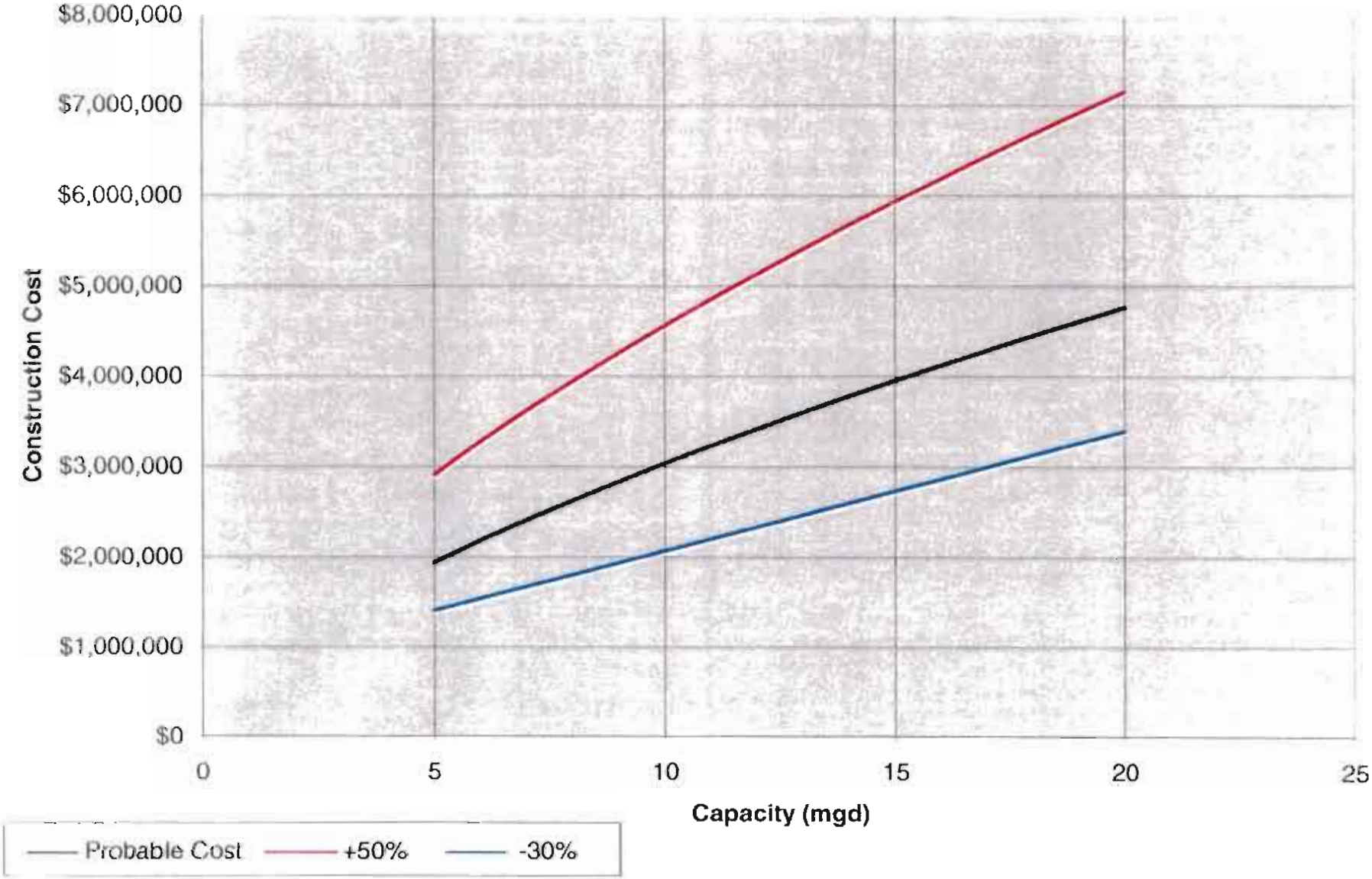
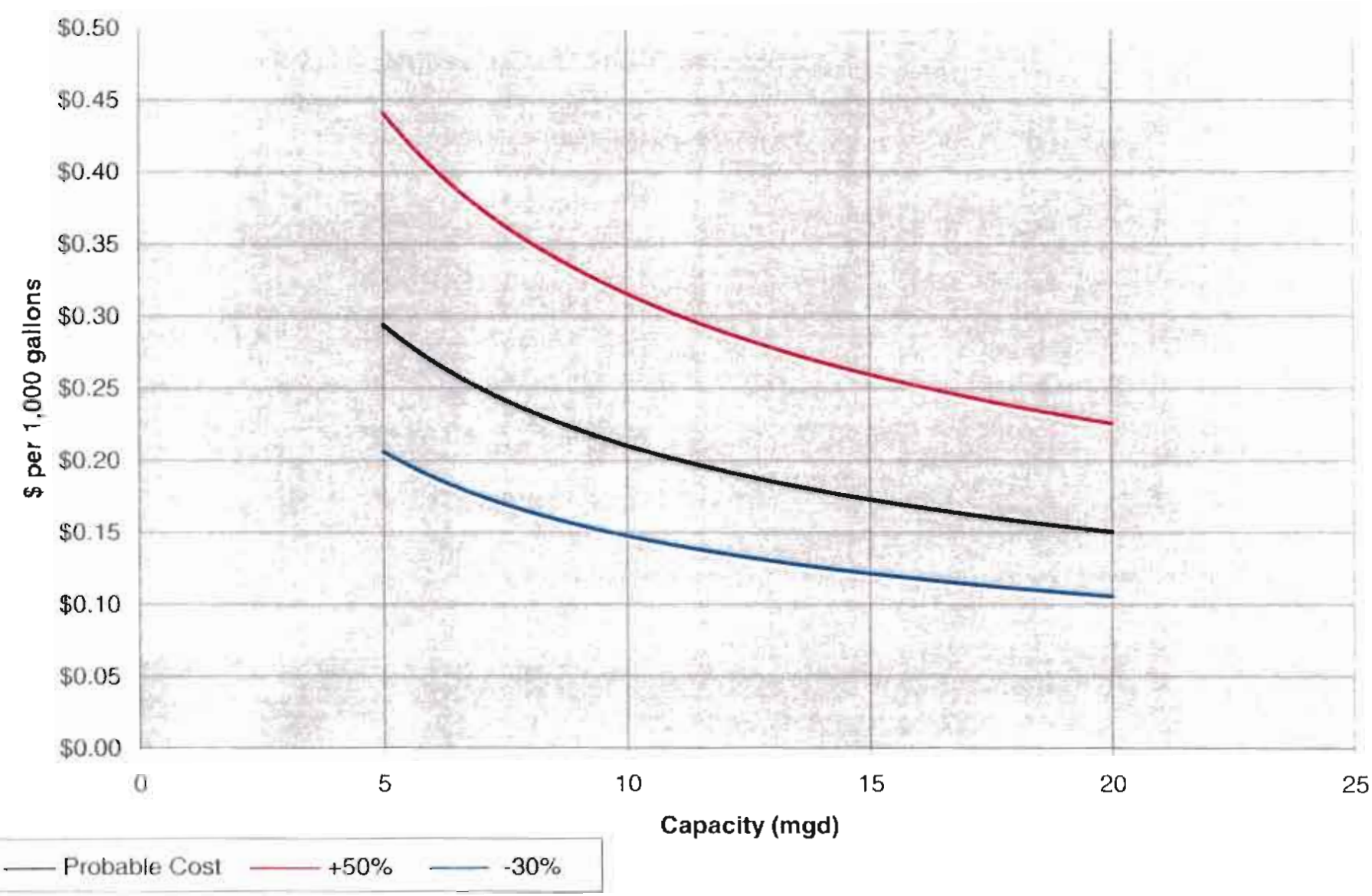


Figure 5-23 Ozone Disinfection Production Cost



Costs for ozone disinfection were derived from technology cost estimates for complying with new drinking water regulations, published in December 2005 by the US Environmental Protection Agency (EPA)[1]. EPA relied on a traditional cost build-up approach and vendor quotations for identifying, sizing and costing process components for ozone and UV disinfection systems for design capacities ranging from 0.1 to 520 mgd.

All capital cost estimates were derived directly from the EPA capital cost tables, with appropriate adjustments for inflation and contractor and project mark-ups. The O&M costs (except for replacement parts and materials) were developed by CDM using standard unit costs for power, liquid oxygen and labor.

The EPA cost tables assumed a design dose of 4.5 mg/L, contact time of 12 minutes and N+1 equipment redundancy for achieving 0.5-log *Cryptosporidium* inactivation credit under the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). These also represent conservative design criteria for providing 3-log *Giardia* inactivation for water supplies with moderate ozone demand and decay rates, based on CDM's ozone design experience. The ozone generation building cost was based on a unit cost of $150/ft^2, based on CDM's design experience, which was significantly higher than the unit cost used in the EPA estimates.

Power and liquid oxygen chemical costs for O&M cost opinions were calculated based on average process flows for each design capacity, an average ozone dose of 2.5 mg/L, and constant ozone-in-oxygen concentration of 10 percent by weight. The required O&M labor for the ozone system assumes that this process is an "add-on" process to a fully staffed conventional water treatment plant with no additional staff positions required.

5.1.5.3 Ultraviolet Light (UV) Disinfection

The opinion of probable cost for UV disinfection is shown in **Tables 5-15A, 5-15B,** and **5-15C**. Cost curves for UV disinfection are shown on **Figures 5-24** and **5-25** for construction costs and production costs.

Costs for UV disinfection were also derived from technology cost estimates for complying with new drinking water regulations, published in December 2005 by the EPA.

All capital cost estimates were derived directly from the EPA capital cost tables, with appropriate adjustments for inflation and contractor and project mark-ups. The O&M costs (except for replacement parts and materials) were developed by CDM using standard unit costs for power and labor.

[1] EPA, 2005. *Technologies and Costs Document for the Final Long-Term 2 Enhanced Surface Water Treatment Rule and Final Stage 2 Disinfectants and Disinfection By-Products Rule*, EPA Office of Water, Report 815-R-05-013, December 2005.

Table 5-15A
South Florida Management District Water Supply Cost Estimation Study
Opinion of Probable Capital Cost
Treatment Technology: UV Disinfection
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity			
			5	10	15	20
1	UV Equipment		214,000	423,000	686,000	949,000
2	UV Building		28,000	64,000	124,000	164,000
3	Pipes and Valves		84,000	161,000	231,000	294,000
	Subtotal:		326,000	648,000	1,041,000	1,407,000
4	Yard Piping	8%	26,000	52,000	83,000	113,000
5	Mechanical	10%	0	0	0	0
6	Electrical	14%	46,000	91,000	146,000	197,000
7	Instrumentation and Controls	8%	26,000	52,000	83,000	113,000
8	Site Work	8%	26,000	52,000	83,000	113,000
	Subtotal:		450,000	895,000	1,436,000	1,943,000
9	General Requirements	9%	41,000	81,000	129,000	175,000
10	Contractor Overhead and Profit	15%	68,000	134,000	215,000	291,000
11	Construction Contingency	15%	68,000	134,000	215,000	291,000
	Opinion of Probable Construction Cost:		627,000	1,244,000	1,995,000	2,700,000
12	Technical Services	25%	157,000	311,000	499,000	675,000
13	Owner Administration and Legal	5%	31,000	62,000	100,000	135,000
14	Project Contingency	15%	94,000	187,000	299,000	405,000
	Opinion of Probable Capital Cost:		909,000	1,804,000	2,893,000	3,915,000
	Opinion of Equivalent Annual Capital Cost		$86,000	$170,000	$273,000	$370,000

Plant Service Life= 20 years
Annual Interest Rate= 7%

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Table 5-15B
South Florida Management District Water Supply Cost Estimation Study
Opinion of Annual Operation and Maintenance Cost
Treatment Technology: UV Disinfection
August 2006 Dollars

Item No.	Description	Plant Capacity			
		5	10	15	20
1	Electricity	$12,200	$27,000	$42,100	$58,400
2	Replacement Parts and Materials (lamps, sleeves, ballasts, sensors	$11,400	$12,200	$13,000	$14,800
3	Operation and Maintenance Labor	$25,000	$25,000	$25,000	$25,000
	Opinion of Annual O&M Cost:	48,600	64,200	80,100	98,200

Table 5-15C

South Florida Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost

Treatment Technology: UV Disinfection

August 2006 Dollars

Item No.	Description	Plant Capacity			
		5	10	15	20
1	Equivalent Annual Capital Cost	$86,000	$170,000	$273,000	$370,000
2	Annual Operation and Maintenance Cost	$48,600	$64,200	$80,100	$98,200
3	Annual R&R Fund Deposit	$8,600	$17,000	$27,300	$37,000
	Total Annual Cost:	$143,200	$251,200	$380,400	$505,200
	MDD/AADD Factor (2):	1.50	1.35	1.30	1.25
	Annual Finished Water Production Rate (mgy)(3):	1,217	2,704	4,212	5,840
	Annual Production Cost ($k/gal):	$0.12	$0.09	$0.09	$0.09

Figure 5-24 UV Disinfection Construction Cost

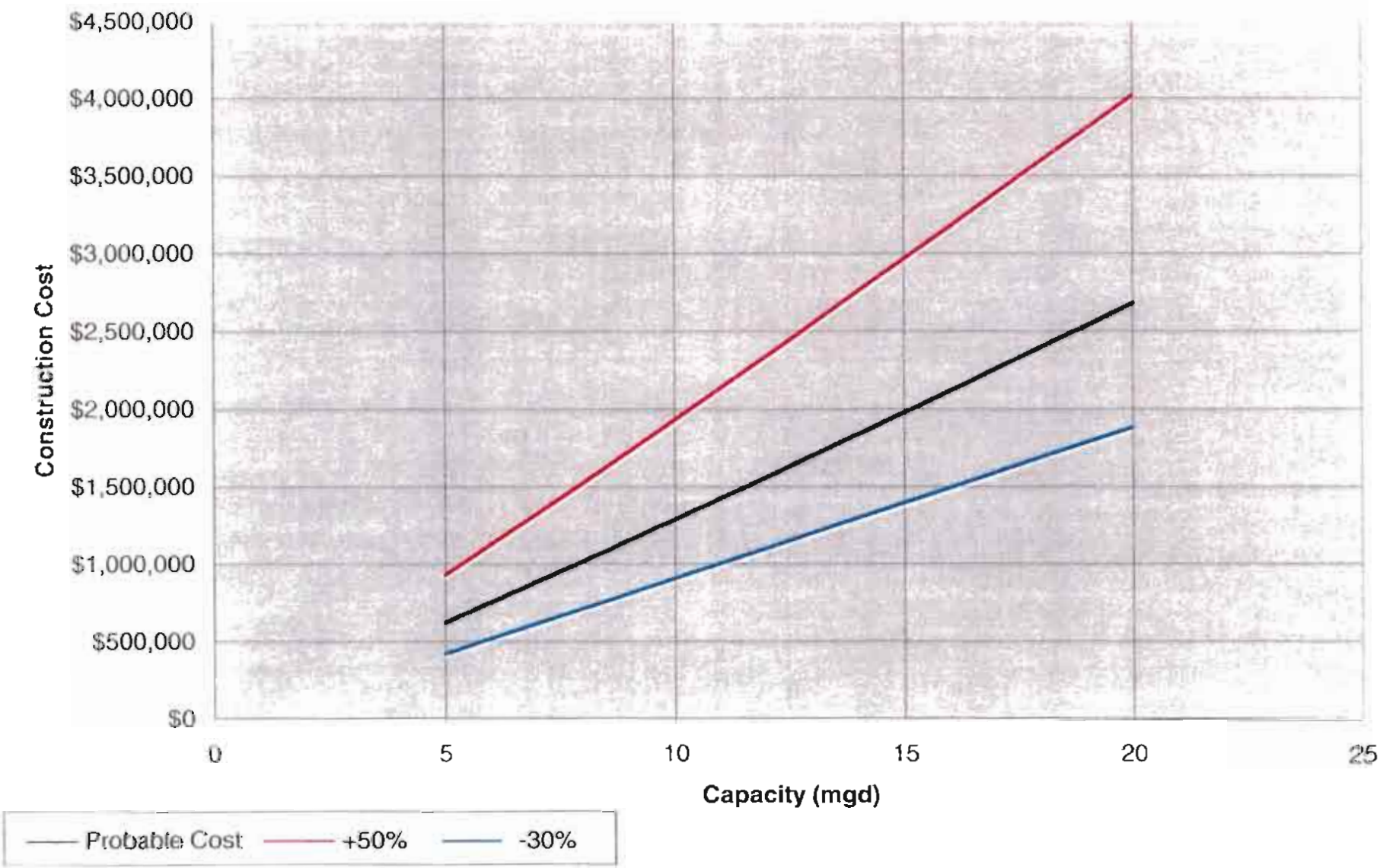
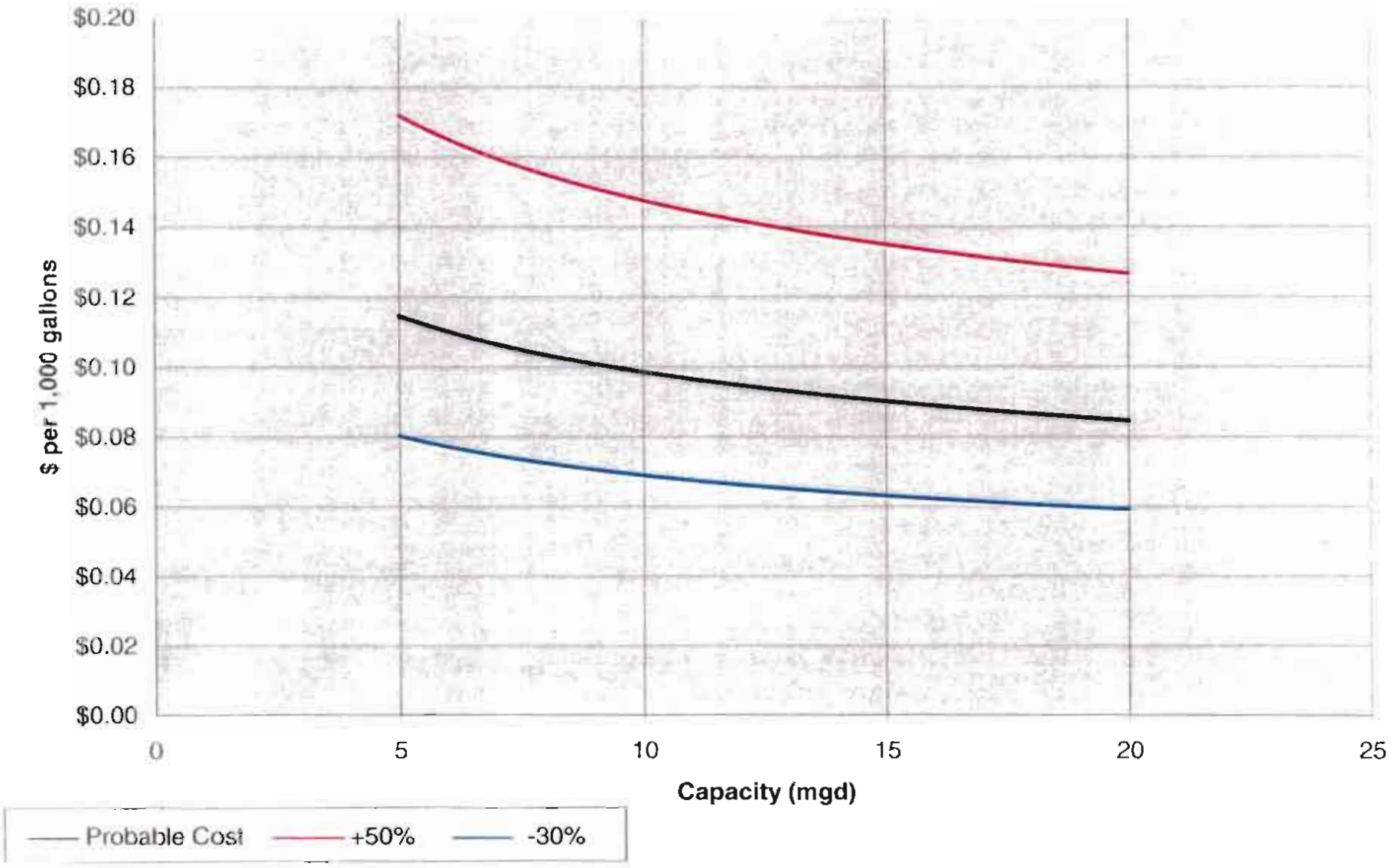


Figure 5-25 UV Disinfection Production Cost



A UV dose of 40 mJ/cm^2 was selected as a conservative design dose to achieve 3-log credit for *Giardia* and *Cryptosporidium* inactivation under the LT2ESWTR. The design UV transmittance (UVT) of 89% was the average value observed for filtered water supplies under EPA's Information Collection Rule. For design flows of 5 to 20 mgd, it is anticipated that three UV reactors (with N+1 redundancy) will be required. UV equipment costs were based on the average of vendor quotations for UV reactors with medium-pressure (MP) and low-pressure high-output (LPHO) lamps. The UV building cost was based on a unit cost of $150/sft.

Power costs for O&M cost opinions were calculated based on the average process flows for each design capacity, an average UV dose of 40 mJ/cm2, and average UVT of 93 percent. An average rate of 0.10 kW-hr/kgal was used to calculate power consumption for the UV system. This represents the average of typical power consumption rates for MP and LPHO systems, as noted in the table. The required O&M labor for the ozone system assumes that this process is an "add-on" process to a fully staffed conventional water treatment plant with no additional staff positions required.

5.2 Cost of Power

This report cites a power cost of $0.10/KWh based on review of planning-level power costs for water utilities in both Palm Beach and Collier counties. Power rates are very complicated and there are numerous rates available as evidenced by the FPL website. A discussion with Manny Rodriguez of FPL's sales group (personal communication, January 29, 2007) indicated that $0.10/KWh is in the neighborhood but what drives a rate is the load profile of the use. A constant and steady usage profile results in a lower rate than a pump that goes on and off periodically. Irrigation or drainage pumps in the EAA may experience rates of $0.15-0.20/KWh for this reason. For a new facility, FPL would assign a person to do an assessment of the load profile prior to establishing a rate.

Steve McGrew of Palm Beach County Water Utilities Department (PBCWUD)(email communication on January 25, 2007) indicated that the $0.10/KWh estimate is a good number based on their experience. PBCWUD is planning on using the Commercial Demand Reduction Rate (CDR) at the Lake Region Water Treatment Plant near Belle Glade which would provide a rate around this magnitude. He indicated that the plant rate may be slightly lower than this rate but the wells could be higher (more periodic power usage), thus averaging around $0.10/KWh. This rate involves a cessation of power from FPL with a remote start of the on-site standby generator by FPL at the water treatment plant. Wells are individual accounts and are not on the CDR rate, however, so their power costs are slightly higher. PBCWUD uses the Commercial Industrial Load Control rate (CILC) at water treatment plants 2, 3, 8, and 9 that offers a lower rate but this rate is closed and is no longer available.

Billing data for Collier County's power usage present a wide range of power costs for wells and pumps, some more and some less than $0.10/KWh. Collier County's water

plants ranged lower than wells and ranged from $0.079 to $0.0991/KWh. As noted in the discussion of the Tampa Bay Water Surface Water Treatment Plant (not an FPL powered facility)(Appendix F), this plant is also operating at a lower rate, $0.0715/KWh. Thus, plants may be able to operate at a lower rate because of their steady load profile. However, for planning purposes when considering facilities that operate both plants, wells and other pumps, the rate of $0.10/KWh appears reasonable. For an actual facility, in the case of FPL, it would need to do an evaluation to appraise the load profile.

Section 6
Capital and O&M Costs for Wastewater Treatment Technologies

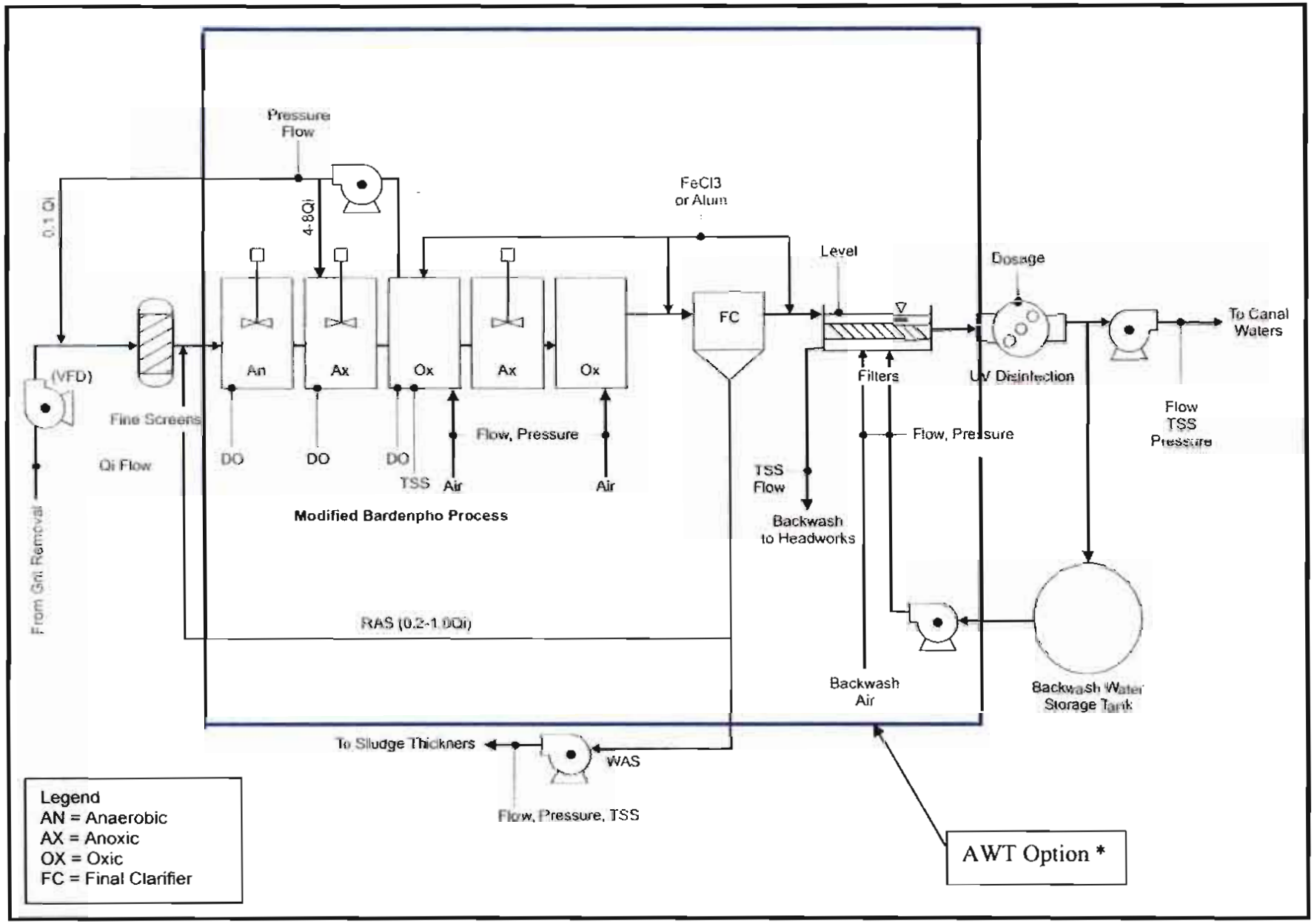
6.1 Advanced Wastewater Treatment Bardenpho Process

CDM has developed opinions or probable capital, operation and maintenance (O&M), and production costs for various wastewater treatment technologies. Cost tables and curves were developed for this Water Supply Cost Estimation Study to accomplish advanced wastewater treatment (AWT) from existing secondary treatment plants.

AWT refers to a level of treatment that meets effluent limits of 5 mg/L Total Suspended Solids (TSS), 5 mg/L Carbonaceous Biochemical Oxygen Demand ($CBOD_5$) , 3 mg/L Total Nitrogen (TN), and 1 mg/L Total Phosphorus (TP) on an annual average basis. AWT effluent limits can be met by modifying the activated sludge process in existing secondary treatment plants or by adding tertiary treatment processes. Anaerobic, anoxic, and additional aerobic tank volumes, mixing equipment, aeration equipment, and recycle pumps can be added to conventional or high-rate activated sludge processes to provide nitrification, denitrification, and biological phosphorus removal. Many process configurations have been developed for activated sludge systems to accomplish biological nutrient removal (BNR). The selection of a BNR configuration depends heavily on the influent wastewater characteristics and effluent requirements. One configuration that is commonly used in Florida to provide high levels of nitrogen and phosphorus removal is the five-stage Bardenpho process. This cost estimate assumes a five-stage Bardenpho process configuration for nutrient removal and deep bed filters after secondary clarification to further remove TSS, and consequently the incremental BOD_5, phosphorous, and nitrogen included in the suspended solids. A process configuration is shown on **Figure 6-1**.

6.1.1 Approach for Developing Probable Costs

Costs include capital and O&M costs for design plant capacities of 5 mgd, 10 mgd, 15 mgd, and 20 mgd. For the purpose of this study, an order-of-magnitude approach was used to develop probable capital and operating costs. Probable costs are based on cost-capacity curves, scale factors, bid prices, technical literature, and costs from other studies. This approach is appropriate for planning where detailed engineering data has not yet been developed. This type of estimate cannot be substituted for carefully prepared estimates of cost based on sound, thorough engineering evaluation and a complete set of construction drawings and specifications. The following is a more specific approach used in the development of this cost estimating effort.



CDM

Figure 6-1 AWT Option Configuration

* The Construction cost for the AWT option includes only expansion of existing aeration basin and equipment for nitrification, anoxic (AX) zones, anaerobic (AN) zone, mixers, recycle pumps, chemical feed system, and filters.

Construction costs for the five-stage Bardenpho process were derived from a best-fit cost equation resulting from the survey of a full-scale wastewater treatment plant using BNR processes, published in 1998 by the Water Environment Federation (WEF). Cost data requested for that study included bid prices, schedules of values, actual construction costs, and annual operating expenses or budgeted O&M expenses. BNR construction cost equations were developed for new and upgraded plants as part of the 1998 WEF study. The cost equation for upgraded plants was used to determine the construction cost for the five-stage Bardenpho process, with appropriate adjustments for inflation.

Construction costs for deep bed filters were obtained from unit costs derived from vendor equipment and bid prices.

Yard piping, mechanical, electrical, instrumentation and controls, and site work are assumed to be part of the construction cost derived from the BNR equations and filter unit costs. Therefore, percentage allowances for these components were not included in the construction cost table presented in the next section.

The construction costs were adjusted to the August 2006 ENR Index (CCI 7762). General requirements, contractor overhead and profit, contingency, technical services, and administration and legal mark-ups were included to develop the opinion of probable capital cost.

The O&M costs were developed from standard unit costs, survey information from BNR plants, and EPA O&M curve for granular media filters. The O&M costs include labor, chemicals, maintenance, and power. The annual operation costs were developed for 6-months and 12-months of plant operation.

The annual production cost was calculated based on the total annual cost (i.e., equivalent annual capital, plus annual O&M cost, plus annual R&R fund deposit) divided by the average finished water production rate in million gallons per year (mgy). The equivalent annual capital cost was calculated using a typical service life of 20 years for the AWT option, a discount rate of 7 percent, and constant dollars (i.e., no allowance for inflation).

6.1.2 Cost Tables

Tables 6-1, 6-2 and **6-3** summarize capital, O&M, and total production costs (6-months and 12-months of plant operation) for the AWT option.

Table 6-1

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Capital Cost
Treatment Technology : AWT

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	5-stage Bardenpho Configuration		$12,236,000	$19,287,000	$26,338,000	$33,389,000
2.	Granular Media Filters		$890,000	$1,781,000	$2,671,000	$3,166,000
Subtotal:			$13,126,000	$21,068,000	$29,009,000	$36,555,000
3.	General Requirements	2%	$262,520	$421,360	$580,180	$731,100
4.	Contractor overhead and profit	15%	$1,968,900	$3,160,200	$4,351,350	$5,483,250
5.	Construction contingency	15%	$1,968,900	$3,160,200	$4,351,350	$5,483,250
Opinion of Probable Construction Cost::			**$17,326,320**	**$27,809,760**	**$38,291,880**	**$48,252,600**
19.	Technical Services	25%	$4,332,000	$6,952,000	$9,573,000	$12,063,000
20.	Owner administration and legal	5%	$866,000	$1,390,000	$1,915,000	$2,413,000
21.	Project contingency	15%	$2,599,000	$4,171,000	$5,744,000	$7,238,000
Opinion of Probable Capital Cost:			**$25,123,000**	**$40,323,000**	**$55,524,000**	**$69,967,000**
Opinion of Equivalent Annual Capital Cost:			**$2,371,000**	**$3,806,000**	**$5,241,000**	**$6,604,000**
Plant service life =		20 years				
Annual interest rate =		7%				

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Table 6-2

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Annual Operation and Maintenance Cost
Treatment Technology : AWT

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
1.	Biological Nutrient Removal Facilities (1)	$1,168,000	$2,336,000	$3,504,000	$4,672,000
2.	Granular Media Filters (2)	$248,743	$402,128	$532,593	$650,096
	Opinion of Annual O&M Cost (12-months in Operation):	**$1,417,000**	**$2,738,000**	**$4,037,000**	**$5,322,000**
	Opinion of Annual O&M Cost (6-months in Operation):	**$708,500**	**$1,369,000**	**$2,018,500**	**$2,661,000**

Table 6-3

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Total Production Cost
Treatment Technology : AWT

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
1.	Equivalent annual capital cost	$2,371,000	$3,806,000	$5,241,000	$6,604,000
2a.	Annual O&M cost (12-months)	$1,417,000	$2,738,000	$4,037,000	$5,322,000
2b.	Annual O&M cost (6-months)	$708,500	$1,369,000	$2,018,500	$2,661,000
3.	Annual R&R fund deposit (1):	$237,000	$381,000	$524,000	$660,000
Total Annual Cost (12-months):		$4,025,000	$6,925,000	$9,802,000	$12,586,000
Total Annual Cost (6-months):		$3,316,500	$5,556,000	$7,783,500	$9,925,000
Annual (12-month)production rate (mgy) (2):		1,825	3,650	5,475	7,300
Annual (6-month) production rate (mgy) (3):		913	1,825	2,738	3,650
Annual (12-month) Production Cost ($/kgal):		**$2.21**	**$1.90**	**$1.79**	**$1.72**
Annual (6-month) Production Cost ($/kgal):		**$3.63**	**$3.04**	**$2.84**	**$2.72**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.

(2) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

6.1.3 Cost Curves

Figures 6-2, 6-3, and **6-4** illustrate construction and total production costs for the AWT option. A +50 percent of base cost and -30 percent of base cost are also included in the graphs to show an envelope of potential costs.

Figure 6-2 AWT Construction Cost

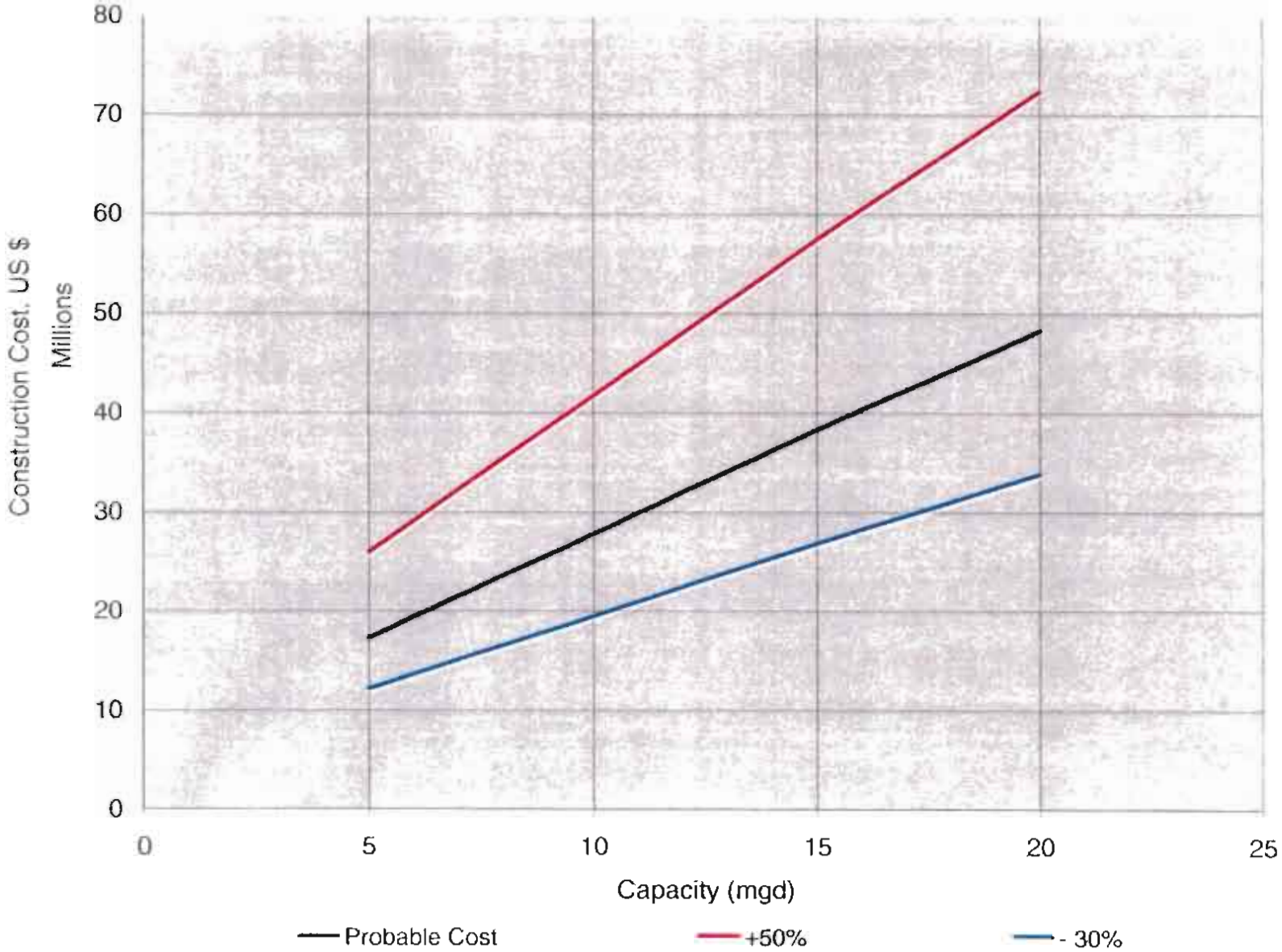

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Figure 6-3 AWT Production Costs (12-Months)

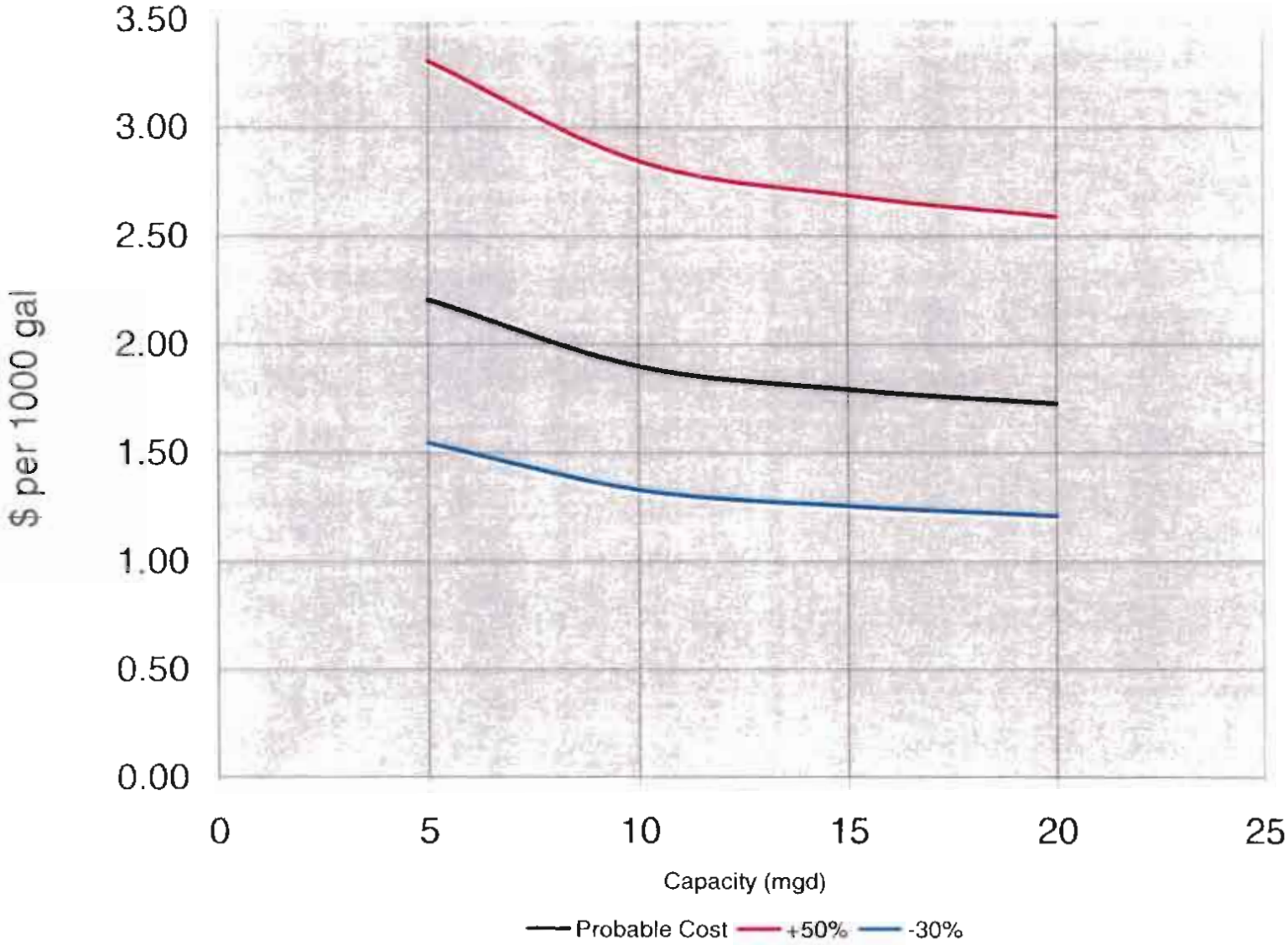

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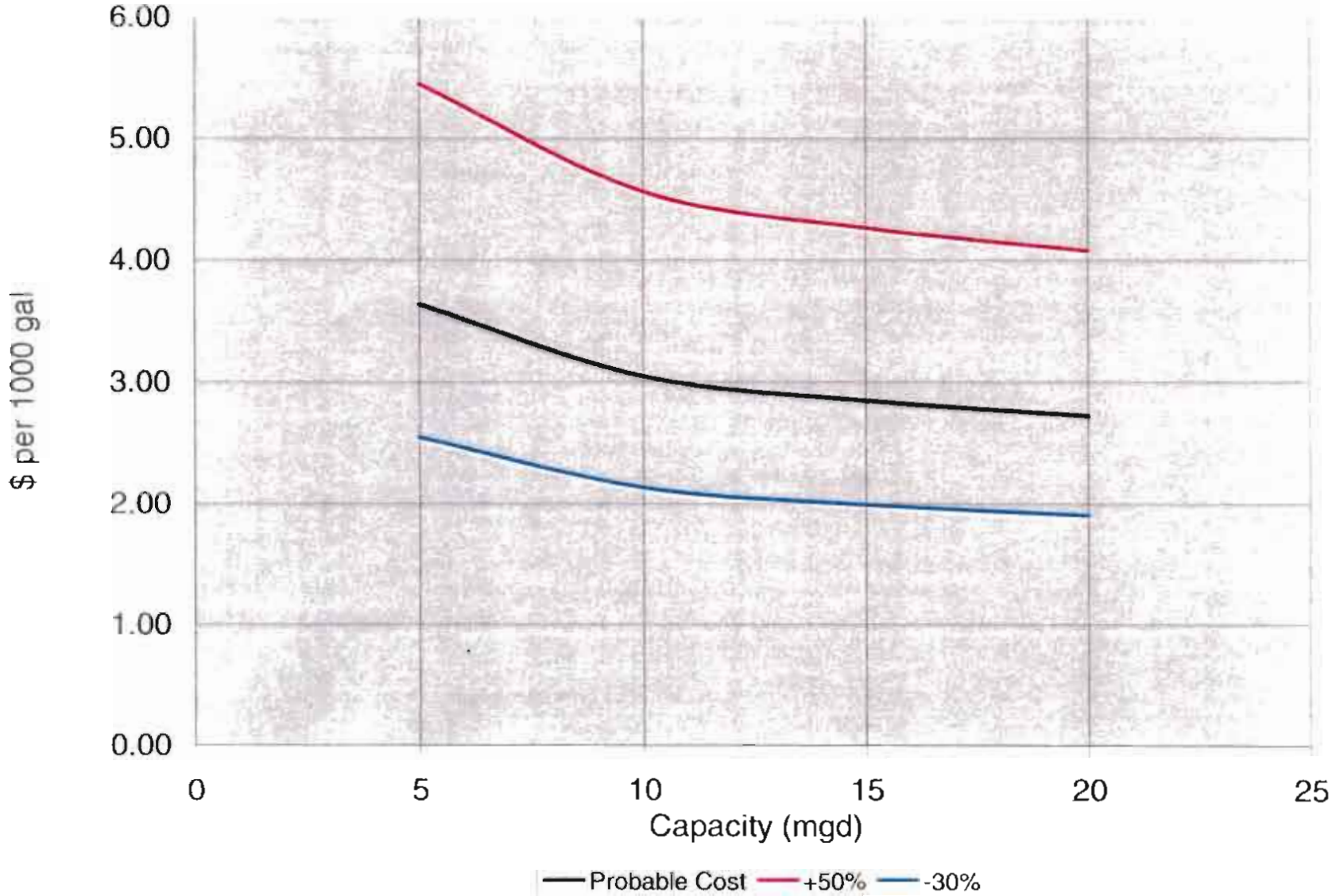
Figure 6-4 AWT Production Costs (6-Months)



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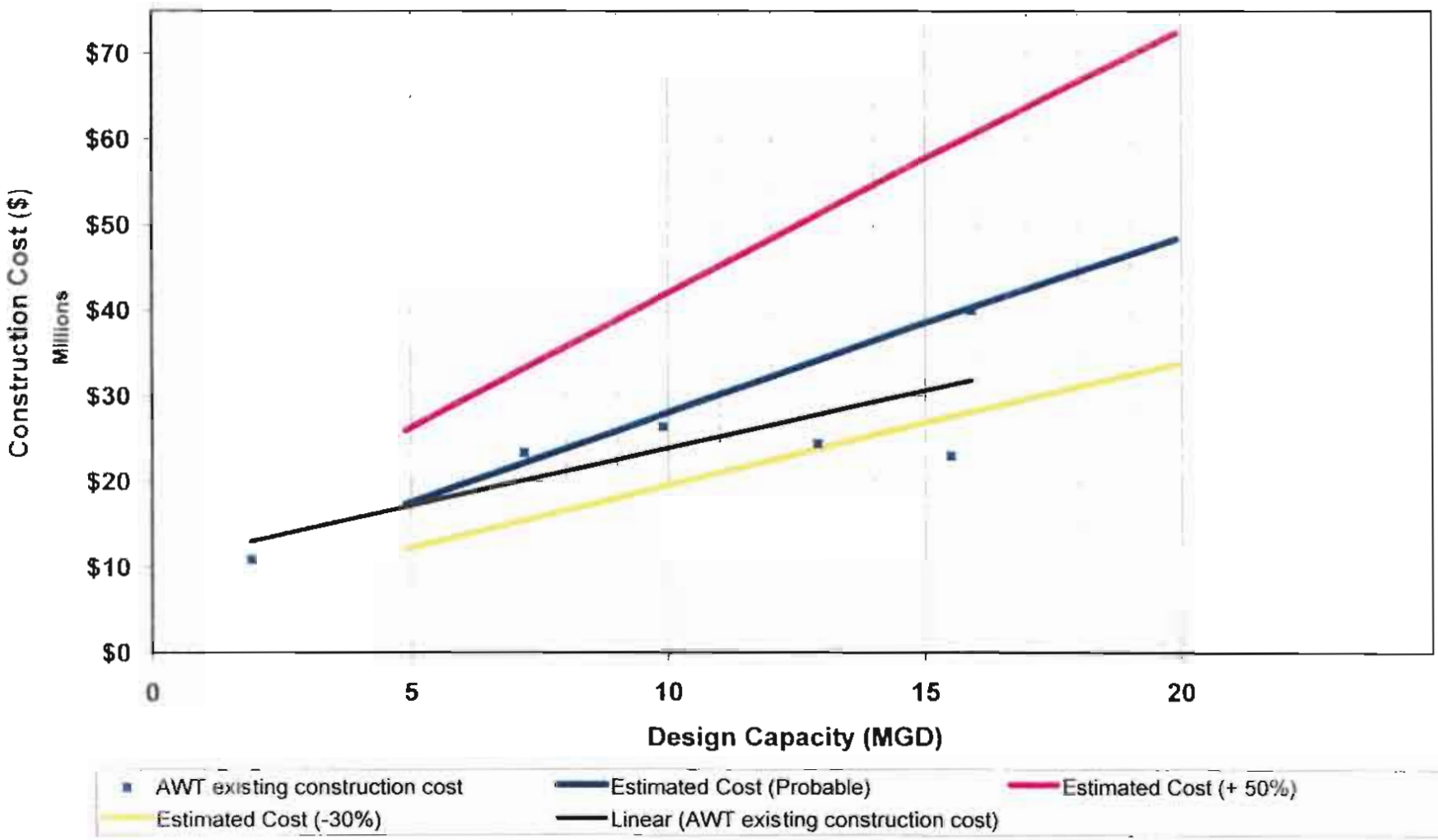
6.1.4 Existing Construction Cost for Plants

SFWMD requested that CDM provide representative projects that corroborate their cost information for various unit processes. **Figure 6-5** shows six representative upgraded plant projects constructed in the 1990s with biological nutrient removal to comply with AWT. The bid costs of these projects were adjusted to August 2006 values and compared with the cost estimates developed for this study.

Figure 6-5 AWT Option Construction Cost



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6.2 Membrane Bioreactor (MBR)

As part of this study, the SFWMD requested the evaluation of membrane bioreactors as a potential technology for water supply alternative in South Florida considering its application in water reuse.

An opinion of probable capital and O&M costs were developed for design rates of 5 mgd, 10 mgd, 15 mgd, and 20 mgd. For the MBR option, the four design rates represent the annual average daily flows. Peak factors were considered in the probable capital cost when applicable. The O&M cost is based on the annual average flows.

The construction costs of the MBR plants are based on the following process modules: influent pumping, preliminary treatment, aeration tanks, membrane tanks, UV disinfection, effluent pump station, and sludge treatment and handling. Sludge treatment includes thickening, stabilization, and dewatering to produce a Class B product for land application. Preliminary sizing for these processes were developed based on key design parameters presented in **Table 6-4**. Previous CDM studies, equipment costs, construction bids, and technology cost curves were used to determine cost estimates.

Other assumptions were used in the development of construction and capital cost estimates for the MBR plants. These assumptions are summarized below:

- The construction cost does not include collection system and water reuse distribution piping. A yard piping cost is included as percentage of the total construction cost to account for process piping within the boundaries of the treatment plants.
- Construction cost does not include land cost and it assumes that the plants are new facilities.
- Instrumentation, yard piping, mechanical, site work, and electrical are included in the total construction cost using typical percentages of the construction costs.
- Construction cost includes standby units for major equipment.
- Estimated costs were adjusted to August 2006 values based on the ENR Construction Cost Index of 7762.
- Pretreatment construction cost includes preliminary estimates for rotary drum 2-mm fine screens and pista grit chambers.
- Process construction cost includes preliminary estimates for anoxic and aeration tanks, process blowers, return activated sludge (RAS) pumps, membrane tanks, air scour blowers, permeate pumps, and membrane cleaning system. The Modified Ludzack-Ettinger (MLE) process is assumed for the MBR configuration.

Table 6-4 Key Design Parameters

Wastewater Characteristics		
Peak Factor		1.5
BOD5	mg/L	200
TSS	mg/L	200
VSS/TSS		0.8
Expected EffluentQuality		
BOD_5	mg/L	5
TSS	mg/L	5
Turbidity	NTU	0.1
Fecal Coliforms		ND FC per 100 mL
Mechanical Fine Screens		
Type		Rotary drum
Opening Size	mm	2
Grit Removal		
Type		Pista Grit
Membrane Bioreactor		
Aeration Tank		
Net observed yield coefficient	lb TSS/lb BODR	0.9
SRT	days	8 – 10
MLSS	mg/L	8000 - 9000
MLVSS/MLSS		0.8
RAS Recycle	Ratio Qrec/Qin	4
Membrane Tank		
Membrane type		Immersed hollow-fiber, UF
Design flux (Average flow)	gfd	12.0
WAS Production		
Net observed yield coefficient	lb TSS/lb BODR	0.9
WAS concentration	mg/L	9000
VSS/TSS		0.75
UV Disinfection		
Type		Medium Pressure In line system
T10% at 254 nanometers		65
Dose (mJ/cm2)		80
WAS Thickening		
Type		Gravity Belt Thickeners
TWAS	%TS	5
Capture rate	%	95
SLR	pph	600 - 700
Operating time		2 shifts, 5 days a week
WAS stabilization		
Type		Anaerobic Digestion
SRT	days	20
VSS destruction	%	0.4
Dewatering		
Type		Belt Filter Presses
Cake	%TS	20
Capture rate	%	0.95
SLR	pph	600 - 700
Operating time		1 - 2 shifts, 5 days a week

- Post-treatment cost includes preliminary estimates for UV disinfection and effluent pump station.
- Sludge handling facilities include preliminary estimates for gravity belt thickeners, anaerobic digestion, and belt filter presses.
- The plant infrastructure includes buildings to house process equipment and other plant buildings.

Operation and maintenance costs include labor costs, chemical costs, electrical power costs, land application of biosolids, membrane replacements, and replacement and repairs for other equipment. **Table 6-5** provides a summary of the O&M assumptions.

Table 6-5 O&M Assumptions

Labor	The labor rates are based on hourly rate posted in the Florida Water and Pollution Control Operators Association. http://fwpcoa.org. The hourly rates were increased by 25 percent to account for benefits. Per DEP Treatment Plant Classification and Staffing it is assumed that the plants would be staffed 24 hours/day for 7 days/week. Staffing includes superintendent, instrumentation/electrical, chief operator (Class A), operators (Class B) and mechanics.
Electric power	
Power cost, $/kw-hour	0.10
Chemical Cost	
Sodium Hypochlorite, $/gal	0.66 (Per Boca Raton WTP)
Citric Acid Cost, $/lb	0.71 (Per Boca Raton WTP)
Polymer Cost, $/lb	2.5 Per MDWASD WWTPs operating data
Replacement	
Membrane replacement, $/module	811 (Per MFR)
Membrane replacement	A 10 year membrane life is assumed to estimate the membrane replacement cost
UV Equipment	Replacement UV parts include lamps, sleeves, rings
Other equipment replacement (except Membrane and UV)	2 percent of equipment cost
Administration/biosolids disposal/regulatory compliance	This includes operating insurance, water quality monitoring, and sludge land application
Land Application Cost, $/ton	$25 per MDWASD plant operating records

Table 6-6 provides a summary of the Capital Cost for four design capacity MBR plants.

Table 6-7 provides a summary of the operation and maintenance (O&M) for four design capacity MBR plants.

Table 6-8 provides a summary of the total production cost for four design capacity MBR plants.

Table 6-6

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Capital Cost

Treatment Technology : Membrane Bioreactor

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	Influent Pump Station		$1,400,000	$2,100,000	$2,600,000	$3,100,000
2.	Pretreatment		$759,766	$1,116,692	$1,294,415	$1,541,084
3.	Process equipment		$11,090,655	$18,679,298	$25,914,021	$30,172,468
4.	Post treatment		$3,367,920	$4,845,131	$6,122,342	$7,334,786
5.	Sludge handling facilities		$4,423,130	$6,768,209	$9,133,985	$11,314,850
6.	Plant infrastructure		$4,160,000	$5,280,000	$6,500,000	$7,300,000
Subtotal:			$25,201,000	$38,789,000	$51,565,000	$60,763,000
11.	Yard piping	10%	$2,520,000	$3,879,000	$5,157,000	$6,076,000
12.	Mechanical	10%	$2,520,000	$3,879,000	$5,157,000	$6,076,000
13.	Electrical	15%	$3,780,000	$5,818,000	$7,735,000	$9,114,000
14.	Instrumentation and controls	8%	$2,016,000	$3,103,000	$4,125,000	$4,861,000
15.	Site work	10%	$2,520,000	$3,879,000	$5,157,000	$6,076,000
Subtotal:			$38,557,000	$59,347,000	$78,896,000	$92,966,000
16.	General Requirements	2%	$771,000	$1,187,000	$1,578,000	$1,859,000
17.	Contractor overhead and profit	15%	$5,784,000	$8,902,000	$11,834,000	$13,945,000
18.	Construction contingency	15%	$5,784,000	$8,902,000	$11,834,000	$13,945,000
Opinion of Probable Construction Cost::			**$50,896,000**	**$78,338,000**	**$104,142,000**	**$122,715,000**
19.	Technical Services	25%	$12,724,000	$19,585,000	$26,036,000	$30,679,000
20.	Owner administration and legal	5%	$2,545,000	$3,917,000	$5,207,000	$6,136,000
21.	Project contingency	15%	$7,634,000	$11,751,000	$15,621,000	$18,407,000
Opinion of Probable Capital Cost:			**$73,799,000**	**$113,591,000**	**$151,006,000**	**$177,937,000**
Opinion of Equivalent Annual Capital Cost:			**$6,966,000**	**$10,722,000**	**$14,254,000**	**$16,796,000**
Plant service life =		20 years				
Annual interest rate =		7%				

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Table 6-7

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Annual Operation and Maintenance Cost
Treatment Technology : Membrane Bioreactor

Assumptions

Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
1.	Power	$811,957	$1,621,255	$2,430,807	$3,653,195
2.	Chemicals	$74,447	$148,893	$223,340	$297,780
3.	Operation and maintenance labor	$792,323	$924,284	$1,114,388	$1,234,352
4.	Replacement parts and materials				
	a. Replacement membranes:	$99,387	$192,694	$298,162	$397,549
	b. Other replacement parts and materials:	$90,532	$161,373	$226,487	$288,426
5.	Administration/biosolids disposal/regulatory compliance	$350,339	$596,618	$815,397	$1,018,226
	Opinion of Annual O&M Cost:	**$2,219,000**	**$3,645,000**	**$5,109,000**	**$6,890,000**

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Table 6-8

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Total Production Cost
Treatment Technology : Membrane Bioreactor

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
1.	Equivalent annual capital cost	$6,966,000	$10,722,000	$14,254,000	$16,796,000
2.	Annual operation and maintenance cost	$2,219,000	$3,645,000	$5,109,000	$6,890,000
3.	Annual R&R fund deposit(1):	$697,000	$1,072,000	$1,425,000	$1,680,000
	Total Annual Cost:	$9,882,000	$15,439,000	$20,788,000	$25,366,000
	Annual finished water reuse production rate (mgy) (2):	1,825	3,650	5,475	7,300
	Annual Production Cost ($/kgal):	**$5.41**	**$4.23**	**$3.80**	**$3.47**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.

(2) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

The opinion of probable construction costs and annual production costs for the four design flow options are presented in Figure 6-6 and Figure 6-7, respectively.

Figure 6-6 Opinion of Probable MBR Construction Costs

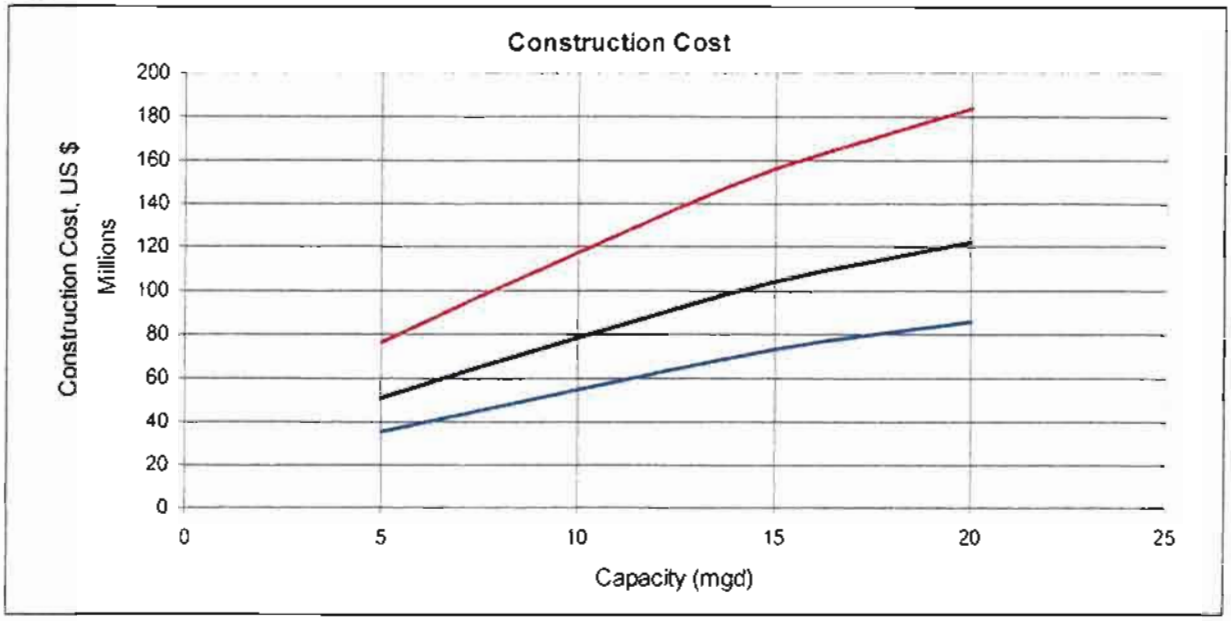
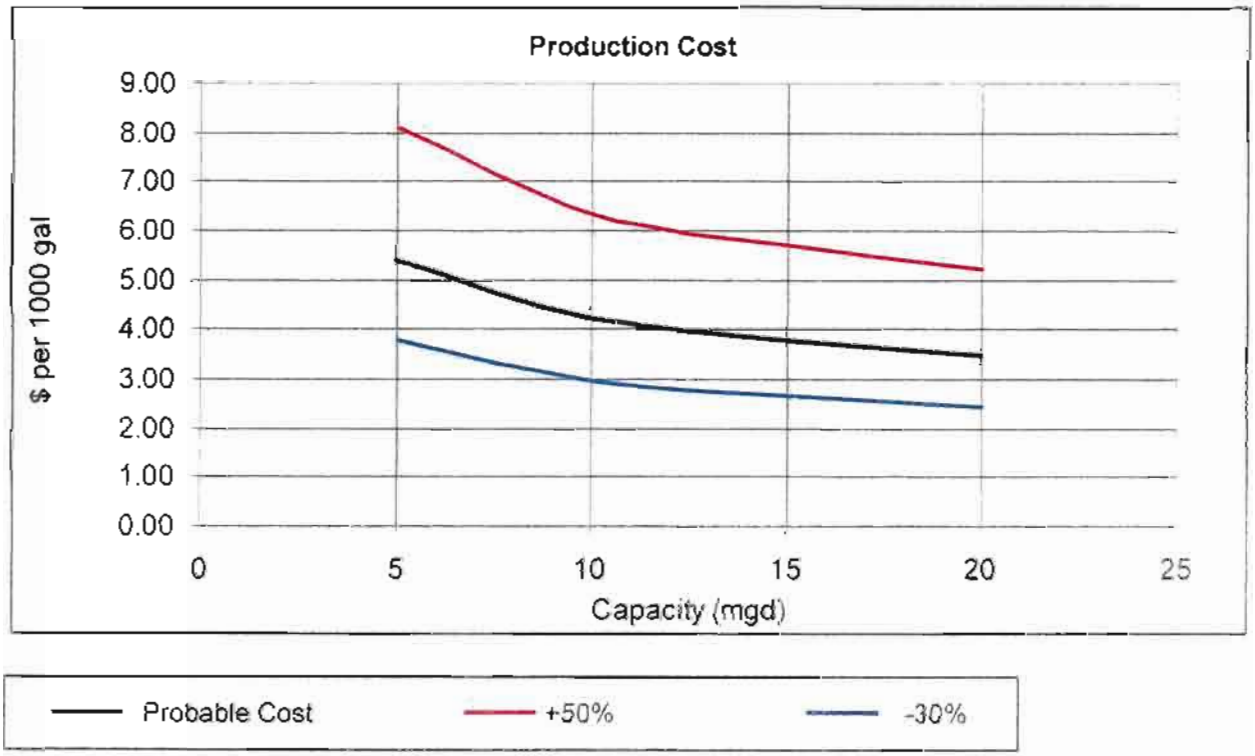
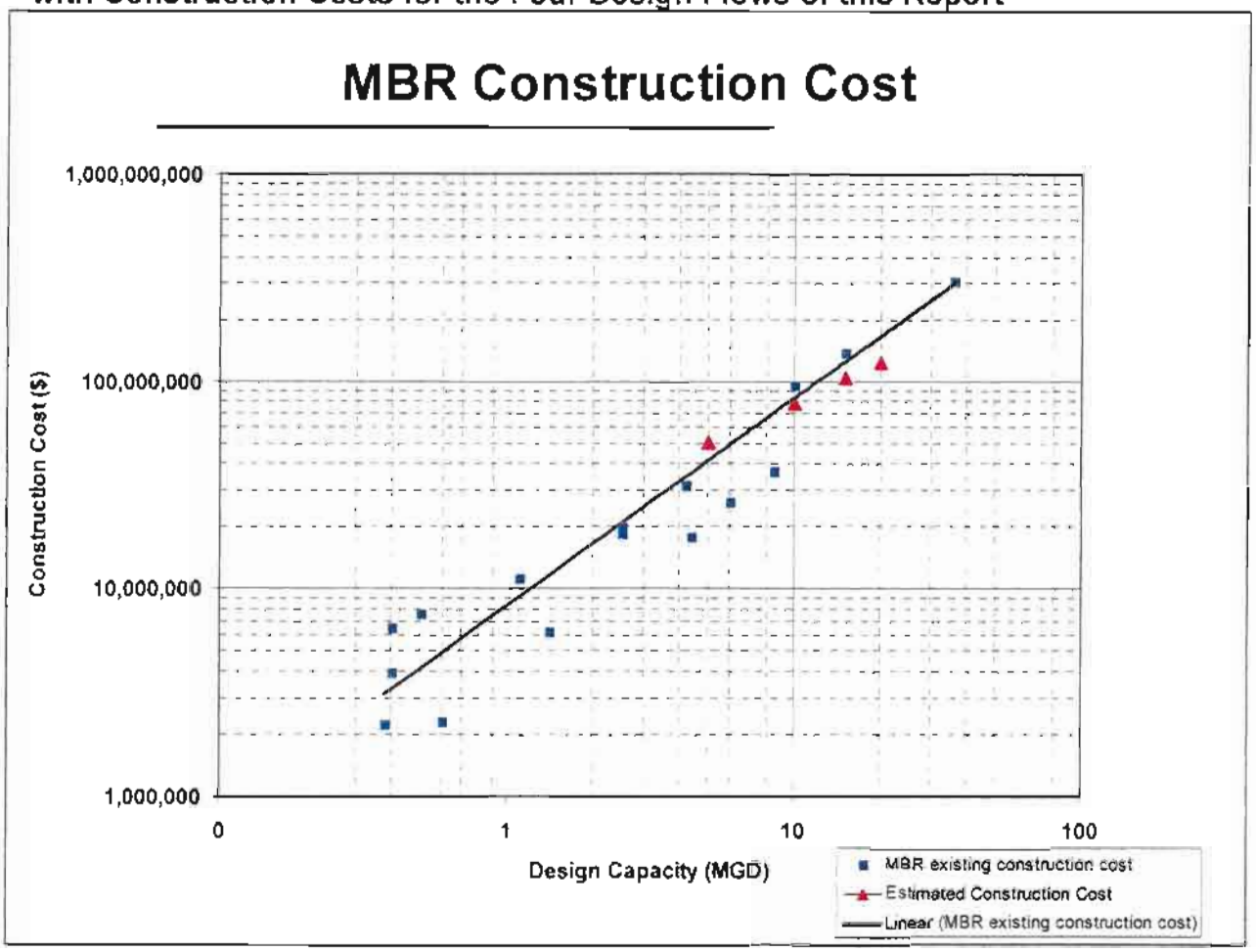


Figure 6-7 Opinion of Probable Annual MBR Production Costs



Existing MBR construction costs were collected from 16 WWTPs varying from engineering cost estimates to bid construction costs. **Appendix G** presents a list of the 16 WWTPs. The MBR design capacities range from 0.4 mgd to 36 mgd. **Figure 6-8** compares the construction cost data of existing MBR plants to the construction costs developed for the four design flows in this study.

Figure 6-8 Comparison of Construction Costs for Existing MBR Plants with Construction Costs for the Four Design Flows of this Report



6.3 Microfiltration and Reverse Osmosis

Capital, Operation and Maintenance (O&M), and production cost tables and curves were developed for the SFWMD Water Supply Cost Estimation Study to include advanced treatment facilities to existing secondary treatment plants. The advanced treatment facilities include fine screening, microfiltration (MF) system, and reverse osmosis (RO) system. Disinfection is not included in the cost estimates.

6.3.1 Approach for Cost Estimates

Costs include capital and O&M costs for the design plant capacities of 5 mgd, 10 mgd, 15 mgd, and 20 mgd. For the purpose of this study, an order-of-magnitude approach was used to develop capital and operating costs. Order-of-magnitude estimates are based on cost-capacity curves, scale factors, bid prices, technical literature, and costs from other studies. This approach is appropriate for planning where detailed engineering data has not yet been developed. This type of estimate; however, cannot be a substitute for carefully prepared estimates of cost based on a sound, thorough engineering evaluation and a complete set of construction drawings and specifications.

The assumptions used in the development of capital and O&M cost estimates for the MF/RO option are summarized below:

- The design plant capacity (5 mgd, 10 mgd, 15 mgd, and 20 mgd) refers to the production capacity (RO permeate).
- The construction cost does not include collection system and water reuse distribution piping. Yard piping cost is included as a percentage of the total construction cost to account for process piping within the boundaries of the treatment plants.
- Construction cost does not include land cost.
- Instrumentation and controls, mechanical, site work, and electrical are included in the total construction cost using typical percentages of the construction costs.
- Estimated costs are adjusted to August 2006 values based on the ENR Construction Cost Index of 7762.
- Pretreatment construction cost includes preliminary estimates for rotary drum 2-mm fine screens.
- Microfiltration System cost is based on a submerged microfiltration system. Cost includes equipment, concrete, and installation.
- Reverse Osmosis System cost includes membranes, break tank, in-line pump station, and chemical feed and storage systems for pH adjustment and corrosion

protection. The cost estimate is based on an RO system with 80-percent recovery rate.

- Disinfection is not included in the cost estimate. Costs for UV disinfection are included in a separate section of this report.
- Concentrate disposal is based on a deep injection well. Concentrate transmission piping is considered to be included in the yard piping line item cost. The cost of a deep injection well is assumed to be $5.5 million, regardless of the concentrate flow rate.
- The plant infrastructure includes building to house process equipment.
- General requirements, contractor overhead and profit, contingency, technical services, and administration and legal mark-ups are included to develop the opinion of probable capital cost as a percentage of the construction cost.
- The O&M costs include labor, chemicals, maintenance, and power. The O&M costs are based on unit cost ($/1000 gal) for MF and RO obtained from previous studies.
- The annual production cost was calculated based on the total annual cost (i.e., equivalent annual capital, plus annual O&M cost, plus annual R&R fund deposit) divided by the average finished water production rate in million gallons per year (mgy). The equivalent annual capital cost was calculated using a typical service life of 20 years for the MF/RO, a discount rate of 7 percent and constant dollars (i.e., no allowance for inflation).
- A 12-month plant operation is assumed in the development of the annual production cost.

6.3.2 Cost Tables

Tables 6-9, 6-10 and **6-11** summarize capital, O&M, and total production costs for the MF/RO option.

Table 6-9

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Capital Cost
Treatment Technology : MF/RO

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
1.	Pretreatment		$756,000	$1,134,000	$1,276,800	$1,512,000
2.	Microfiltration System		$7,141,000	$13,326,000	$18,204,000	$20,720,000
3.	Reverse Osmosis Treatment System		$8,000,000	$15,000,000	$21,000,000	$28,000,000
4.	Plant Infrastructure		$1,500,000	$2,000,000	$3,000,000	$3,500,000
5.	Concentrate Disposal		$5,000,000	$5,000,000	$5,000,000	$5,000,000
Subtotal:			$22,397,000	$36,460,000	$48,481,000	$58,732,000
6.	Yard piping	10%	$2,240,000	$3,646,000	$4,848,000	$5,873,000
7.	Mechanical	10%	$2,240,000	$3,646,000	$4,848,000	$5,873,000
8.	Electrical	15%	$3,360,000	$5,469,000	$7,272,000	$8,810,000
9.	Instrumentation and controls	8%	$1,792,000	$2,917,000	$3,878,000	$4,699,000
10.	Site work	10%	$2,240,000	$3,646,000	$4,848,000	$5,873,000
Subtotal:			$34,269,000	$55,784,000	$74,175,000	$89,860,000
16.	General Requirements	2%	$685,000	$1,116,000	$1,484,000	$1,797,000
17.	Contractor overhead and profit	15%	$5,140,000	$8,368,000	$11,126,000	$13,479,000
18.	Construction contingency	15%	$5,140,000	$8,368,000	$11,126,000	$13,479,000
Opinion of Probable Construction Cost::			**$45,234,000**	**$73,636,000**	**$97,911,000**	**$118,615,000**
19.	Technical Services	25%	$11,309,000	$18,409,000	$24,478,000	$29,654,000
20.	Owner administration and legal	5%	$2,262,000	$3,682,000	$4,896,000	$5,931,000
21.	Project contingency	15%	$6,785,000	$11,045,000	$14,687,000	$17,792,000
Opinion of Probable Capital Cost:			**$65,590,000**	**$106,772,000**	**$141,972,000**	**$171,992,000**
Opinion of Equivalent Annual Capital Cost:			**$6,191,000**	**$10,079,000**	**$13,401,000**	**$16,235,000**
Plant service life =		20 years				
Annual interest rate =		7%				
			9.0468	7.3636	6.5274	5.93075

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Table 6-10

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Annual Operation and Maintenance Cost
Treatment Technology : MF/RO

Item No.	Description	Plant Capacity (mgd) (RO Production) 5	10	15	20
1.	Microfiltration	$547,500	$1,095,000	$1,642,500	$2,190,000
2.	Reverse Osmosis	$2,737,500	$5,110,000	$5,475,000	$7,300,000
3.	Concentrate Disposal	$25,550	$51,100	$76,650	$102,200
Opinion of Annual O&M Cost:		**$3,311,000**	**$6,256,000**	**$7,194,000**	**$9,592,000**
Unit Cost, $/1000 gal		**$1.8**	**$1.7**	**$1.3**	**$1.3**

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Table 6-11

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Total Production Cost
Treatment Technology : MF/RO

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
1.	Equivalent annual capital cost	$6,330,000	$10,217,000	$13,539,000	$16,373,000
2.	Annual operation and maintenance cost	$3,311,000	$6,256,000	$7,194,000	$9,592,000
3.	Annual R&R fund deposit(1):	$633,000	$1,022,000	$1,354,000	$1,637,000
Total Annual Cost:		$10,274,000	$17,495,000	$22,087,000	$27,602,000
Annual finished water reuse production rate (mgy) (2):		1,825	3,650	5,475	7,300
Annual Production Cost ($/kgal):		**$5.63**	**$4.79**	**$4.03**	**$3.78**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.

(2) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

6.3.3 Cost Curves

Figures 6-9 and **6-10** illustrate construction and total production costs for the MF/RO option. A +50 percent of base cost and -30 percent of base cost are also included in the graphs to show an envelope of potential costs.

Figure 6-9 MF/RO Construction Cost

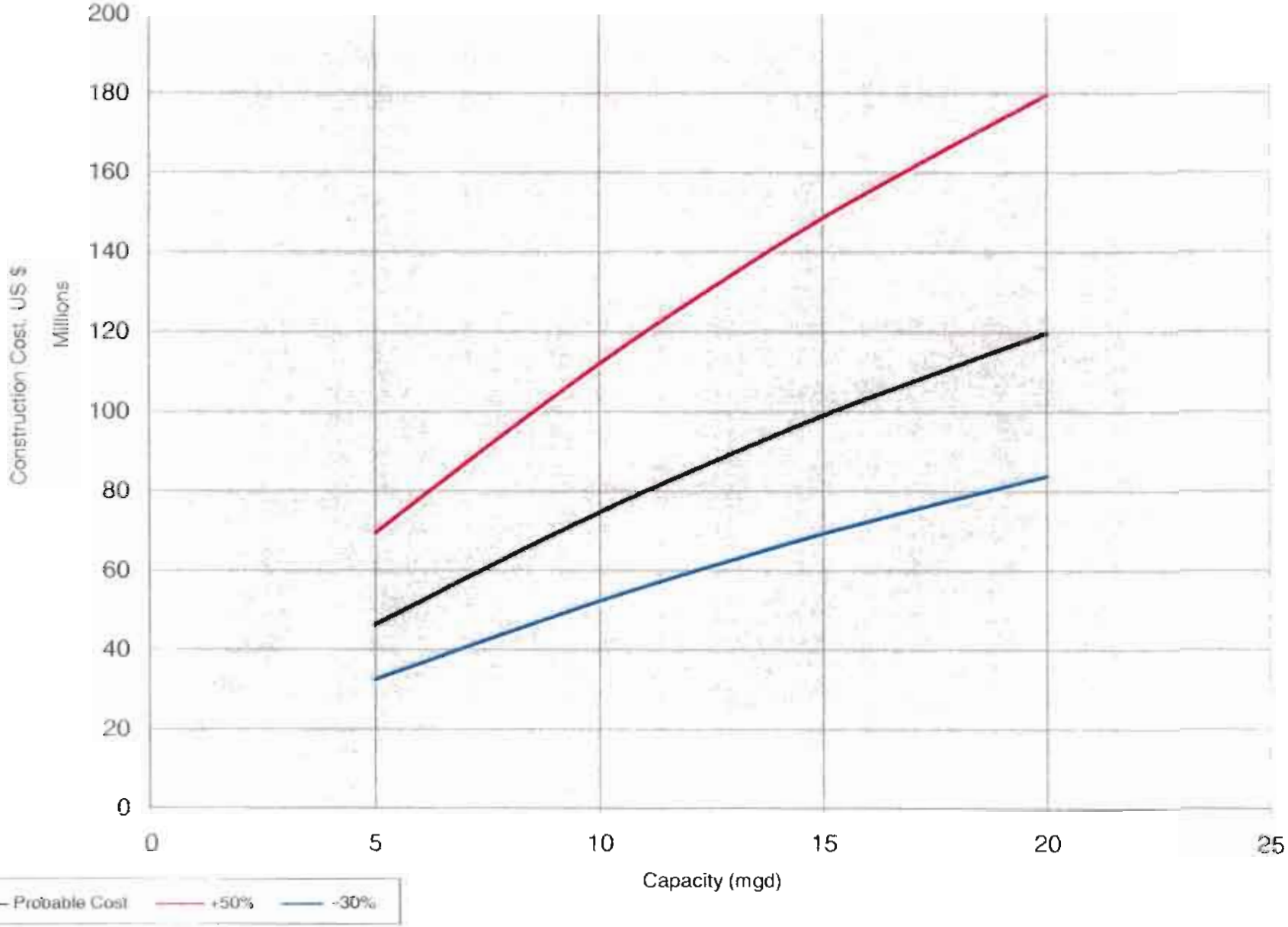

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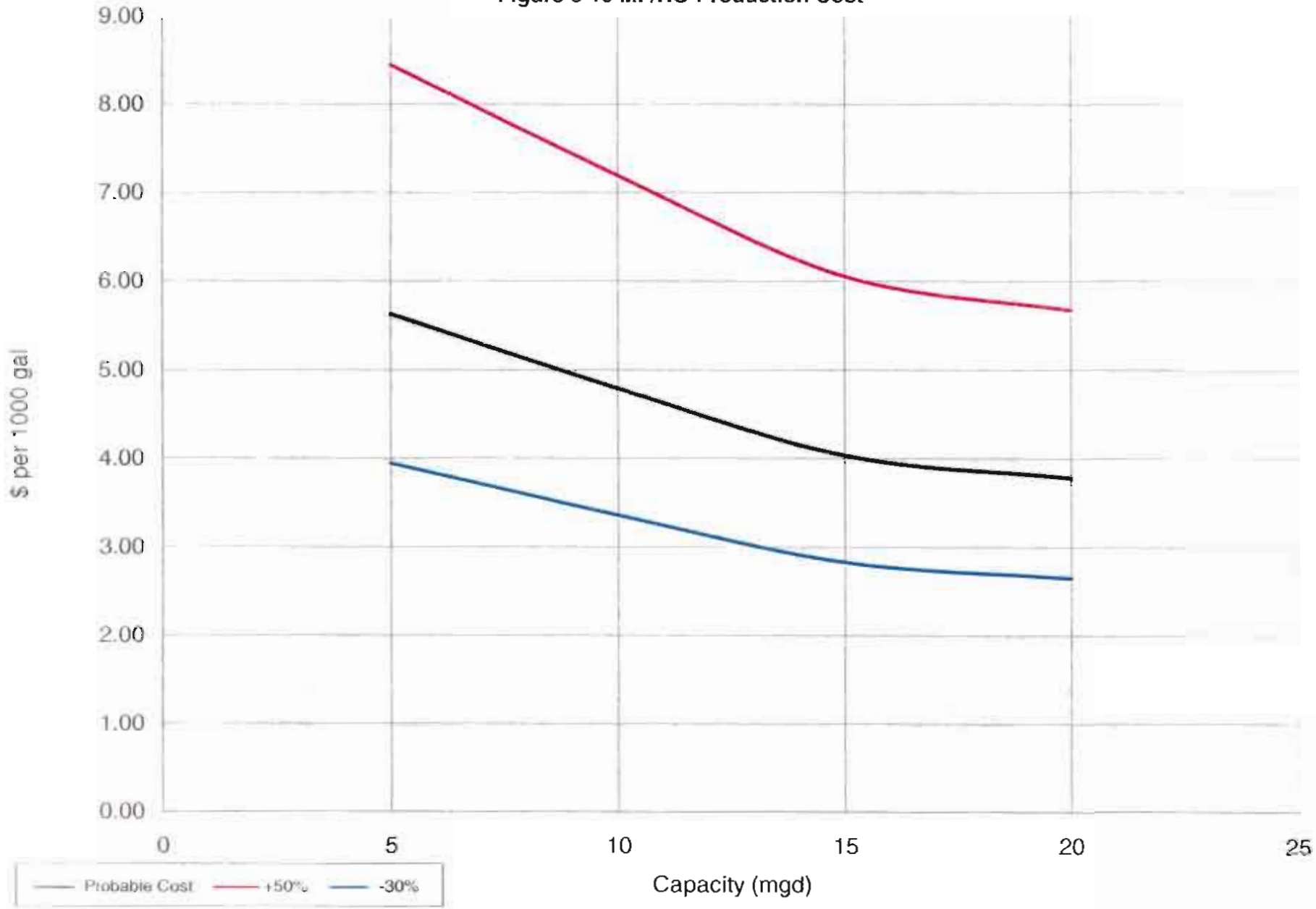
Figure 6-10 MF/RO Production Cost



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6.3.4 Existing Construction Cost Plants

SFWMD requested that CDM provide representative projects that corroborate cost information. Existing MF/RO construction costs were collected from 12 WWTPs varying from engineering cost estimates to bid construction costs. The MF/RO design capacities (production) range from 0.66 mgd to 20 mgd with most of the plants with capacities below 5-mgd. **Figure 6-11** compares the construction cost data of existing MF/RO plants to the construction costs developed for the four design flows in this study.

6.4 Granular Media Filters (GMF) Followed by Ultraviolet (UV) Disinfection

An opinion of probable capital, operation and maintenance (O&M), and production costs were developed for the addition of granular media filters followed by UV to existing secondary treatment plants. This scenario is used for the production of irrigation quality (IQ) water.

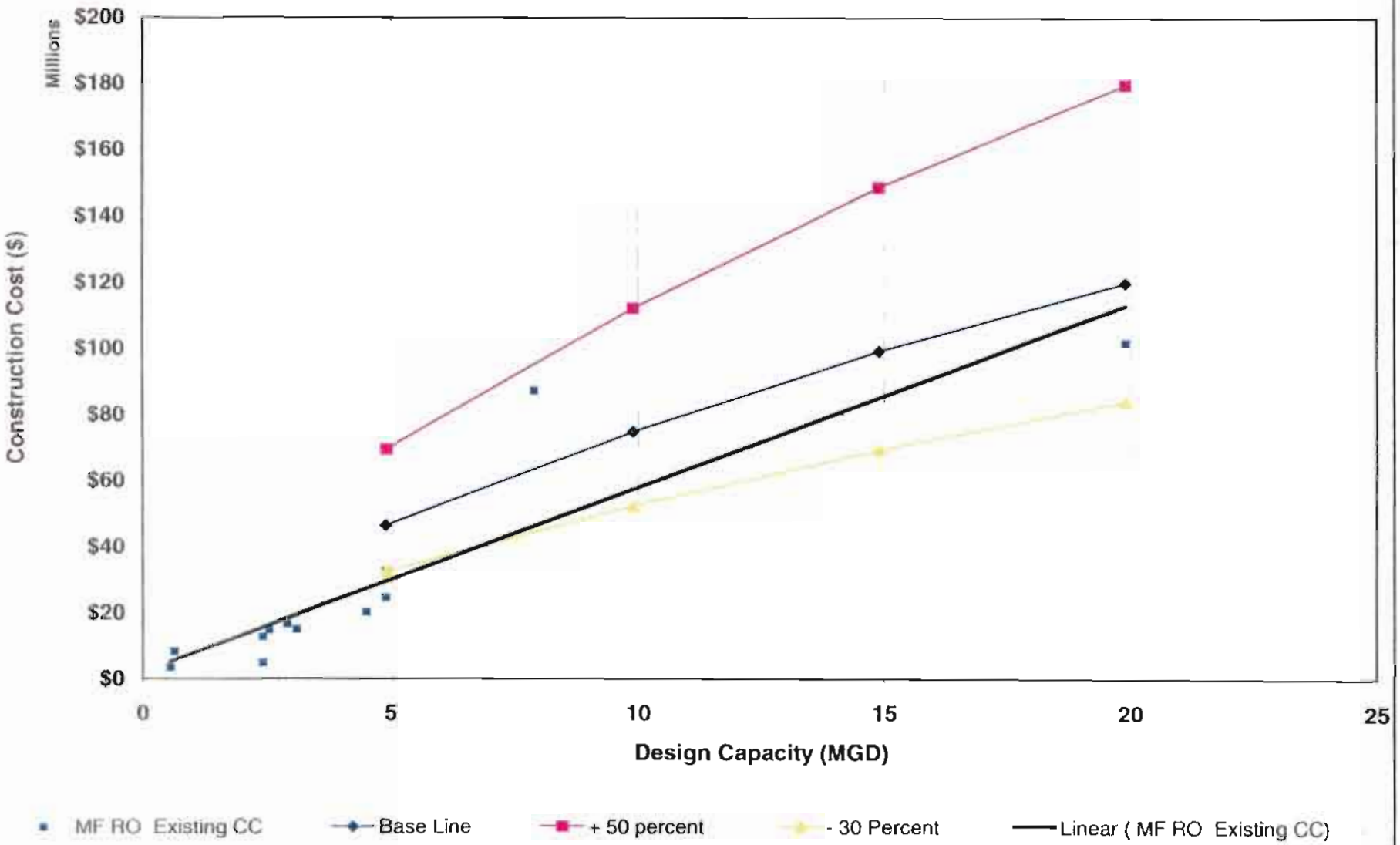
6.4.1 Approach for Cost Estimates

Costs include capital and O&M costs for the design plant capacities of 5 mgd, 10 mgd, 15 mgd, and 20 mgd. For the purpose of this study, an order-of-magnitude approach was used to develop probable capital and operating costs. Probable costs are based on cost-capacity curves, scale factors, bid prices, technical literature, and costs from other studies. This approach is appropriate for planning where detailed engineering data has not yet been developed. This type of estimate cannot be substituted for carefully prepared estimates of cost based on a sound, thorough engineering evaluation and a complete set of construction drawings and specifications.

The assumptions used in the development of probable capital and O&M cost estimates for the GMF/UV option are summarized below:

- The construction cost does not include collection system and water reuse distribution piping. Yard piping cost is included as a percentage of the total construction cost to account for process piping within the boundaries of the treatment plants.
- Construction cost does not include land cost.
- Instrumentation and controls, mechanical, site work, and electrical are included in the total construction cost using typical percentages of the construction costs.
- Estimated costs are adjusted to August 2006 values based on the ENR Construction Cost Index of 7762.

Figure 6-11 MF/RO Construction Cost



- GMF construction cost is based on deep bed filters. Cost includes equipment, concrete, and installation.
- UV construction cost is based on an in vessel medium pressure system.
- The plant infrastructure includes building to house process equipment.
- General requirements, contractor overhead and profit, contingency, technical services, and administration and legal mark-ups are included to develop the opinion of probable capital cost as a percentage of the construction cost.
- The O&M costs include labor, chemicals, maintenance, equipment parts, and power. The O&M costs are based on unit cost ($/1000 gal) for GMF and UV obtained from previous studies.
- The annual production cost was calculated based on the total annual cost (i.e., equivalent annual capital, plus annual O&M cost, plus annual R&R fund deposit) divided by the average finished water production rate in million gallons per year (mgy). The equivalent annual capital cost was calculated using a typical service life of 20 years for the GMF/UV, a discount rate of 7 percent and constant dollars (i.e., no allowance for inflation).
- A 12-month plant operation is assumed in the development of the annual production cost.

6.4.2 Cost Tables

Tables 6-12, 6-13 and **6-14** summarize capital, O&M, and total production costs for the GMF/UV option.

Table 6-12

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Capital Cost
Treatment Technology : Granular Media Filters + UV Disinfection

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 5	10	15	20
2.	Deep Bed Filters		$890,000	$1,781,000	$2,638,000	$3,166,000
3.	Ultraviolet (UV) Disinfection		$1,050,000	$1,987,900	$2,982,000	$3,960,000
4.	Plant Infrastructure		$194,000	$377,000	$562,000	$712,600
Subtotal:			$2,134,000	$4,146,000	$6,182,000	$7,839,000
6.	Yard piping	10%	$213,000	$415,000	$618,000	$784,000
7.	Mechanical	10%	$213,000	$415,000	$618,000	$784,000
8.	Electrical	15%	$320,000	$622,000	$927,000	$1,176,000
9.	Instrumentation and controls	8%	$171,000	$332,000	$495,000	$627,000
10.	Site work	10%	$213,000	$415,000	$618,000	$784,000
Subtotal:			$3,264,000	$6,345,000	$9,458,000	$11,994,000
16.	General Requirements	2%	$65,000	$127,000	$189,000	$240,000
17.	Contractor overhead and profit	15%	$490,000	$952,000	$1,419,000	$1,799,000
18.	Construction contingency	15%	$490,000	$952,000	$1,419,000	$1,799,000
Opinion of Probable Construction Cost::			**$4,309,000**	**$8,376,000**	**$12,485,000**	**$15,832,000**
19.	Technical Services	25%	$1,077,000	$2,094,000	$3,121,000	$3,958,000
20.	Owner administration and legal	5%	$215,000	$419,000	$624,000	$792,000
21.	Project contingency	15%	$646,000	$1,256,000	$1,873,000	$2,375,000
Opinion of Probable Capital Cost:			**$6,247,000**	**$12,145,000**	**$18,103,000**	**$22,957,000**
Opinion of Equivalent Annual Capital Cost:			**$590,000**	**$1,146,000**	**$1,709,000**	**$2,167,000**
Plant service life =		20 years				
Annual interest rate =		7%				

Table 6-13

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Annual Operation and Maintenance Cost
Treatment Technology : Granular Media Filters + UV Disinfection

Item No.	Description	Plant Capacity (mgd) (RO Production) 5	10	15	20
1.	Deep Bed Filters	$150,000	$300,000	$450,000	$600,000
2.	UV Disinfection	$270,740	$541,479	$812,219	$1,082,959
Opinion of Annual O&M Cost:		**$421,000**	**$841,000**	**$1,262,000**	**$1,683,000**

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Table 6-14

South Florida Water Management District Water Supply Cost Estimation Study

Summary of Total Production Cost
Treatment Technology : Granular Media Filters + UV Disinfection

Item No.	Description	Plant Capacity (mgd) 5	10	15	20
1.	Equivalent annual capital cost	$590,000	$1,146,000	$1,709,000	$2,167,000
2.	Annual operation and maintenance cost	$421,000	$841,000	$1,262,000	$1,683,000
3.	Annual R&R fund deposit(1):	$59,000	$115,000	$171,000	$217,000
Total Annual Cost:		$1,070,000	$2,102,000	$3,142,000	$4,067,000
Annual finished water reuse production rate (mgy) (2):		1,825	3,650	5,475	7,300
Annual Production Cost ($/kgal):		**$0.59**	**$0.58**	**$0.57**	**$0.56**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.

(2) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

6.4.3 Cost Curves

Figures 6-12 and **6-13** illustrate construction and total production costs for the GMF/UV option. A +50 percent of base cost and -30 percent of base cost are also included in the graphs to show an envelope of potential costs.

Figure 6-12 GMF/UV Construction Cost

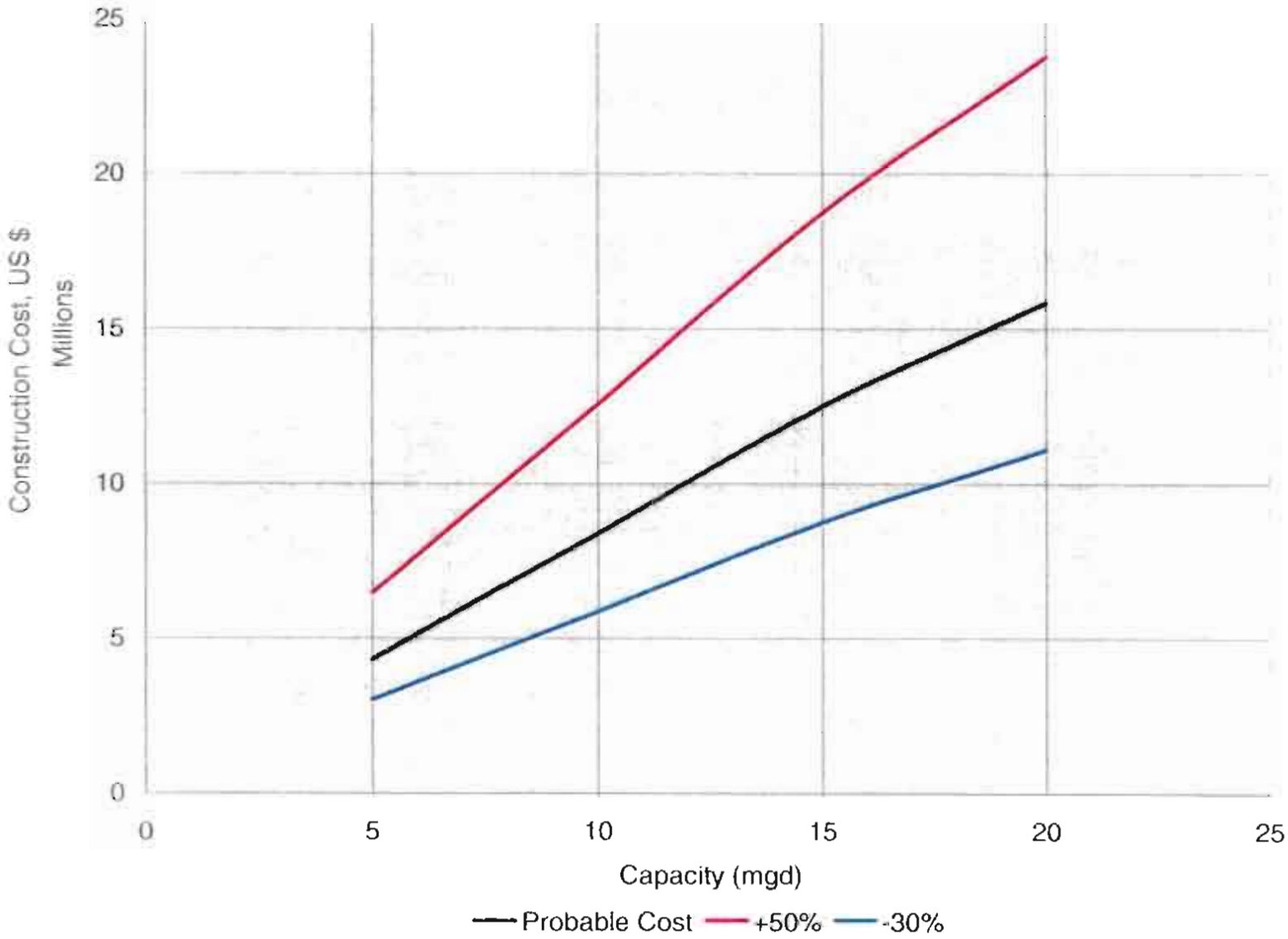

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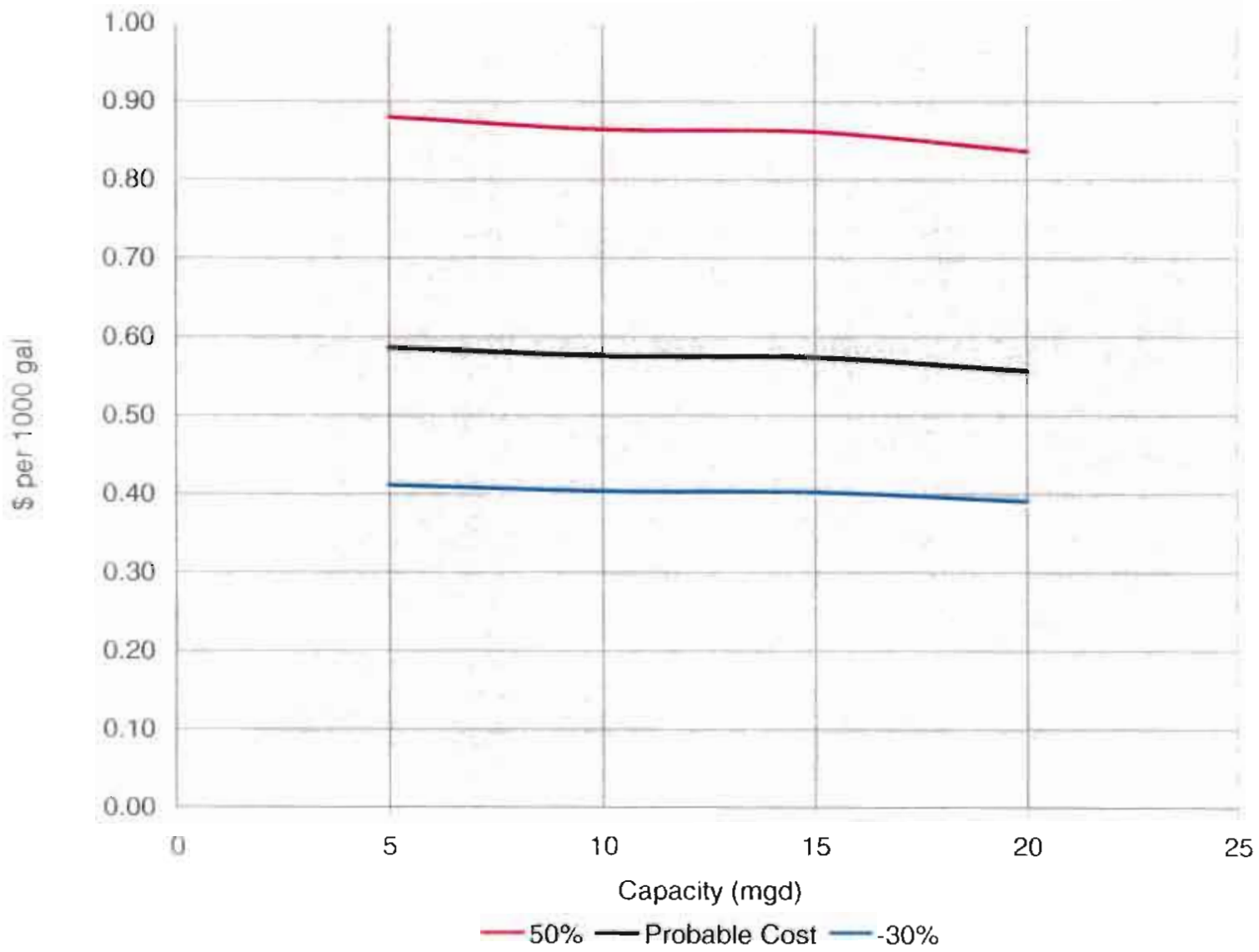
Figure 6-13 GMF/UV Production Cost



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Section 7
Capital and O&M Costs for a Range of Sizes of Reverse-Osmosis Treatment By-product Disposal Methods

This section addresses the capital and O&M costs for a range of sizes of deep injection wells (DIW). Within SFWMD only one contractor constructs DIW and that is Youngquist Brothers, Inc., of Ft. Myers (Youngquist). Ed McCullers of Youngquist has provided CDM with a listing of deep injection wells that they have constructed and associated costs; this complete list is contained in **Appendix H**. DIW used for the disposal of reverse-osmosis concentrate require a tubing-and-packer construction (TP). The wells and their costs that are relevant to concentrate disposal are indicated with a "TP" in this appendix.

DIW with TP construction for the Upper East Coast, Lower East Coast and Lower West Coast planning areas are shown in **Tables 7-1, 7-2**, and **7-3**, and **Figures 7-1, 7-2**, and **7-3** below. There are no DIW within the Kissimmee Basin area.

The costs of DIW have risen dramatically in the past several years. According to Youngquist, the cost of an average DIW with Tubing and Packer and with a monitor well is about $5.5 million in 2006 dollars. This cost is essentially for an injection well that is valved without any pumps or other surface features. For concentrate disposal, there are no additional power costs associated with disposal of concentrate down a DIW. The concentrate pressure from the membrane trains is usually sufficient to inject the concentrate without booster pumps.

Additional testing requirements would add more cost. The amount of time spent on the site is more important than the cost of the materials used for the well according to Youngquist. Inner diameter of the tubing could range from 4 to 20 inches-in-diameter for DIW. The cost of the tubing is about $700,000 for a 16-inch diameter tubing, but the tubing costs could range from $250,000 to $1,000,000. Costs will continue to escalate at a rate of 4 to 5 percent per year because of increases in fuel, labor, cement, steel, and other materials according to Youngquist.

Table 7-1 Upper East Coast Deep Injection Wells

Well Name	Tropical Farms Injection Wells[1,2]	St. Lucie West Services District - IW[1]	City of Palm Bay Southern Regional DIW[1,3]
County	Martin	St. Lucie	Brevard
Start Date	Dec-03	Jan-04	Jul-04
Finish Date	Sep-05	Jul-05	Jul-05
Tubing and Packer Construction (Y/N)	Y	Y	Y
Deep Injection Well (Y/N)	Y	Y	Y
Monitoring Well (Y/N)	Y	Y	Y
Injection Casing Diameter (inches OD[4])	26 & 26	12	24
Tubing Diameter[5]	18" OD FRP & 18" OD FRP	7.625" OD FRP	16.5 ID FRP
Casing Depth (feet)	2,190 & 2,510	2,704	2,070
Total Depth (feet)	3,200	3,295	3,000
ENR Date	Oct-04	Sep-04	Dec-04
CCI ENR Value	7,314	7,298	7,308
August 2006 CCI ENR Value	7,722	7,722	7,722
Total Cost	$8,943,900	$3,440,757	$5,056,015
Total Cost per IW in August 2006 Dollars	$4,721,411	$3,640,658	$5,342,439

Notes:

1) Correspondence with Ed McCullers, Youngquist Brothers, Inc.

2) The total cost is for two injection wells. The adjusted cost is divided in half to reflect the cost of one injection well.

3) Palm Bay is located in the St. Johns River Water Management District. Due to its proximity to the UEC it is included in this evaluation.

4) "OD" signifies Outer Diameter

5) "ID" signifies Inner Diameter. "FRP" signifies Fiberglass Reinforced Plastic.

Table 7-2 Lower East Coast Deep Injection Wells

Well Name	FP&L West Coast Energy Exploratory Well[1]	FP&L West County Energy Exploratory IW[1,2]	Village of Wellington WTP IW[1]	PB Lake Region DIW & DZMW[1]	Key West DIW[1]	Concentrate Disposal Well for the City of Hallandale Beach[1]	City of Clewiston Water System Improvements Concentrate Disposal IW[1]	Deerfield Beach Concentrate DIW[1]
County		Palm Beach	Palm Beach	Palm Beach	Monroe	Broward	Hendry	Broward
Start Date	Apr-06	Sep-06	Apr-05	Sep-05	Dec-05	Feb-06	Apr-06	Aug-06
Finish Date	Oct-06	--	Jan-06	Sep-06	Jun-06	--	--	--
Test Well (Y/N)	N	N	N	N	N	N	N	N
Tubing and Packer Construction (Y/N)			Y	Y	N	Y	Y	Y
Deep Injection Well (Y/N)	Y	Y	Y	Y	Y	Y	Y	Y
Monitoring Well (Y/N)	Y	N	Y	Y	N	Y	Y	Y
Injection Casing Diameter (inches OD[3])	--	20	18	18	24	18	16	18
Tubing Diameter[4]		16" OD FRP	11.97" ID FRP	11.97' ID FRP	--	11.75" ID FRP	11.2 " ID FRP	10.72" ID FRP
Casing Depth (feet)	--	3,000	2,890	2,900	2,800	2,880	2,900	2,900
Total Depth (feet)	--	3,400	3,450	3,500	3,000	3,500	3,500	3,400
ENR Date	Jul-06	Sep-06	Aug-05	Mar-06	Mar-06	Feb-06	Apr-06	Aug-06
CCI ENR Value	7,721	7,763	7,479	7,692	7,692	7,689	7,695	7,722
August 2006 CCI ENR Value	7,722	7,722	7,722	7,722	7,722	7,722	7,722	7,722
Total Cost	$3,177,675	$4,656,800	$3,552,184	$2,847,722	$3,735,226	$4,434,337	$4,943,153	$5,700,000
Total Cost per IW in August 2006 Dollars	$3,178,087	$4,656,800	$3,667,598	$2,858,829	$3,749,794	$4,453,368	$4,960,497	$5,700,000

Notes:

1) Correspondence with Ed McCullers, Youngquist Brothers, Inc.

2) Costs dated after August 2006 are not adjusted using the ENR CCI values. The actual cost is displayed.

3) "OD" signifies Outer Diameter

4) "ID" signifies Inner Diameter. "FRP" signifies Fiberglass Reinforced Plastic.

Table 7-3 Lower West Coast Deep Injection Wells

Well Name	Pine Island RO Plant[1,2]	Three Oaks WWTF DIW[1]
County	Lee	Lee
Start Date	Feb-04	Feb-05
Finish Date	Feb-05	Dec-05
Tubing and Packer Construction (Y/N)	Y	Y
Deep Injection Well (Y/N)	Y	Y
Monitoring Well (Y/N)	Y	Y
Injection Casing Diameter (inches OD[3])	18	20
Tubing Diameter[4]	12" OD FRP	14.5" OD FRP
Casing Depth (feet)	1,955	2,500
Total Depth (feet)	3,138	3,000
ENR Date	Aug-04	Jul-05
CCI ENR Value	7,188	7,422
August 2006 CCI ENR Value	7,722	7,722
Total Cost	$4,876,000	$4,246,800
Total Cost per IW in August 2006 Dollars	$5,238,240	$4,418,457

Notes:

1) Correspondence with Ed McCullers, Youngquist Brothers, Inc.

2) Total cost includes $1,048,000 for surface facilities.

3) "OD" signifies Outer Diameter

4) "FRP" signifies Fiberglass Reinforced Plastic.

Figure 7-1 Upper East Coast Deep Injection Well Costs vs Time

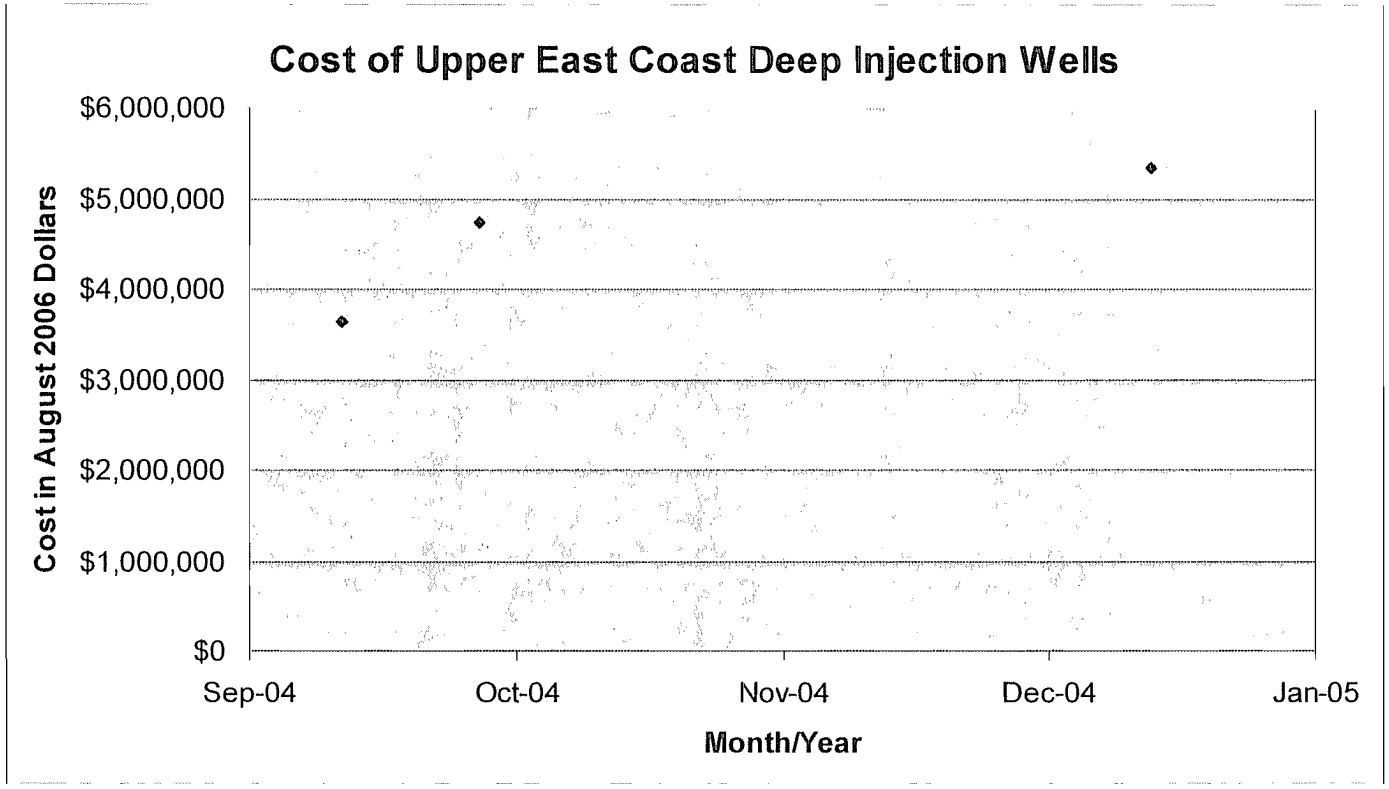


Figure 7-2 Lower East Coast Deep Injection Well Costs vs Time

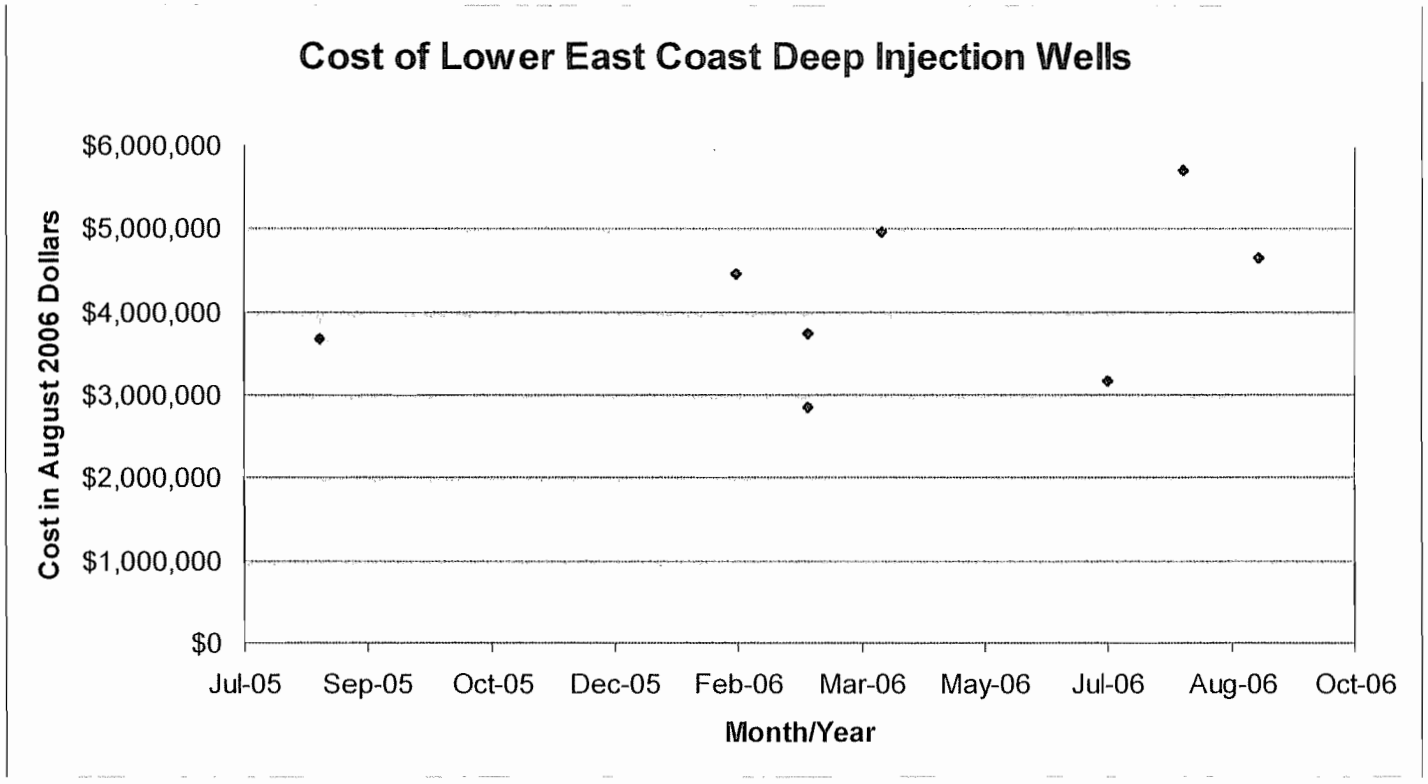
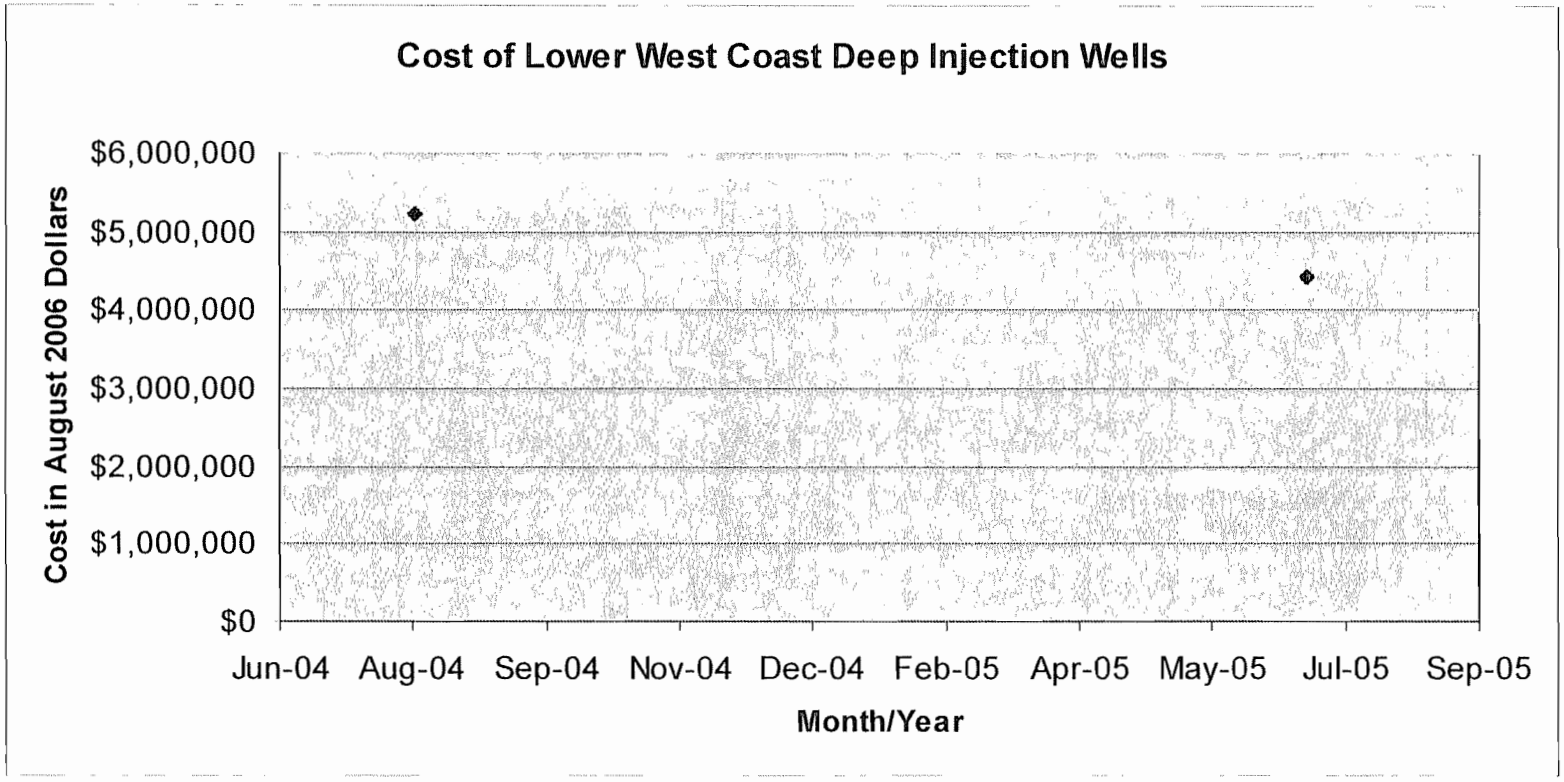


Figure 7-3 Lower West Coast Deep Injection Well Costs vs Time



The primary operational costs associated with concentrate disposal injection wells are related to meeting regulatory requirements. The injection well itself should require very little in the way of maintenance expenditures, although an allowance should be included to cover periodic replacement of monitoring equipment.

Water Treatment Plants (WTP) that are using DIW for the disposal of concentrate were contacted by CDM regarding their O&M costs attributed directly to the injection wells. In most cases, the primary cost is associated with the Mechanical Integrity Test (MIT) which is a requirement of the FDEP.

Mechanical Integrity is defined by the FDEP in Rule 62-528.300(6), F.A.C. as demonstrating that there are no leaks in the casing, tubing or packer; and that there is no fluid movement into an underground source of drinking water (USDW) through channels adjacent to the well bore. This is generally demonstrated by pressure testing the inner casing or tubing, a temperature or noise log, and a radioactive tracer survey (RTS). MIT's are required every five years by the FDEP.

Three drilling companies that routinely perform MIT's were verbally contacted regarding the costs associated with the testing and are listed below:

1. Youngquist Brothers, Inc. – Mr. Ed McCullers, V.P., was contacted (9/27/06) and said that the prices ranged from $30,000 (basic price for a tubing and packer well) to $75,000 (basic price for a non-tubing and packer well).

2. All Webb's Enterprises – Ms. Tammy Wells was contacted (9/27/06) and said that prices ranged from $50,000 to $100,000 depending on the diameter of the well and if any site work is required.

3. Diversified Drilling – Mr. Bill Musselwhite, V.P., was contacted (9/28/06) and gave a range of $45,000 to $65,000 depending on whether or not the well is tubing and packer.

The following Utilities were verbally contacted regarding their O&M costs:

- Lee County Utilities – North Lee County WTP - Mr. Ivan Velez (Deputy Director) and Mr. Tom Hill (Senior Manager) were contacted (9/28/06) and said that the WTP had just started up within the last couple of months so they had very little data. They said that the primary cost would be the MIT and since that was only performed once every five years, There is one well at this site receiving RO concentrate only.

- Greater Pine Island Water Association – Mr. Bill Thatcher (Plant Manager) was contacted and said that other than the cost of the five year MIT's (estimated to be approximately $75,000), they do not track O&M costs since they use the pressure from the RO trains to inject down the injection well. There is one well at this site receiving RO concentrate only.

- City of Fort Myers WTP - Mr. Byron Weightman (Plant Manager) was contacted (9/28/06) and they do not calculate O&M costs separately for the DIW. There is one well at this site receiving RO concentrate only.

- South Collier County WTP - Mr. Steve Lang (Plant Manager) was contacted (9/28/06) and said that they do not track the O &M costs (other than MIT's and tubing replacement which is a capital expenditure). There are two DIW at this site receiving RO concentrate only.

A number of older injection wells in South Florida developed leaks in their steel injection tubing, which required replacement. The cost of replacement of a steel tubing with a fiberglass tubing is estimated to be on the order of $800,000 to $1,100,000 including engineering and permitting fees. New injection wells are now constructed with a fiberglass tubing which should not require replacement. Concentrate may be sent to injection wells under residual pressure from the reverse-osmosis membranes or by using a dedicated wet well and pump system. In the former case there is no direct electrical operational cost. The cost of operating the pump system, if required, would be considered a treatment plant cost.

The primary direct operation and maintenance costs for a concentrate disposal injection well system are costs for laboratory analyses required by the FDEP for the injectate and monitoring wells, and costs for the 5-year mechanical integrity test (MIT) and operational permit renewals. Analytical costs were estimated based on FDEP general monitoring requirements for concentrate disposal wells and state-certified laboratory cost schedules. The costs for the MIT and operational permit renewals are current market rates in Southwest Florida based on Missimer Groundwater Science, Inc. recent experience and discussions with local drillers. The operation and maintenance costs do not include labor costs for utility personnel, as work associated with injection wells requires only a small percentage of the water treatment plant staff's time. A breakdown of estimated O&M costs for an injection well system is provided in **Table 7-4**. The costs below do not vary with injection well size (diameter) or injected volume.

Table 7-4 Class I Injection Well Operation and Maintenance Costs (2006)

Item	Annual Costs
Laboratory analyses	$14,650
Mechanical integrity test ($50,000 every 5 years)	$10,000
Operational Permit renewal (including application fee ($50,000 every 5 years)	$10,000
Allowance for miscellaneous repairs	$10,000
Estimated Total Cost	**$44,650**

Section 8
Capital and O&M Costs for the Development of Aquifer Storage and Recovery (ASR) Systems

Data were obtained regarding capital and operating costs for nine ASR wellfields in Florida plus monitor well expansion programs at two of these sites, as shown in **Table 8-1**. Capital costs were identified for ASR wells, monitor wells and ASR wellhead facilities constructed since 1999. Capital costs for ASR wells and monitor wells were adjusted to a common August 2006 basis using escalation factors estimated by ASR Systems based upon experience in Florida with such projects during the past few years. Capital costs for construction of wellhead facilities were adjusted to August 2006 using the ENR Construction Cost Index (CCI) where possible. ENR CCI values since 1999, and for well construction, are shown on **Table 8-2**. June values in each year were selected since we were unable to document the month in each year that bid prices were obtained for capital expansion projects for some of the ASR projects considered for this study.

Table 8-1 ASR Wellfields Considered in the Survey

City of Tampa Rome Avenue Park ASR Wellfield
City of Tampa Enhanced Monitoring Program
City of Tampa Avon Park ASR Well
City of St Petersburg Southwest Water Reclamation Facility ASR Wellfield
Englewood Water District Reclaimed ASR Well
Peace River/Manasota Regional Water Supply Authority ASR Wellfield No. 2
Peace River/Manasota Regional Water Supply Authority Enhanced Monitoring Program
USACE/SFWMD Hillsboro Canal Pilot ASR Well
USACE/SFWMD Kissimmee River Pilot ASR Well
USACE/SFWMD Port Mayaca Pilot ASR Well
Seminole County Markham ASR Well
City of Sanford ASR Well at Auxiliary Water Treatment Plant
City of Bradenton ASR Well

Table 8-2 Construction Cost Indices

	ENR CCI	Well Construction*
Jun-99	6039	0.45
Jun-00	6238	0.5
Jun-01	6318	0.56
Jun-02	6532	0.63
Jun-03	6694	0.71
Jun-04	7109	0.77
Jun-05	7415	0.83
Jun-06	7700	1

* estimate by ASR Systems LLC based on Florida experience

Since 1999 we estimate that well construction costs in Florida, and nationwide, have more than doubled, reflecting increasing cost for fuel and materials plus competitive forces due to heavy demand for drilling rigs and staff to meet nationwide oil and gas exploration needs, plus the needs of the water supply sector of the national economy. The ENR construction cost index during the same period has increased by about 30 percent. For some sites incomplete data were available. In particular, operation and maintenance cost data were available for only four of the eleven sites. Average values were determined from those sources for which data is available.

ASR well depths ranged from 400 to 1,215 feet. Well recovery capacities ranged from 1.0 to 5.0 mgd. The number of wells in each wellfield ranged from 1 to 12. Wellfields were located within the Southwest Florida Water Management District (SWFWMD), the St Johns River Water Management District (SJRWMD) and the South Florida Water Management District (SFWMD). The principal factors affecting unit capital costs for new ASR wells are primarily well yield and secondarily well depth, number of wells, and the amount of data collection and testing during well construction. Single well projects have higher unit costs than multiple well projects. Deeper wells are more expensive than shallow wells, and high capacity wells are more cost-effective than low yield wells. Well construction costs for CERP ASR wells are more expensive than for water utility ASR wells because of the additional geotechnical work included in the CERP wells. This includes extensive geophysical logging, coring, geologic and mineralogical analyses, and pump and interval tests.

ASR unit capital costs are expressed in terms of cost per million gallons per day ($/mgd) of recovery capacity. "Recovery capacity" is defined as the production rate (mgd) that can be achieved from an ASR well or wellfield during recovery. In most cases the recovery capacity equals the design capacity; however, in a few cases it is slightly different, reflecting higher or lower well yields, interference between wells, hydraulic head losses, regulatory restrictions, and other changes that sometimes occur in the field. ASR unit capital costs include construction costs and also consultant services for engineering and hydrogeology.

ASR unit operating costs are expressed in terms of $/year/mgd of recovery capacity and also in terms of $/MG. The reason for presenting unit operating costs both ways is that ASR projects store and recover a wide annual range of water quantities, from the small quantity required to meet a peak weekend (i.e., Palm Bay, FL) to the much larger quantity required to meet an extended (up to 210-day) drought demand (i.e., Peace River, FL). Unit costs based upon dollars per unit volume ($/MG, $/cubic meter or $/kgal) can be extremely high if the recovered volumes are low, and vice versa. Both types of projects may be quite cost-effective, however if the unit costs ($/kgal) are compared with much lower unit costs from conventional water sources and treatment facilities that operate throughout the year, incorrect conclusions may easily be drawn regarding the cost-effectiveness of ASR. Care is required to compare "apples to apples." Both units of measurement are therefore presented. Normalizing

the unit cost values by defining unit operating cost in terms of $/year/mgd of recovery capacity provides a more balanced presentation of alternative costs.

Survey results are shown on **Table 8-3A** through **8-3F**. This table includes considerable data regarding well construction, flow rates, treatment facilities, engineering costs and other pertinent information. The table is presented in six parts, 3a through 3e, to facilitate presentation of this large spreadsheet. Table 8-3A includes the entire spreadsheet while Tables 8-3B through 8-3F show each of the workbooks that comprise the spreadsheet.

8.1 ASR Well Costs

Average unit cost (August 2006) for ASR wells is $214,000 per mgd of recovery capacity, within a broad range of $58,000 to $366,000. Data were available for 11 sites. Lowest values are for the City of Tampa Avon Park ASR well and for the City of Bradenton ASR well, both of which are relatively high capacity wells. Highest values are for Seminole County and Sanford, both of which are relatively low capacity wells. For the latter two projects, engineering costs for the design and permitting of well and wellhead facilities were lumped together and included as a part of ASR well design. For other sites it was possible to disaggregate the engineering costs among the ASR wells, monitor wells and wellhead facilities.

8.2 Monitor Well Costs

Average cost for monitor wells is $212,000 per mgd of recovery capacity, within a broad range of $40,000 to $674,000. Eleven wellfields were considered, with one to 8 monitor wells per wellfield. The lowest unit capital cost is for the Peace River/Manasota Regional Water Supply Authority (PRMRWSA), which initially constructed 8 monitor wells for a 12-mgd wellfield expansion. The highest is for Seminole County, which constructed 3 monitor wells for a single, 1-mgd ASR well.

Costs for ASR projects being conducted by the SFWMD and the SJRWMD reflect substantial investments for investigations and data collection during construction of the first "exploratory" well, which is typically then converted to a storage zone observation well. While the first well at any new ASR site is typically utilized to collect additional data to guide the design of the ASR well and other facilities, ASR projects for these two Districts entail a much greater amount of data collection than normally conducted, as part of an effort to add to the science underlying the ASR technology.

At two of these wellfields, Tampa and Peace River, additional monitor wells were constructed during 2005 to address arsenic mobilization and attenuation issues. Five monitor wells were constructed at Tampa, averaging $71,000 each. Thirteen additional monitor wells were constructed at Peace River, averaging $80,000 each.

Table 8-3A ASR Cost Data, Master List

Site Information / ASR Well Construction

Owner	Site	ASR Type	Design Recovery Capacity (mgd)	Actual Recovery Capacity (Cost Basis) (mgd)	Cost Basis Year	No. of ASR Wells	Average Casing Diameter (in)	Average Casing Depth (feet)	Casing Material Type	Average Total Depth (feet)	Engineering Costs ($1000)	ASR Well Drilling Costs ($1000)	Total ASR Well Costs ($1000)	ASR Well Costs (2006 escalation, $1000)	2006 Cost/ MGD recovery capacity
City of Tampa	Rome Avenue Park	TSW	10	8.75	2000	7	16	300	CL	400	180.3	924.4	1105	1546	211
	Enhanced Monitoring Program	TSW													
	Avon Park Well	TSW	4	4	2004	1	16	830	CS	700	94.27	180	274.3	234	58
City of St. Petersburg	SW WRF	RW	1	1.35	2001	1	16	490	CS	600	99.22	216.3	315.5	389	288.4
Englewood Water District	Englewood WWTP	RW	1.5	1.5	2000	1	18	507	CS	700	160.0	181.4	341.4	363	241.9
PRMRWSA	Wellfield No. 2	TSW	12	12	1999	12	16	587.7	PVC	899	1201	1853	3054	4077	339.8
	Enhanced Monitoring Program	TSW													
ACOE/SFWMD	Hillsboro Canal Pilot Well	PTS	5	5	2000	1	24	1015	CS	1215	50	310	360	620	124
	Kissimmee River Pilot Well	PTS	5	5	2003	1	24	565	CS	875	62	550	612	770	154
	Port Mayaca Well	PTS	5	5	2003	1	24	800	CS	1050	60	505	565	707	141.4
Seminole County	Markham	TGW	1	1	2006	1	10.5	940	FRP	1070	898.4	365.8	1264	366	365.8
Sanford	Auxiliary WTP	TGW	1	1	2006	1	16	530	FRP	630	627.8	349.6	977.5	350	349.6
City of Bradenton	High Service Pump Station	TSW	2.6	2.6	2003	1	17.4	415	CL	505	250	140	390.0	196	75
											334.8	506.9		Avg.	214

Monitor Well Construction

Owner	Site	Cost Basis Year	No. of Monitor Wells	Avg Casing Depth (ft)	Average Total Depth (ft)	Casing Material Type	Engineering Costs ($1000)	MW Drilling Costs ($1000)	Actual Monitoring Well Costs ($1000)	Monitor Well Costs (2006 escalation, $1000)	2006 Cost/ MGD recovery capacity
City of Tampa	Rome Avenue Park	2000	5	300	400	CL	70	308.4	378.4	616.8	70
	Enhanced Monitoring Program	2006	5	300	375	CL	113	356.4	469.8	356.4	
	Avon Park Well	2004	3	520	592	CL	19.8	193.5	213.3	251.6	63
City of St. Petersburg	SW WRF	2001	1	319	335	CL	20	53	73.0	95.4	71
Englewood Water District	Englewood WWTP	2000	3	5.333	320	CL	40.0	126.9	166.9	253.6	169
PRMRWSA	Wellfield No. 2	1999	8	345	370	PVC	80	215.9	295.9	475	40
	Enhanced Monitoring Program	2005	13	600	675	CL	180	870	1050	1044	
ACOE/SFWMD	Hillsboro Canal Pilot Well	2005	1	1020	1215	FRP	75	450	525	540	108
	Kissimmee River Pilot Well	2006	2	583.5	1233	CS	170	970	1140	1426	285
	Port Mayaca Well	2001	1	790	1490	CS	80	540	620	972	194
Seminole County	Markham	2006	3	866.7	970	PVC	150	674.1	824.1	674.1	674
Sanford	Auxiliary WTP	2006	3	595	695	PVC	150	580.5	730.5	580.5	580
City of Bradenton	High Service Pump Station	2003	2	301.5	389	CL	60	135	195.0	189	73
							110	497.6		Avg	212

ASR Facilities Construction

Owner	Site	ASR Well Pumping Capacity (MGD)	ASR Well Pump Type	No. of ASR Well Pumps	Wellhead Appurtenances Costs ($1000)	Transmission Piping (1000 feet)	Transmission Piping Costs ($1000)	Wellfield Distribution Piping (1000 feet)	Wellfield Distribution Piping Costs ($1000)	ASR Electrical System Costs ($1000)	ASR Control System Costs ($1000)	ASR Recharge Treatment Facilities Type	ASR Recovery Treatment Facilities Type	Engineering Costs ($1000)	ASR Treatment Facilities Capacity (mgd)	ASR Treatment Facilities Costs	Total Surface Facilities Construction Costs	2006 Cost w/ escalation ($1000)	2006 Cost/ MGD recovery capacity
City of Tampa	Rome Avenue Park	14	Sub	7	1267	10	3000	10	500	160	272	None	Full	488	0	0	5677.4	7027	649
	Enhanced Monitoring Program																		
	Avon Park Well	4	Sub	1	452.3	0.1	20	0	0	40	32	None	Full	125	0	0	669.3	727	167
City of St. Petersburg	SW WRF	1.4	Sub	1	157.3	0	0	0.3	30	30	30	None	F,D	75	0	0	322.3	394	239
Englewood Water District	Englewood WWTP	1	Sub	1	231.0	0	0	0.5	20	14	22.9	None	None	150	0	0	437.9	542	292
PRMRWSA	Wellfield No. 2	12	VT	12	827.6	5.6	737	3.3	174	301	13.9	None	Full	382	0	0	2514.9	3216	210
	Enhanced Monitoring Program																		
ACOE/SFWMD	Hillsboro Canal Pilot Well	0	N/A	0	1150	0	0	0	0	50	100	F,D	None	300	1	1200	2000.0	3466	560
	Kissimmee River Pilot Well	0	N/A	0	673		259		741	613	580	F,D	None		5	1996	4862.0	5608	972
	Port Mayaca Well	0	N/A	0								F,D	None		5				
Seminole County	Markham	1	VT	1	136.2	2.4	302	1	108	105	105	0	D		1	0	755.2	755	755
Sanford	Auxiliary WTP	1	VT	1	127.5	0	0	0.7	86	66.8	83.7	0	D		1	0	363.9	364	364
City of Bradenton	High Service Pump Station	2.6	VT	1	202.2	0	0	0	0	40	125	None	D	160	2.6	75	592.5	683	228
																		Avg.	444

Totals

Owner	Site	TOTAL ASR FACILITIES ACTUAL COSTS ($1000)	TOTAL ASR FACILITIES ACTUAL COSTS PER MGD RECOVERY CAPACITY ($1000)
City of Tampa	Rome Avenue Park	9493	1085
	Enhanced Monitoring Program		
	Avon Park Well	1212	303
City of St. Petersburg	SW WRF	879	651
Englewood Water District	Englewood WWTP	1159	773
PRMRWSA	Wellfield No. 2	7768	647
	Enhanced Monitoring Program	1044	
ACOE/SFWMD	Hillsboro Canal Pilot Well	4626	925
	Kissimmee River Pilot Well	7804	1561
	Port Mayaca Well		
Seminole County	Markham	1795	1795
Sanford	Auxiliary WTP	1294	1294
City of Bradenton	High Service Pump Station	1068	411
			944

Annual O & M Costs / Comments

Owner	Site	ASR Well Rehabilitation Costs	ASR Well Testing Analytical Costs	Monitor Well Sampling Analytical Costs	Annual Sample Crew Days	Annual Maintenance Crew Days	Maintenance Labor Costs @$800/day	Annual Misc. Maintenance Costs	Nominal ASR Treatment Costs (Recharge)	Nominal ASR Treatment Costs (Recovery)	ASR Electrical Power Costs	Long-Term Recovery Percentage	Nominal Cost of Water Produced ($/1000 gal)	Cost of Water Left in Storage	Consulting costs (permitting, cycle testing)	Estimated Volume Stored Annually (MG)	TOTAL ANNUAL O&M COSTS PER 1M GAL STORED ($1000/MG)	TOTAL ANNUAL O&M COSTS ($1000)	TOTAL ANNUAL O&M COSTS PER MGD RECOVERY CAPACITY ($1000)	Other Comments Pertaining to Site Costs
City of Tampa	Rome Avenue Park	1	42	52	52	13	52	10	0	500	100	100%	0.5	0	35	1000	0.792	791.6	90	
	Enhanced Monitoring Program																			
	Avon Park Well															300				
City of St. Petersburg	SW WRF	0	29	68	52	7	46.8	26	0	0	12	75%	0	0	51	120	1.942	233	173	
Englewood Water District	Englewood WWTP	0	16	16	13	7	15.6	5	0	0	10	75%	0	0	30	100	0.916	91.6	61	
PRMRWSA	Wellfield No. 2	60	100	56	130	12	114	5	0	630	100	85%	0.63	95	50	1000	1.193	1193	99	
	Enhanced Monitoring Program																			
ACOE/SFWMD	Hillsboro Canal Pilot Well																			
	Kissimmee River Pilot Well																			
	Port Mayaca Well																			
Seminole County	Markham																			
Sanford	Auxiliary WTP																			
City of Bradenton	High Service Pump Station																			
		Avg.															1,211	Avg.	106	

Well Drilling Escalation Factors

1999	2000	2001	2002	2003	2004	2005	2006
2.2	2.0	1.8	1.6	1.4	1.3	1.2	1.0

Legend:
ASR Type: Treated Surface Water (TSW); Treated Groundwater (TGW); Reclaimed water (RW), Partially Treated Surface Water (PTS)
Casing Type: Carbon Steel (CS); Certa-Lok (CL); Polyvinal Chloride (PVC); Fiberglass Reinforced Pipe (FRP), Stainless Steel (SS)
Pump Type: Vertical Turbine (VT); Submersible (Sub)
Treatment Types: Filtration (F); Disinfection (D); pH Adjustment (pH).
Abbreviations: N/A = Not Available, dna = does not apply;
All costs presented are in thousands of US dollars ($1,000's) unless otherwise indicated.
Note: Engineering costs for Seminole and Markham are included in ASR capital costs

Table 8-3B ASR Cost Data, ASR Wells

Site Information					ASR Wells										Comments
Owner	Site	ASR Type	Site Capacity (mgd)	Capacity Cost Basis (mgd)	Cost Basis Year	No. of ASR Wells	Average Casing Diameter (in)	Average Casing Depth (feet)	Casing Material Type	Average Total Depth (feet)	Engineering Costs ($1000)	ASR Well Drilling Costs ($1000)	Total ASR Well Costs ($1000)	ASR Well Costs (2006 escalation, $1000)	Other Comments Pertaining to ASR Well Costs
City of Tampa	Rome Avenue Park	TSW	10	8.75	2000	7	16	300	CL	400	180	924	1105	1849	
	Enhanced Monitoring Program	TSW													
	Avon Park Well	TSW	4	4	2004	1	18	630	CS	700	94	180	274	234	
City of St. Petersburg	SW WRF	RW	1	1.35	2001	1	16	490	CS	600	99	216	316	389	
Englewood Water District	Englewood WWTP	RW	1.5	1.5	2000	1	18	507	CS	700	160	181	341	363	
PRMRWSA	Wellfield No. 2	TSW	12	12	1999	12	16	588	PVC	899	1201	1853	3054	4077	
	Enhanced Monitoring Program	TSW													
ACOE/SFWMD	Hillsboro Canal Pilot Well	PTS	5	5	2000	1	24	1015	CS	1215	50	310	360	620	
	Kissimmee River Pilot Well	PTS	5	5	2003	1	24	565	CS	875	62	550	612	770	
	Port Mayaca Well	PTS	5	5	2003	1	24	800	CS	1050	60	505	565	707	
Seminole County	Markham	TGW	1	1	2006	1	10.5	940	FRP	1070	898	366	1264	366	
Sanford	Auxiliary WTP	TGW	1	1	2006	1	16	530	FRP	630	628	350	977	350	
City of Bradenton	High Service Pump Station	TSW	2.6	2.6	2003	1	17.4	415	CL	505	250	140	390	196	Does not include $150k for Phase I studies

Legend:

ASR Type: Treated Surface Water (**TSW**); Treated Groundwater (**TGW**); Reclaimed water (**RW**); Partially Treated Surface Water (**PTS**)

Casing Type: Carbon Steel (CS); Certa-Lok (CL); Polyvinyl Chloride (PVC); Fiberglass Reinforced Pipe (**FRP**); Stainless Steel (**SS**)

Pump Type: Vertical Turbine (VT); Submersible (Sub)

Treatment Types: Filtration (F); Disinfection (D); pH Adjustment (**pH**)

Abbreviations: N/A = Not Available; dna = does not apply.

All costs presented are in thousands of US dollars ($1,000's) unless otherwise indicated.

Well Drilling Escalation Factors							
1999	2000	2001	2002	2003	2004	2005	2006
2.2	2.0	1.8	1.6	1.4	1.3	1.2	1.0

Table 8-3C ASR Cost Data, Monitor Wells

Site Information					Monitor Wells									Comments
Owner	Site	ASR Type	Site Capacity (mgd)	Capacity Cost Basis (mgd)	Cost Basis Year	No. of Monitor Wells	Avg Casing Depth (ft)	Average Total Depth (ft)	Casing Material Type	Engineering Costs ($1000)	MW Drilling Costs ($1000)	Actual Monitoring Well Costs ($1000)	Monitor Well Costs (2006 escalation) ($1000)	Other Comments Pertaining to Monitoring Well Costs
City of Tampa	Rome Avenue Park	TSW	10	8.75	2000	5	300	400	CL	70	308	378	617	Does not include water table monitoring wells.
	Enhanced Monitoring Program	TSW			2006	5	300	375	CL	113.4	356	470	356	
	Avon Park Well	TSW	4	4	2004	3	570	592	CL	19.8	194	213	257	
City of St. Petersburg	SW WRF	RW	1	1.35	2001	1	319	335	CL	20	53	73	95	
Englewood Water District	Englewood WWTP	RW	1.5	1.5	2000	3	5	320	CL	40.0	127	167	254	Does not include water table monitoring well.
PRMRWSA	Wellfield No. 2	TSW	12	12	1999	8	345	370	PVC	80	216	296	475	
	Enhanced Monitoring Program	TSW			2005	13	600	675	CL	180	870	1050	1044	
ACOE/SFWMD	Hillsboro Canal Pilot Well	PTS	5	5	2005	1	1020	1215	FRP	75	450	525	540	
	Kissimmee River Pilot Well	PTS	5	5	2006	2	563.5	1233	CS	170	970	1140	1426	The exploratory well (OKF-100) was constructed in 2001 at a cost of $570K. The well has 12" diameter CS casing set to 562' bls with an open hole from 562 to 1590' bls. There is a temporary inflatable packer at 1,350 that separate the poor quality below. The original nominal 8" borehole was drilled to 2,052' bls then back plugged to 1,650 feet bls. The USACE completed this well as a dual zone monitor well at additional costs.
	Fort Mayaca Well	PTS	5	5	2001	1	790	1490	CS	80	540	620	972	The exploratory well (MF-37) was constructed in 2001 at a cost of $540K. The well has 12" diameter CS casing set to 790' bls with an open hole from 790 to 1490' bls. There is a temporary inflatable packer at 1,490 that separate the poor quality below. The original nominal 8" borehole was drilled to 2,045' bls then back plugged to 1,650 feet bls. The USACE plans to install 4" casing to 1,490' bls and will cement it back to 1,050' bls, completing it as a dual zone monitor well.
Seminole County	Markham	TGW	1	1	2006	3	867	970	PVC	150	674	824	874	
Sanford	Auxiliary WTP	TGW	1	1	2006	3	595	695	PVC	150	580	730	580	
City of Bradenton	High Service Pump Station	TSW	2.8	2.8	2003	2	301.5	369	CL	60	135	195	189	Does not include water table monitoring well.

Legend:
ASR Type: Treated Surface Water (**TSW**), Treated Groundwater (**TGW**), Reclaimed water (**RW**), Partially Treated Surface Water (**PTS**)
Casing Type: Carbon Steel (CS), Certa-Lok (CL), Polyvinyl Chloride (PVC), Fiberglass Reinforced Pipe (**FRP**), Stainless Steel (**SS**)
Pump Type: Vertical Turbine (VT), Submersible (Sub)
Treatment Types: Filtration (F), Disinfection (D), pH Adjustment (pH)
Abbreviations: N/A = Not Available, **dna** = does not apply.

Well Drilling Escalation Factors							
1999	2000	2001	2002	2003	2004	2005	2006
2.2	2.0	1.8	1.6	1.4	1.3	1.2	1.0

All costs presented are in thousands of US dollars ($1,000's) unless otherwise indicated.

Table 8-3D ASR Cost Data, Facilities

Site Information					ASR Surface Facilities																Comments
Utility	Site	ASR Type	Site Capacity (mgd)	Capacity Cost Basis (mgd)	Cost Basis Bid Date	ASR Well Pumping Capacity (MGD)	ASR Well Pump Type	No. of ASR Well Pumps	Wellhead Appurtenances Costs ($1000)	Transmission Piping (1000 feet)	Transmission Piping Costs ($1000)	Wellfield Distribution Piping (1000 feet)	Wellfield Distribution Piping Costs ($1000)	ASR Electrical System Costs ($1000)	ASR Control System Costs ($1000)	ASR Recharge Treatment Facilities Type	ASR Recovery Treatment Facilities Type	Engineering Costs ($1000)	ASR Treatment Facilities Capacity (mgd)	ASR Treatment Facilities Costs	Total Surface Facilities Construction Costs	Other Comments Pertaining to ASR Facilities Costs
City of Tampa	Rome Avenue Park	TSW	10	8.8		14	Sub	7	1257	16	3000	10	500	160	272	None	Full	488	0	0	5677	
	Enhanced Monitoring Prog	TSW																			
	Avon Park Well	TSW	4	4		4	Sub	1	452.3	0	20	0	0	40	32	None	Full	125	0	0	669	
City of St. Petersburg	SW WRF	RW	1	1.4		1.35	Sub	1	157.3	0	0	0.3	30	30	30	None	F,D	75	0	0	322	
Englewood Water Dist	Englewood WWTP	RW	2	1.5		1	Sub	1	231.0	0	0	0.5	20	14	23	None	None	150	0	0	438	
PHMRWSA	Wellfield No. 2	TSW	12	12		12	VT	12	927.6	5	737	3	174	301	14	None	Full	362	0	0	2515	
	Enhanced Monitoring Prog	TSW																			
ACOE/SFWMD	Hilsboro Canal Pilot Well	PTS	5	5		0	N/A	0	1150	0	0	0	0	50	100	F,UV	None	300	5	1200	2800	No transmission costs assumed as they are pulling from the canal to the well (reverse for recovery) No wellhead distribution piping assumed (only one ASR well) The electrical and control $ is a rough estimate for construction only and doesn't include an electrical consultant to do all the programming (another $50K) ASR treatment facility cost – The UV units = $500K; and the filters = $500K. That doesn't include the peripheral stuff like piping, valves to control the UV and filters, so added another $200K to make it $1.2M total. The total construction contract ongoing right now (not including any wells) is $2.5M, so put the rest ($1.15M) in "Wellhead Appurtenances", but in this case – it's really more than that. This cost includes an intake discharge structure along the canal ($250K) and a personnel building ($200K)
	Kissimmee River Pilot Well	PTS	5	5		0	N/A	0	673		259		741	613	580	F,UV	None		5	1996	4862	Not a utility treatment facility (no pre-existing infrastructure); built from scratch. $700K needed for site preparation. Line AB includes cost for ASR wellhead equipment ($457K) and the actual wellhead structure ($116K). Line AD is what we call "Water Supply Well System" ($28K) plus buried yard piping, valves and appurtenances ($251K). This does not include wells. Line AF includes raw water intake and pump station ($541K), plus equipment ($200K) Line AG includes getting a primary power line to the site ($100K), site electrical work ($223K) plus the electrical enclosure ($290K) Line AH includes prefab operations building ($123K), plus site instrumentation and control work ($461K) Line AM includes backwash equalization pond and solids pond inlet structures ($5.5K), plus pressure filter ($155K), pressure filter equipment ($909K), and backwash decant pump station ($222K)
	Port Mayaca Well	PTS	5	5		0	N/A	0								F, UV	None		5		12000	The costs for the Port Mayaca system will be larger owing to its greater size (almost double that of KRASR). We only have a ballpark figure of $12M.
Seminole County	Markham	TGW	1	1		1	VT	1	136.2	2	302	1	108	105	105	0	D		1		755	
Sanford	Auxiliary WTP	TGW	1	1		1	VT	1	127.5	0	0	1	86	67	84	0	D		1		364	
City of Bradenton	High Service Pump Station	TSW	3	2.6		2.6	VT	1	202.2	0	0	0	0	40	125	None	D	150	3	75	593	Bid construction cost was lump sum for all work. Estimated cost of the WTP test/monitor well has been deducted from the final construction cost so that only HSPS costs are included. Issuance of operating permit is now on hold pending resolution of current arsenic issues that arose following Cycle 6 when City pumped out their buffer zone. Property line at 80 ft from ASR well

Legend:
ASR Type: Treated Surface Water (TSW); Treated Groundwater (**TGW**); Reclaimed water (**RW**); Partially Treated Surface Water (**PTS**)
Casing Type: Carbon Steel (**CS**); Certa Lok (CL); Polyvinyl Chloride (PVC); Fiberglass Reinforced Pipe (**FRP**); Stainless Steel (**SS**)
Pump Type: Vertical Turbine (VT); Submersible (Sub)
Treatment Types: Filtration (F); Disinfection (D); UV disinfection (**UV**); pH Adjustment (**pH**)
Abbreviations: N/A = Not Available; **dna** – does not apply;
All costs presented are in thousands of US dollars ($1,000's) unless otherwise indicated

Table 8-3E ASR Cost Data, O&M

Site Information						Annual O & M Costs																		Comments
Owner	Site	ASR Type	Site Capacity (mgd)	Capacity Cost Basis (mgd)	TOTAL ASR FACILITIES ACTUAL COSTS	ASR Well Rehabilitation Costs	ASR Well Testing Analytical Costs	Monitor Well Sampling Analytical Costs	Annual Sample Crew Days	Annual Maintenance Crew Days	Maintenance Labor Costs @$480/day	Annual Misc. Maintenance Costs	Nominal ASR Treatment Costs (Recharge)	Nominal ASR Treatment Costs (Recovery)	ASR Electrical Power Costs	Long-Term Recovery Percentage	Nominal Cost of Water Produced ($/1000 gal)	Cost of Water Left in Storage	Consulting costs (permitting, cycle testing)	Estimated Volume Stored Annually (MG)	TOTAL ANNUAL O&M COSTS PER MG ACTUAL STORED	TOTAL ANNUAL O&M COSTS	Other Comments Pertaining to ASR O&M Costs
City of Tampa	Rome Avenue Park	TSW	10	8.75	7160.5	1	42	52	52	13	52	10	0	500	100	100%	0.5	0	35	1000	0.792	791.6	
	Enhanced Monitoring Program	TSW																					
	Avon Park Well	TSW	4	4	1156.8															300			
City of St. Petersburg	SW WRF	RW	1	1.35	710.8	0	29	88	52	7	46.8	26	0	0	12	75%	0	0	51	120	1.942	233	
Englewood Water District	Englewood WWTP	RW	1.5	1.5	346.2	0	18	18	13	7	15.6	5	0	0	10	75%	0	0	30	100	0.918	91.8	
PRMRWSA	Wellfield No. 2	TSW	12	12	5865.2	50	100	50	130	12	114	5	0	630	100	85%	0.63	95	50	1000	1.193	1193	
	Enhanced Monitoring Program	TSW			1050.0																		
ACOE/SFWMD	Hillsboro Canal Pilot Well	PTS	5	5	3665.6															750			
	Kissimmee River Pilot Well	PTS	5	5	13752.0															750			
	Port Mayaca Well	PTS	5	5	1185.6															750			
Seminole County	Markham	TGW	1	1	2943.6															100			Did not account for $90,040 for estimated cost of startup and cycle testing, or $374,765 construction contingency. Total project cost estimate is $4,460,333
Sanford	Auxiliary WTP	TGW	1	1	2071.9															100			Did not account for $93,086 for startup and cycle testing, or $236,549 for construction contingency. Total project cost is $2,952,436
City of Bradenton	High Service Pump Station	TSW	2.6	2.6	1177.5																		

Legend:

ASR Type: Treated Surface Water (**TSW**), Treated Groundwater (**TGW**), Reclaimed water (**RW**), Partially Treated Surface Water (**PTS**)
Casing Type: Carbon Steel (**CS**), Certa-Lok (**CL**), Polyvinal Chloride (**PVC**), Fiberglass Reinforced Pipe (**FRP**), Stainless Steel (**SS**)
Pump Type: Vertical Turbine (**VT**), Submersible (**Sub**)
Treatment Types: Filtration (**F**), Disinfection (**D**), pH Adjustment (**pH**)

Abbreviations: NA = Not Available, dna = does not apply
All costs presented are in thousands of US dollars ($1,000's) unless otherwise indicated

Well Drilling Escalation Factors							
1999	2000	2001	2002	2003	2004	2005	2006
2.2	2.0	1.8	1.6	1.4	1.3	1.2	1.0

Data not available due to limited amount of operational testing, if any

Not relevant

Table 8-3F ASR Cost Data, Summary

Site Information					ASR Wells	Monitoring Wells	Surface Facilities	Total ASR System Costs	Annual O & M	
Owner	Site	ASR Type	Site Capacity (mgd)	Capacity Cost Basis (mgd)	Total ASR Well Costs ($1000)	Actual Monitoring Well Costs ($1000)	Total Surface Facilities Construction Costs ($1,000)	TOTAL ASR FACILITIES ACTUAL COSTS ($1,000)	TOTAL ANNUAL O&M COSTS PER 1M GAL STORED	TOTAL ANNUAL O&M COSTS ($1,000)
City of Tampa	Rome Avenue Park	TSW	10	8.75	$1,104.662	$378.410	$5,677.414	$7,160.486	$0.792	$791.600
	Enhanced Monitoring Program	TSW				$469.800		$469.800		
	Avon Park Well	TSW	4	4	$274.258	$213.316	$669.325	$1,156.899		
City of St. Petersburg	SW WRF	RW	1	1.35	$315.521	$73.000	$322.292	$710.813	$1.942	$233.000
Englewood Water Dist	Englewood WWTP	RW	1.5	1.5	$341.425	$166.920	$437.900	$946.245	$0.918	$91.800
PRMRWSA	Wellfield No. 2	TSW	12	12	$3,054.427	$295.920	$2,514.853	$5,865.200	$1.193	$1,193.100
	Enhanced Monitoring Program	TSW				$1,050.000		$1,050.000		
ACOE/SFWMD	Hillsboro Canal Pilot Well	PTS	5	5	$360.000	$525.000	$2,800.000	$3,685.000		
	Kissimmee River Pilot Well	PTS	5	5	$612.000	$1,140.000	$4,862.000	$6,614.000		
	Port Mayaca Well	PTS	5	5	$565.000	$620.000	$12,000.000	$13,185.000		
Seminole County	Markham	TGW	1	1	$1,264.214	$824.104	$755.241	$2,843.559		
Sanford	Auxiliary WTP	TGW	1	1	$977.473	$730.481	$363.920	$2,071.874		
City of Bradenton	High Service Pump Station	TSW	2.6	2.6	$390.000	$195.000	$592.540	$1,177.540		

8.3 Wellhead Facilities

Average cost of wellhead facilities is $444,000 per mgd of recovery capacity, within a broad range of $167,000 to $972,000. Bradenton, Tampa Avon Park, and St Petersburg anchor the low end of the range while Kissimmee, Seminole County, Tampa Rome Avenue and Hillsboro are at the high end of the range. The Tampa Rome Avenue cost included a long pipeline to convey recovered water back to the water treatment plant. If the cost of that pipeline is separated from the total, the unit cost falls below the average. The two projects for the Everglades CERP program (Kissimmee and Hillsboro) included pretreatment costs (filtration and UV disinfection) that accounted for almost half of the total wellhead facilities cost, substantially increasing unit capital costs for these two sites.

8.4 Total Capital Cost

Average total capital cost is $944,000 per mgd of recovery capacity, within a broad range of $303,000 to $1,795,000. For example, a best estimate of the cost for a 3-mgd ASR facility, including the ASR well, monitor wells and surface facilities, would be $2,832,000. However total cost may vary above or below this estimate, depending upon well yields and other site-specific opportunities and constraints. These costs are based upon data from each of nine survey wellfields, adjusted to costs in August 2006. Costs would need to be adjusted in the future to match changes in construction cost indices for future years.

The low end of the range is for the Tampa Avon Park ASR well, which included three monitor wells. The high end of the range is for the Seminole County ASR well, which also included 3 monitor wells. A significant part of the difference between the two sites is the yield of the Tampa ASR well being 4 mgd while the Seminole County ASR well yield is 1 mgd. For future ASR wells in the SFWMD, typical well yields are expected to occur within a range of 3 to 10 mgd. These are high capacity ASR wells. As a result unit capital costs for ASR in this part of Florida should tend toward the low end of the unit cost range.

Well construction costs comprise approximately one third of the total capital cost of ASR facilities. Well construction costs have increased rapidly in recent years, more than doubling between 2000 and 2006. This has occurred nationwide, not just in Florida as a consequence of cost increases in steel, cement, PVC and other materials. Other portions of the cost (surface facilities, engineering) have increased approximately 30 percent during that period. It is unknown whether well construction costs will continue to increase at the same rate in the near future.

During 2006, FDEP has established a policy requiring three monitor wells for each ASR site, typically two in the storage zone and one in the next overlying aquifer. This is in response to concerns regarding arsenic mobilization and attenuation in aquifers containing groundwater with ambient total dissolved solids (TDS) concentration up to 10,000 mg/l. Such aquifers are deemed to be drinking water sources. The

regulatory framework for ASR in Florida is still evolving. Extensive water quality data collected during the last few years at many ASR wellfields in Florida suggests that arsenic mobilization is localized around the ASR well, typically extending less than about 150 feet. It also attenuates with successive operating cycles and with formation of a buffer zone around the well. Based upon experience to date, the arsenic issue does not appear to be significant in the SFWMD or SJRWMD areas but is significant in the SWFWMD area. The formation of buffer zones around ASR wells is prevalent in the two former areas and is generally lacking in the SWFWMD area. Until such time as the regulatory framework is resolved, it is appropriate to assume that multiple monitor wells will be required for each ASR wellfield. As indicated elsewhere in this report, the associated cost is substantial. Monitoring requirements may increase or decrease in the future, probably depending upon the evolution of FDEP policy regarding where to measure compliance with drinking water standards, whether at the ASR wellhead or at a monitor well in the aquifer.

ASR wellfield facilities in the SWFWMD area average $0.64 million per mgd of recovery capacity. For SJRWMD the average is $1.54 million, reflecting relatively low well yields for the two selected projects and also the rather comprehensive approach being taken by the SJRWMD during development of the two ASR projects considered in this survey. The SJRWMD is paying essentially the full cost for these ASR Demonstration Program projects whereas SWFWMD is paying half the cost as part of cooperative funding arrangements with local utilities. It is likely that addition of data for the City of Cocoa third ASR wellfield expansion that occurred about 2001, adding four wells and about 4 mgd recovery capacity, would yield very low unit capital and operating costs; however, we were unable to obtain this data for the current survey. No pretreatment is required for SWFWMD and SJRWMD ASR projects since they are storing either treated drinking water or high quality reclaimed water.

For SFWMD the average unit capital cost is $1.24 million per mgd of recovery capacity. This is the average of Hillsboro and Kissimmee unit costs including ASR well and monitor well construction, plus surface facilities, updated to August 2006. This cost reflects the higher yields of wells in this part of Florida, offsetting the relatively high investment costs in wellhead and pretreatment facilities. These are both for CERP projects storing partially treated surface water. Pretreatment includes wellhead filtration and UV disinfection. If data for the Cities of Delray Beach or Boynton Beach, or for Marco Lakes, were added to the survey, unit capital costs for those sites would probably be lower, reflecting the relatively small capital investments and the relatively high yield of these ASR wells, two of which store treated drinking water. Until such time as data for these three water utilities may be added to the survey data base, a reasonable estimate is that unit costs for water utility ASR wellfields within SFWMD will cost about $1.0 million per mgd of recovery capacity while CERP ASR wells will cost about $1.25 million per mgd recovery capacity. The difference in unit cost is primarily attributable to the need for pretreatment of recharge water for CERP projects.

Some differences may be anticipated in ASR unit capital costs within the four planning areas of the SFWMD, reflecting variability in hydrogeology, well depths and well yields. Potential ASR storage zones along the southwest coast of Florida may tend to be lower yielding than those along the southeast coast. Consequently relatively higher unit costs may be anticipated in the southwestern planning areas.

For planning purposes, this analysis suggests an approximate statewide ASR unit capital cost of about $1.00 per gallon per day of recovery capacity. Compared to other water supply alternatives in Florida such as brackish water desalination, seawater desalination and reuse of reclaimed water, ASR storage of seasonally available water is cost-effective. Typical costs of alternative water supply sources now being developed in Florida are in the range of $3.00 to $10.00 per gallon per day of installed capacity.

8.5 ASR Operation and Maintenance Cost

Only four sites provided information on operation and maintenance costs. These averaged $106,000 per year per mgd of recovery capacity, within a range of $61,000 to $173,000. Labor costs were estimated based upon $800/day, following discussion with utility personnel. This rate includes labor costs plus an allowance for vehicle usage, materials and other overhead items relating to maintenance of ASR facilities. Electrical costs were based on assumed power charges of $0.10 per kilowatt-hour.

Results may be compared with those published in 1995 (Pyne, 1995), indicating a range of $5,000 to $40,000 per year per mgd of recovery capacity, with a best estimate of $15,000. The substantial increase primarily reflects the increasing cost of permit compliance in Florida, including collecting, analyzing and reporting water level, water quality and other data from the ASR well and an increasing number of monitor wells. This has been related to concern during the past five years regarding arsenic mobilization and attenuation during ASR storage.

As the newer ASR wells complete their cycle testing and become operational, monitoring requirements should reduce, possibly by as much as half. On the other hand, pre-and post-treatment requirements may increase both capital and operating costs. The key regulatory issue yet to be resolved is the point of compliance with drinking water standards, whether for arsenic, microbiota or any other constituent. Current FDEP policy is to allow no treatment in the ASR storage zone that would cause any elevation of arsenic or pathogen concentrations to exceed drinking water standards at any point in the aquifer, even for a brackish aquifer with total dissolved solids concentrations up to 10,000 mg/l. An alternative approach that is used in several other states for ASR permitting and is consistent with federal law (Safe Drinking Water Act, 1974) is to allow such natural treatment to occur in the aquifer close to the ASR well and to measure compliance with drinking water standards at one or more appropriately located monitor wells, typically a few hundred feet from the ASR well. These other states are regulating ASR operations in freshwater aquifers, not brackish aquifers. Eventual resolution of this important issue for Florida will

indicate the direction of ASR pre- and post treatment requirements, and therefore ASR capital and operating costs.

A second factor that will tend to reduce ASR operating costs is that as newer wells achieve their target storage volumes, recovery efficiencies will improve, probably approaching 100 percent for most of these wells. Most ASR wells in Florida that have been operating continuously for more than about five years have achieved close to 100 percent recovery efficiency. The operating costs associated with treating water that is not recovered in early cycles, or has to be retreated to meet regulatory requirements, is substantial. This cost will be reduced or eliminated once operating permits are issued and as storage volumes increase. Achieving full ASR recovery efficiency in Florida's brackish aquifers requires initial formation and maintenance of a buffer zone, separating the stored water from the ambient brackish groundwater. Relatively high initial operating costs at some Florida ASR wellfields are associated with the cost of water utilized for forming the buffer zone. Once the buffer zone is formed and maintained, this initial cost will typically decline or cease.

In highly saline storage zones where full recovery efficiency is not expected, some continuing loss of stored water will occur due to density stratification. For these sites, operating costs will tend to be higher. Density stratification is insignificant in aquifers containing ambient groundwater with total dissolved solids concentrations less than about 5,000 mg/l. Most Floridan aquifer ASR wellfields store fresh water in brackish aquifers with total dissolved solids concentrations below about 5,000 mg/l.

For planning purposes, a unit operation and maintenance cost estimate of about $100,000 per year per mgd of recovery capacity seems appropriate for planning purposes, excluding any cost for pre-treatment of the recharge water.

8.6 ASR Summary

ASR capital and operating costs have been assembled for 11 Florida ASR wellfields, representing a reasonable cross-section of geographic distribution, hydrogeologic conditions, flow rates and well depths. While some data gaps are evident, the data set supports conclusions regarding average unit capital and operating costs that might be applied to planned future water storage projects in Florida, and the factors that might cause actual costs to vary above and below the average costs.

Conclusions and recommendations are as follows:

- Total capital costs of ASR wells in Florida average about $944,000 per mgd of recovery capacity, within a range of $303,000 to $1,795,000. For planning purposes an estimate of $1.00 per gallon per day of recovery capacity is suggested as a statewide average, plus or minus about 50 percent.

- Operation and maintenance costs average $106,000 per year per mgd of recovery capacity, within a range of $61,000 to $173,000. For planning purposes a reasonable cost estimate is $100,000 per year per mgd of recovery capacity.

- Typical ASR capital costs vary around Florida, as follows: SWFWMD - $0.54 million per mgd of recovery capacity; SJRWMD - $1.54 million; SFWMD - $1.24 million. Within the SFWMD, water utility ASR unit costs are expected to cost about $1.0 million per mgd of recovery capacity. It is possible that ASR unit capital costs in southwest Florida may be slightly greater than in southeast Florida, reflecting generally lower yields of potential ASR storage zones in southwest Florida.

- ASR costs have increased during the past five years, however, so have the costs of other water supply alternatives. ASR costs are still typically less than half the cost of other water supply alternatives.

- Within Florida, useful additional data may be obtained from ASR wellfield facilities for the City of Cocoa completed within the last five years, plus for the City of Delray Beach, Marco Island, and Port Mayaca.

Section 9
Capital and O&M Costs for the Development of Surface Water Storage

Capital and O&M costs for various SFWMD reservoirs are shown in **Tables 9-1** and **9-2**. The source of this information is the Acceler8 Progress Report, October 2006, except for the Tampa Bay Water's Surface Water Treatment Plant Reservoir. The Tampa Bay Water Reservoir is the only existing reservoir. Reservoir costs are estimated costs based on the current level of design for the projects and may change in the future.

Table 9-1 Reservoir Construction Costs

Storage Reservoir	Site 1 Impoundment [1]	C-44 [1]	C-43 [1]	Tampa Bay Water Reservoir [2]	C-9 Impoundment [1]	C-11 Impoundment [1]	EAA Reservoir [1]	Taylor Creek [1,4]
Design Cost	$6,566,991	$21,301,065	$12,749,672	$24,424,880	$7,565,303	$7,330,204	$16,790,481	$5,916,938
Interim Land Management Cost	$30,000	$2,467,414	$2,184,222	--	$57,551	$611,558	$485,465	$337,500
Construction Cost	$34,700,000	$316,000,000	$320,776,156	$175,561,971	$50,600,000	$77,600,000	$482,900,000	$116,115,520
Total Capital	$41,296,991	$339,768,479	$335,710,050	$199,986,851	$58,222,854	$85,541,762	$500,175,946	$122,369,958
Total Area (acres)[5]	1,660	12,657	10,489 [3]	980	1,804	1,790	16,414	4,785
Estimated Depth of Water (feet)	8	15	20 [3]	49	4	4	12	7
Estimated Storage Capacity (acre-feet)	13,280	50,200	170,000	47,570	6,600	5,960	190,000	32,000
Unit Capital Cost ($/acre-foot)	$3,110	$6,768	$1,975	$4,204	$8,822	$14,353	$2,633	$3,824

Notes:

1) Acceler8 Progress Report, October 2006. Costs are in October 2006 dollars. Total area is the total area of land acquired for the project, not the area of the reservoir.

2) Bid Comparison Worksheets, Tampa Bay Water Master Plan South Section, Tampa Bay Regional Reservoir Project/Reservoir Transmission Main Project

3) Phone correspondence with LuAnn McVicker, Project Manager, Acceler8 on November 13, 2006. Nominal depth of reservoir is 20 feet. Actual depths range from 15 feet to 25 feet.

4) Construction cost from latest version of Basis of Design Report, Opinion of Probable Construction Cost, 15% Design, October 2006. Cost is for Alternative 2-B with a reservoir footprint of 2,010 acres.

5) Total area is total area for the project but reservoir area may be a smaller footprint.

Table 9-2 Reservoir O&M Costs

Storage Reservoir	Site 1 Impoundment [1]	C-44 [1]	C-43 [1]	Tampa Bay Water Reservoir [2]	C-9 Impoundment [1]	C-11 Impoundment [1]	EAA Reservoir [1]	Taylor Creek [1]
Vegetation Control	$70,209	$495,596	$454,296	--	$74,505	$74,876	$689,704	--
Pump Station Power	$580,776	$774,368	$580,776	--	$503,339	$774,368	$1,548,736	--
Pump Station Mechanical Maintenance	$61,949	$77,437	$61,949	--	$61,949	$77,437	$123,899	--
Structure Maintenance	$260,188	$334,527	$260,188	--	$260,188	$260,188	$334,527	--
Embankment Maintenance	$86,729	$148,679	$204,433	--	$86,729	$124,931	$260,188	--
Pump Station Staff	$412,996	$412,996	$412,996	--	$412,996	$412,996	$825,993	--
Total Annual O&M Cost	$1,472,848	$2,243,603	$1,974,639	$3,463,195	$1,399,707	$1,724,797	$3,783,047	---
Total Area (acres)	1,660	12,657	10,489 [3]	980	1,804	1,790	16,414	4,785
Estimated Depth of Water (feet)	8	15	20 [3]	49	4	4	12	7
Estimated Storage Capacity (acre-feet)	13,280	50,200	170,000	47,570	7,216	7,160	190,000	32,000
Unit O&M Cost per ac-ft ($/ac-ft)	$111	$45	$12	$73	$194	$241	$20	--

Notes:

1) "Opinion of Annual Operation and Maintenance Costs," Acceler8 Program, SFWMD

2) O&M costs is the proposed Fiscal Year 2007 Budget which includes operation staff contract, security, mowing, water quality monitoring, electricity, chemicals, engineering , regulatory oversight, surveying, mitigation/ecological monitoring, and mitigation maintenance. Cost is in August 2006 dollars.

3) Phone correspondence with LuAnn McVicker, Project Manager, Acceler8 on November 13, 2006. Nominal depth of reservoir is 20 feet. Actual depths range from 15 feet to 25 feet.

4) Total area is total area for the project but reservoir area may be a smaller footprint.

Section 10
Opinion of Probable Pipeline Costs

Bid Tabs from recently awarded projects in the City of Fort Lauderdale in 2005 and 2006 were used as the primary source to develop a unit cost for ductile iron pipe (DIP) on a dollars per 1 (one) linear foot (LF) basis. Unit prices include: transporting, storing, furnishing, and installing the pipe, removal and disposal of small trees and brush, excavation, dewatering, pipe bedding, backfilling and compaction, cleaning, and testing. Additionally, results from this analysis were compared to bid tabs from jobs being awarded in Dania Beach (May 2006), the City of Clewiston, and the Palm Beach County Lake Region Water Treatment Plant.

Unit prices from six different contractors were taken into consideration for development of an opinion of probable pipeline costs based on the bid tabs from the City of Fort Lauderdale. However, prices from two contractors were significantly different than from the other contractors, so they were eliminated from the analysis. Additionally, prices for long runs of pipes were taken into consideration. Several bid tabs contained unit prices for relatively short runs of pipe (approx. 100 ft), making them higher than for longer runs of pipe. In order to have representative numbers, only unit prices for long runs of pipe were taken into consideration to calculate average values.

RSMeans CostWorks 2007 software (http://www.rsmeans.com/bookstore) was used to corroborate results obtained form the analysis of the Tabs. In addition, a leading manufacturer was also contacted to verify the most current prices of DIP pipe. Information on the average increase of raw material was obtained from the vendor and will need to be taken into consideration for long-term planning cost estimation.

The Cost of Pipe presented in **Table 10-1** represents the cost of 1LF of restrained DIP pipe (not installed). Bid Tabs Total is the cost of 1LF of installed, restrained DIP Pipe based on the bid tabs. RS Means Total represents the cost of 1LF of installed, restrained DIP Pipe based on the RSMeans from the South Florida Area. Cost of Pipe Percent Total shows the ratio of cost of raw material (DIP Pipe) to the Total Cost derived from the Bid Tabs. The Cost of Installation is the difference between the Bid Total Cost and the Cost of Pipe.

Table 10-1 Results of the Analysis for Year 2006 Based on the Bid Tabs and RSMeans CostWorks Software Evaluation

Diameter	COST OF PIPE ($)	BID TABS TOTAL ($)	RSMEANS TOTAL ($)	Cost of Installation ($)	Cost of Pipe % TOTAL
16-inch	43.10	95.00	82.25	51.90	43.83
20-inch	57.90	106.92	99.55	49.02	54.15
24-inch	79.25	184.33	129.25	105.08	42.99
30-inch	112.95	235.00.[1]	162.95	122.05	48.06

Note [1] – number obtained from the extrapolation based on the prices of 16, 20 and 24-inch pipe

Based on the conversation with the pipe manufacturer, a 12-percent increase per year in the material cost (DIP pipe) should be used for estimating planning level costs of the installation of DIP pipe for the future.

It is assumed that due to the high unit prices for installation of 1LF of DIP pipe presented in Table 10-1, they are considered to be typical for URBAN settings. Cost from the Bid Tabs presented in Table 10-1 will be used as a baseline to derive costs for SUB-URBAN and RURAL settings.

The major factor distinguishing the price for URBAN, SUB-URBAN and RURAL is the cost of installation of pipe. Cost of installation for each diameter for URBAN settings is presented in Table 10-1.

It is assumed that three times more pipe per unit time is being laid out in the RURAL settings. As the productivity in the RURAL settings is three times higher, the cost of the installation on 1LF basis is three times lower. **Table 10-2** presents the costs of installation of DIP pipe for each setting (URBAN, SUB-URBAN and RURAL).

Table 10-2 Cost of Installation of Pipe for Various Settings (Urban, Sub-urban, and Rural) per 1 LF

Diameter	COST OF PIPE ($)	Cost of Installation of 1LF of DIP Pipe ($)	Cost of Installation of 1LF of DIP Pipe ($)	Cost of Installation of 1LF of DIP Pipe ($)
		URBAN	SUB-URBAN	RURAL
16-inch	43.10	51.90	34.60	17.30
20-inch	57.90	49.02	32.68	16.34
24-inch	79.25	105.08	70.05	26.42
30-inch	112.95	122.05	81.37	40.68

Table 10-3 below summarizes the cost of pipe and cost of installation for each diameter for each setting.

Table 10-3 Cost of Installation of Pipe for Various Settings (Urban, Sub-urban, and Rural) per 1 LF

Diameter	COST OF PIPE ($)	Total Cost of installed DIP Pipe ($)	Total Cost of installed DIP Pipe ($)	Total Cost of installed DIP Pipe ($)
		URBAN	SUB-URBAN	RURAL
16-inch	43.10	95	78	60
20-inch	57.90	107	91	74
24-inch	79.25	184	149	106
30-inch	112.95	235	194	154

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Appendix A
Bid Tabulation for Floridan Aquifer Wells at the Palm Beach County Lake Region Water Treatment Plant

LAKE REGION WATER TREATMENT PLANT TEST PRODUCTION WELLS
BID OPENING JUNE 10, 2004 AT 2:00 PM
PROJECT 03-169

				Southeast Drilling		Jaffer Associates		A. C. Schultes of Florida	
Item #	Description	Quantity	Unit	Unit Price	Total	Unit Price	Total	Unit Price	Total
1	Test Production Wells TP-1 & TP-2	-	Lump Sum	-	$900,000.00	-	$875,000.00	-	$824,000.00
2	Up to 6 additional wells PW-3 through PW-8	6	Each	$341,500.00	$2,049,000.00	$360,500.00	$2,163,000.00	$370,000.00	$2,220,000.00
3	Well Acidification - up to 8 wells	8	Each	$15,000.00	$120,000.00	$11,250.00	$90,000.00	$15,000.00	$120,000.00
4	Stage 1 Early Completion Bonus	30	Days	$1,000.00	$30,000.00	$1,000.00	$30,000.00	$1,000.00	$30,000.00
5	Stage 2 Early Completion Bonus	30	Days	$500.00	$15,000.00	$500.00	$15,000.00	$500.00	$15,000.00
6	Contract Allowances 01020			$25,000.00	$25,000.00	$25,000.00	$25,000.00	$25,000.00	$25,000.00
7	Indemnification			$20.00	$20.00	$20.00	$20.00	$20.00	$20.00
	TOTAL BID			**$3,139,020.00**		**$3,198,020.00**		**$3,234,020.00**	

				Diversified Drilling		All Webb's Enterprises	
Item #	Description	Quantity	Unit	Unit Price	Total	Unit Price	Total
1	Test Production Wells TP-1 & TP-2	-	Lump Sum	-	$1,374,132.00	-	$1,500,000.00
2	Up to 6 additional wells PW-3 through PW-8	6	Each	$637,394.00	$3,824,364.00	$666,666.00	$3,999,996.00
3	Well Acidification - up to 8 wells	8	Each	$15,000.00	$120,000.00	$21,000.00	$168,000.00
4	Stage 1 Early Completion Bonus	30	Days	$1,000.00	$30,000.00	$1,000.00	$30,000.00
5	Stage 2 Early Completion Bonus	30	Days	$500.00	$15,000.00	$500.00	$15,000.00
6	Contract Allowances 01020			$25,000.00	$25,000.00	$25,000.00	$25,000.00
7	Indemnification			$20.00	$20.00	$20.00	$20.00
	TOTAL BID			**$5,388,516.00**		**$5,738,016.00**	

Appendix B
Bid Tabulation for Installation of Pumps and
Other Work on Floridan Aquifer Wells at the
Palm Beach County Lake Region Water Treatment Plant

Bid Tabulation
Lake region Wellfield Improvement
Project No. WUD 03-169

Bid Opened 8/06

				Southeast Drilling Services		Poole & Kent Co.	
Bid Item	Description	Quantity	Unit	Unit Price	Total	Unit Price	Total
1	Install Pumps PW1 to PW-7	7	Each	$492,000.00	$3,444,000.00	$565,142.86	$3,956,000.00
2	Electrical & instrumentation for master meters	1	Lump	$275,000.00	$275,000.00	$300,000.00	$300,000.00
3	Mechanical, electrical and Instrumentation for remote storage tanks	1	Lump	$900,000.00	$900,000.00	$500,000.00	$500,000.00
4	FP&L Allowance	1	Lump	$200,000.00	$200,000.00	$200,000.00	$200,000.00
5	Substantial Completion Bonus	30		$1,000.00	$30,000.00	$1,000.00	$30,000.00
6	Final Completion Bonus	30		$500.00	$15,000.00	$500.00	$15,000.00
7	Contract Allowance	1	Lump	$25,000.00	$25,000.00	$25,000.00	$25,000.00
				Total	**$4,889,000.00**	**Total**	**$5,026,000.00**

Appendix C
Seacoast Utilities Authority
2006 Bid Sheet for a Floridan Aquifer Test Production Well

SEACOAST UTILITY AUTHORITY

FLORIDAN AQUIFER TEST WELL NO. 1 CONSTRUCTION

BID NO: 06424-W

BID OPENING: 12, JULY 2006
2:00 P. M.

4200 Hood Road
Palm Beach Gardens, FL 33410-2198
(561) 627-2900

BID SCHEDULE A

Project Title: Seacoast Floridan Aquifer Test Well No. 1

ITEMS

MOBILIZATION/DEMOBILIZATION (FOR ENTIRE PROJECT)

1.0 For complete Mobilization (60%) and Demobilization (40%) including all manpower, drill rig, tanks, pumps, piping, tools and accessories required to construct, develop and test Floridan Aquifer Test Well (No. 1) as described herein.

Lump Sum Price of $ 145,883.

FLORIDAN AQUIFER TEST WELL NO. 1 CONSTRUCTION

2.0 For providing all equipment, material, tankage, pumps, piping, wellhead flange, pollution control devices, treatment and labor necessary to construct, develop, and test Floridan Aquifer Test (Production) Well No. 1 including construction of the well, development and testing, and furnishing and installing wellhead and fittings according to the specifications.

The price called for in this bid includes all labor and equipment necessary to drill a nominal 32-inch diameter hole to 400 feet with formation sampling and geophysical logging; set/grout a 26-inch diameter steel surface casing to 400 feet; drill a nominal 12-inch diameter pilot hole to 975 feet with formation sampling and geophysical logging; ream a 26-inch-diameter hole to 975 feet; center; set, and cement 725 feet of 20-inch diameter from 250 feet to 975 feet, 0.375-inch wall thickness steel casing; extend the nominal 12-inch diameter pilot hole to 1750 feet while collecting flow test data, formation samples and with geophysical logging; perform 5 inflatable packer tests; ream a nominal 20-inch diameter hole to 1650 feet while collecting flow test data; install, center, set and grout 1000 feet of 12-inch diameter PVC pipe and 200 feet of 16-inch diameter PVC pipe, perform temperature log on first 5 stages of grouting; develop well for 90 hours; conduct 4-hour step-rate pumping test and 12-hour constant-rate pumping test (106 hours total) and 8 hours of water level recovery; provide for solids handling tankage at the well site; provide for 100 hours standby time; provide for the equipment and perform ten (10) silt density index tests, furnish and install permanent well head flange and blind flange assembly; provide for a total of 4,580 cubic feet of cement installed; provide temporary tankage with regulatory approvals; provide for a $50,000 bid allowance within this well cost; all in accordance with the specifications.

Base Bid Price of $ 665,095

(Items 1.0 through 2.0 inclusive)
Total Base Bid Amount in Words: EIGHT HUNDRED TEN THOUSAND NINE HUNDRED AND SEVENTY EIGHT DOLLARS AND ZERO CENTS

UNIT PRICE ADJUSTMENTS

2.1

Bid Item Number	Contract Description	Unit	Unit Price	Contract Quantity	Contract Cost
2.11	Drill 32" borehole to 400' bpl	feet	78	400	31,200
2.12	Furnish and install 26" casing to 400' bpl	feet	161	400	64,400
2.13	Furnish and install cement & additives -26"	cubic feet	20	1330	26,600
2.14	Drill 12" diameter pilot hole to 975' bpl	feet	55	575	31,625
2.15	Ream nominal 26" borehole from 400' to 975'	feet	67	575	38,525
2.16	Furnish and install 20" casing to 975' bpl	feet	89	725	64,525
2.17	Furnish and install cement & additives - 20"	cubic feet	20	1310	26,600
2.18	Drill 12" diameter pilot hole to 1750' bpl	feet	55	775	42,625
2.19	Perform more or less than 5 inflatable packer tests	each	9500	5	47,500
2.20	Ream nominal 20" borehole from 975' to 1,650' bpl	feet	55	675	37,125
2.21	Furnish and install 1,000' of 12.75-inch O.D. PVC casing per Specifications	feet	75	1000	75,000
2.22	Furnish and install 200' of 16-inch O.D. PVC casing per Specifications	feet	100	200	20,000
2.23	Furnish and install cement & additives – 12.75"/16"	cubic feet	20	1940	38,800
2.24	More or less than 90 hours of well development	hour	340	90	30,600
2.25	Formation acidization procedure	each	25,000	1	25,000
2.26	More or less than 16 hours of pumping tests	hour	500	16	8,000
2.27	More or less than 10 Silt Density Index Tests	each	150	10	1,500
2.28	More or less than one television survey of the completed well	each	2,970	1	2,970
2.29	More or less than 100 hours of Standby Time	hour	25	100	2,500
2.30	Bidding allowance	each	50,000	1	50,000
2.31	Additional cement (>base bid amount of 4,580 cu ft)	cubic feet	20	1000	20,000

SCHEDULE OF SUPPLIERS, EQUIPMENT AND MATERIALS

List Suppliers and Manufacturers to be used on the Project

DESCRIPTION	SUPPLIER	MANUFACTURER	MODEL
16" Certa-Lok	Hajoca	Certainteed	SDR 17
12" Certa-Lok	Hajoca	Certainteed	SDR 17
Ball Valve	Hajoca	Flowserve	Series 45

Failure to utilize suppliers, equipment and manufacturers listed in the Technical Specifications shall be cause for Bid rejection.

Appendix D
Probable Cost of Two Floridan Aquifer Wells at the City of Ft. Lauderdale Peele-Dixie Water Treatment Plant

City of Fort Lauderdale - Peele-Dixie WTP FAS Test Production Wells

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

City Project No.: P10485, H&S Project No.: 43000-009

Item No.	Item Description	COST ESTIMATE - 95% DESIGN			
		Quantity	Unit	Unit Price	TOTAL
	TEST / PRODUCTION WELL FAS-1				
1	Mobilization	1	lump sum	$ 125,000	$ 125,000
2	Drilling pad, pit pipe	1	lump sum	$ 10,000	$ 10,000
3	8" pilot 1,030-1,100'	70	feet	$ 115	$ 8,050
4	Drill 42" hole 0-150'	150	feet	$ 50	$ 7,500
5	Drill 36" hole150-1,030'	880	feet	$ 50	$ 44,000
6	Ream 28" borehole1,030-1,200'	70	feet	$ 50	$ 3,500
7	Ream 20" borehole1,200-1,400'	200	feet	$ 50	$ 10,000
8	Suite 1: 42" borehole Cal. And Gamma, 150'	1	lump sum	$ 10,000	$ 10,000
9	Suite 2: 36" borehole Cal. And Gamma, 880'	1	lump sum	$ 6,000	$ 6,000
10	Suite 3: 8" pilothole Caliper, gamma ray, dual induction, sonic w/VDL and under static and flowing conditions – temperature, fluid resistivity and flowmeter, 370'	1	lump sum	$ 20,000	$ 20,000
11	Suite 4: 28" borehole Cal. And Gamma, 170'	1	lump sum	$ 4,000	$ 4,000
12	Suite 5: 20" borehole Cal. and Gamma, 200'	1	lump sum	$ 4,000	$ 4,000
21	Install 36" casing	150	feet	$ 70	$ 10,500
22	Cementing 36-inch casing	600	sacks	$ 6	$ 3,600
23	Install 28" casing	1,030	feet	$ 70	$ 72,100
24	Cementing 28-inch casing	4,500	sacks	$ 6	$ 27,000
25	Install 20" casing/tubing	1,200	feet	$ 150	$ 180,000
26	Cementing 20-inch casing	4,000	sacks	$ 6	$ 24,000
27	Plug back pilot hole	1	lump sum	$ 5,000	$ 5,000
28	Continous coring & analyses 1,100'-1,400' Payment contingent upon % of core recovered	300	foot	$ 300	$ 90,000
29	Packer test 1,000'-2,000'	8	each	$ 13,000	$ 104,000
30	Well development	1	lump sum	$ 9,000	$ 9,000
31	Acidization	1	lump sum	$ 1,000	$ 1,000
32	Step drawdown test	1	lump sum	$ 3,000	$ 3,000
33	Standby time (rig and crew on site)	10	hour	$ 100	$ 1,000
34	Standby time (rig and crew off site)	10	hour	$ 50	$ 500
35	For extra work (drilling rig and crew)	10	hour	$ 200	$ 2,000
36	For extra work (crew and pump hoist)	10	hour	$ 100	$ 1,000
37	For extra work by crew	10	hour	$ 50	$ 500
38	Demobilizaiton	1	lump sum	$ 20,000	$ 20,000
	SUB-TOTAL				**$ 806,250**

City of Fort Lauderdale - Peele-Dixie WTP FAS Test Production Wells

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST

City Project No.: P10485, H&S Project No.: 43000-009

Item No.	Item Description	COST ESTIMATE - 95% DESIGN			
		Quantity	Unit	Unit Price	TOTAL
	TEST / PRODUCTION WELL FAS-2				
39	Mobilization	1	lump sum	$ 114,000	$ 114,000
40	Drilling pad, pit pipe	1	lump sum	$ 10,000	$ 10,000
41	Drill 34" 0-150'	150	feet	$ 80	$ 12,000
42	Drill 28" 150-1200'	1,050	feet	$ 75	$ 78,750
43	8" pilot 1,200-1,400'	200	feet	$ 115	$ 23,000
44	Drill 20" 1,200-1,400'	200	feet	$ 50	$ 10,000
45	Suite 6: 34" borehole Cal. And Gamma, 150'	1	lump sum	$ 2,000	$ 2,000
46	Suite 7: 28" borehole Cal. And Gamma, 1050'	1	lump sum	$ 5,000	$ 5,000
47	Suite 8: 8" pilothole Caliper, gamma ray, dual induction, sonic w/VDL and under static and flowing conditions – temperature, fluid resistivity and flowmeter, 200'	1	lump sum	$ 2,000	$ 2,000
48	Suite 9: 20" borehole Cal. and Gamma, 200'	1	lump sum	$ 4,000	$ 4,000
49	Install 28" casing	150	feet	$ 70	$ 10,500
50	Cementing 28-inch casing	450	sacks	$ 6	$ 2,700
51	Install 20" casing	1,200	feet	$ 150	$ 180,000
52	Cementing 20-inch casing	4,000	sacks	$ 6	$ 24,000
53	Plug back borehole	1	lump sum	$ 5,000	$ 5,000
54	Well development	1	lump sum	$ 9,000	$ 9,000
55	Acidization	1	lump sum	$ 1,000	$ 1,000
56	Step drawdown test	1	lump sum	$ 3,000	$ 3,000
57	Standby time (rig and crew on site)	10	hour	$ 100	$ 1,000
58	Standby time (rig and crew off site)	10	hour	$ 50	$ 500
59	For extra work (drilling rig and crew)	10	hour	$ 200	$ 2,000
60	For extra work (crew and pump hoist)	10	hour	$ 100	$ 1,000
61	For extra work by crew	10	hour	$ 50	$ 500
63	Demobilizaiton	1	lump sum	$ 50,000	$ 50,000
64	Plugging and Abondonment of PW-16 and 18	1	lump sum	$ 90,000	$ 90,000
	SUB-TOTAL				$ 640,950
65	**PERMIT FEE ALLOWANCE**				**$ 10,000**
66	**INDEMNIFICATION**				**$ 25**
	SUB TOTAL WELLS AND ALLOWANCES				**$ 1,447,200**
	20% CONTINGENCY				**$ 289,440**
	TOTAL				**$ 1,736,640**

Appendix E
July 2006 Bid Tabulation for Palm Beach County
Well Rehabilitation of 40 Wells over a Two-Year Period

Bid Prices
WUD 06-084
Wellfield Rehabilitation Continuing Construction Contract from
Southeast Drilling Services

Well Rehabilitation for 40 wells for two years
Bid tab opened July 2006

Item No.	Description	Quan-tity	Unit	Unit Price	Amount
1	Mobilization/demobilization - System 3W	1	EA	$15,000.00	$15,000.00
2	Mobilization/demobilization - System 9W	1	EA	$15,000.00	$15,000.00
3	Mobilization/demobilization - System 2W	1	EA	$15,000.00	$15,000.00
4	Mobilization/demobilization - System 8W	1	EA	$15,000.00	$15,000.00
5	Well location charge	40	EA	$1,500.00	$60,000.00
6	Set up pump testing equipment	40	EA	$2,000.00	$80,000.00
7	Initial specific capicity/wire to water test	40	EA	$400.00	$16,000.00
8	Remove fencing and reinstall fencing to original condition	36	EA	$1,000.00	$36,000.00
9	Remove pump, column pipe, and well pump with motor	40	EA	$1,200.00	$48,000.00
10	Clean casing	40	EA	$1,600.00	$64,000.00
11	Set up video survey	40	EA	$300.00	$12,000.00
12	Video survey	40	EA	$1,000.00	$40,000.00
13	Well development and removal of reh debris by airlift	2000	HR	$150.00	$300,000.00
14	Re-install piping, pump motor, pump; set up final well testing	40	EA	$1,000.00	$40,000.00
15	Final specific capacity	40	EA	$300.00	$12,000.00
16	Disinfect well	40	EA	$700.00	$28,000.00
17	Bacteriological testing	800	EA	$60.00	$48,000.00
18	Acidization equipment mobilization	12	EA	$300.00	$3,600.00
19	Acidize well	24,000	GAL	$6.00	$144,000.00
20	Add Gravel pack	100	CY	$470.00	$47,000.00
21	Chlorination equipment mobilization	40	EA	$350.00	$14,000.00
22	Chlorinate well	10,000	GAL	$0.35	$3,500.00
23	Jetting equipment mobilization	10	EA	$290.00	$2,900.00
24	Jet Well	10	EA	$1,700.00	$17,000.00
25	Additional work not included in above items	1	EA	$100,000.00	$100,000.00
	TOTAL BASE BID FOR ITEMS 1 - 25 INCLUSIVE:				$1,176,000.00

Appendix F
O&M Costs for the Tampa Bay Water Surface Water Treatment Plant

Chemical and Electrical Use

The total cost for all chemicals was $131.13 per million gallons ($0.13/1000 gal) and the average electric usage for the year was 24,489 kwhr/day.

Chemical Usage

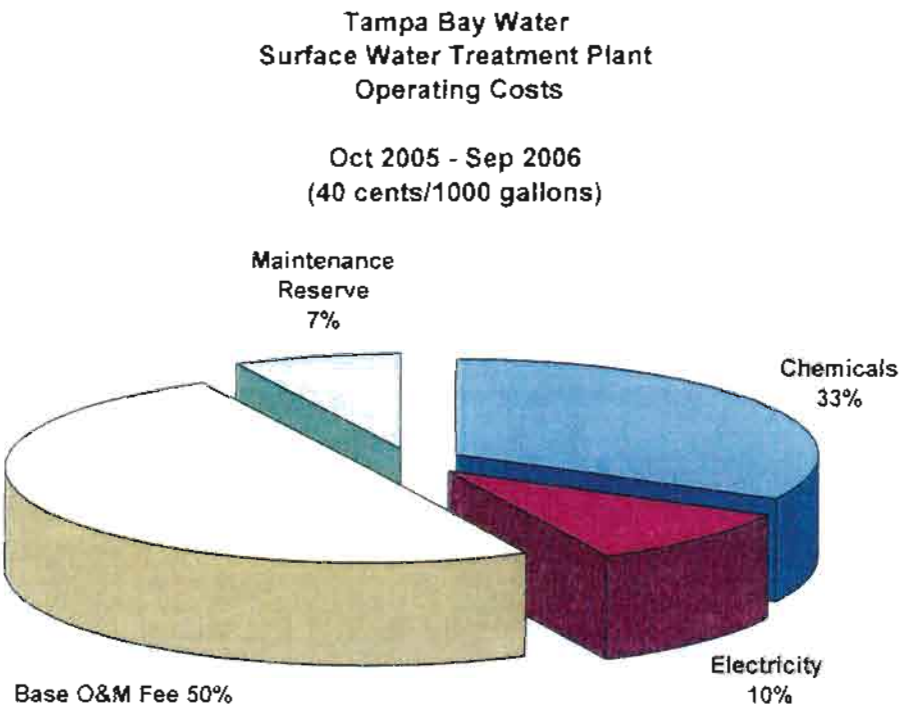
Chemical	Unit Price ($/lb active)	Contract Amount Max Use (lb/mgal)	Contract Amount Max Cost ($/Mgal)	Contract Amount Avg Use (lb/mgal)	Contract Amount Avg Cost ($/Mgal)	Actual Use Delivery (lb/mgal)	Actual Use Cost ($/Mgal)
Sulfuric Acid	0.02	792.3	15.8	625.5	12.5	713.6	14.3
Ferric Sulfate	0.10	792.3	79.2	625.5	62.6	576.6	57.7
Actiflo Polymer	1.28	6.3	8.1	6.3	8.1	8.0	10.3
Lime for pH adjustment	0.07	517.1	36.2	333.6	23.4	449.7	31.5
Sodium Hydroxide	0.22	10	2.2	8.3	1.8	4.9	1.1
Filter Aid Polymer	1.28	6.3	8.1	6.3	8.1	0.3	0.4
Phosphoric Acid	NA	0.8	0.0	0.8	0.0	-	0.0
Hydrogen Peroxide	NA	1.7	0.0	0.0	0.0	-	0.0
Liquid Oxygen	0.04	367	14.7	333.6	13.3	301.5	12.1
Microsand	0.03	8	0.2	8.0	0.2	42.7	1.3
Recycle Treatment Polymer	1.54	0.2	0.3	0.2	0.3	0.2	0.3
Sludge Dewatering Polymer	1.55	1.5	2.3	1.0	1.6	1.5	2.3
Total ($/Mgal)			**$167.15**		**$131.81**		**$131.13**

Operation and Maintenance Costs for Tampa Bay Water Surface Water Treatment Plant

The cost to operate and maintain the surface water treatment plant during this fiscal year was $6.26 million at an average day pumpage of 42.7 million gallons per day. This cost includes chemical and electrical costs, which are paid directly by Tampa Bay Water to the respective chemical vendors and utility company (TECO). Electrical costs are $0.0715 kW-hr.

The Service Fee to Veolia Water includes all labor, repair and maintenance, bonds and insurance, laboratory testing, vehicles and the maintenance reserve accounts. The reserve accounts are intended for replacement of the Granular Activated Carbon Filters and Major Equipment Renewal. Any funds remaining in these accounts at the end of the contract will be turned over to Tampa Bay Water.

In summary, the unit cost to operate and maintain the facility is 40 cents per thousand gallons of water treated, as shown below.



Appendix G
MBR Plants and Construction Costs

Appendix G. MBR Plants and Construction Costs

Process	Projects	Location	New/Upgrade	Project Status	Original Cost Year	ENR (CCI)	Capacity Annual Average (MGD)	Construction Bid Amount ($)	Amount Adjusted to Current Prices ($)	Unit Cost per kgal	Unit Cost per gal	Reference	Comment
MBR													
1	Cohassett	Massachusetts, USA	Upgrade	Operating	Jun-99	6039	0.4	5,000,000	6,393,443	$ 15,984	$ 15.98	1	a
2	Corona	California, USA	New	Operating	Jun-00	6238	1.1	9,000,000	11,141,071	$ 10,128	$ 10.13	1	
3	Key Colony Beach	Florida, USA	New	Operating	Jun-97	5860	0.4	3,000,000	3,953,242	$ 9,883	$ 9.88	1	b
4	American Canyon	California, USA	New		Jun-99	6039	2.5	15,500,000	19,819,672	$ 7,928	$ 7.93	2	
5	Cauley Creek	Georgia, USA	New	Operating	Jun-01	6318	2.5	15,000,000	18,333,333	$ 7,333	$ 7.33	1	c
6	Mariposa (estimate)	New Mexico, USA	New	Operating	Feb-04	6862	0.5	6,640,000	7,472,177	$ 14,944	$ 14.94	3	d
7	Traverse City, Michigan	Michigan, USA	Upgrade	Operating	Jun-04	6532	8.50	31,000,000	36,647,581	$ 4,311	$ 4.31	4	d
8	Powell River	British Columbia, Canada	Upgrade	Operating	Jun-98	5895	1.4	4,700,000	6,156,641	$ 4,398	$ 4.40	2	
9	Buxton Wastewater Treatment Works	UK	Upgrade	-	Jan-03	6581	4.4	15,200,000	17,835,344	$ 4,053	$ 4.05	2	
10	Nordkanal Sewage Treatment Plant	North Rhine-Westphalia, Germany	New	Operating	Mar-02	6502	4.227	26,254,200	31,180,396	$ 7,376	$ 7.38	5	
11	Brightwater Wastewater Treatment Plant	Washington, USA	New	Construction	2004	7115	36	280,000,000	303,887,561	$ 8,441	$ 8.44	6	e
12	Johns Creek Environmental Campus	Georgia, USA	New	Construction	Mar-06	7692	15	137,656,741	138,193,624	$ 9,213	$ 9.21	7	f
13	Butler Drive Water Reclamation Facility	Arizona, USA	New	Design	Apr-06	7695	10	94,964,795	95,298,005	$ 9,530	$ 9.53	8	g
14	Fairview City	Utah, USA	New	-	2005	7446	0.375	2,137,775	2,217,016	$ 5,912	$ 5.91	9	h
15	Running Springs	California, USA	Upgrade	Operating	Jun-05	6694	0.6	1,996,000	2,302,526	$ 3,838	$ 3.84	9	i
16	City of Delphos	Ohio, USA	New	Construction	2005	7446	6	25,055,000	25,983,711	$ 4,331	$ 4.33	9	k

Reference

1 Water Environmental Research Foundation, Project 01-CTS-6, Membrane Treatment of Secondary Effluent for Subsequent Use, 2005
2 MBR Bid prices (rev 3 18 2005) - CDM Table
3 CDM, Estimate Summary - Final spreadsheet, Mariposa Water Reclamation Facility
4 OMI CH2MHill, Tranverse City, MI Wastewater Treatment Plant Conversion, http://www.nemw.org/glci/TraverseCity_Treatment_Plant.pdf
5 VA TECH WABAG News Release, 2002, http://www.vatechwabag.com/view.php3?f_id=7814&LNG=EN

6 King County Web Site, Brightwater Treatment System, 2006, http://dnr.metrokc.gov/wtd/brightwater/contracts/plantcontracts.htm
7 Fulton County Short Term Work Program Update (2006 - 2010), http://www.fultonecd.org/planning/short-term-cip/wastewater-cip.pdf
8 City of Peoria Utilities Department Web site, Engineering Division, Capital Improvement Program Updates. http://www.peoriaaz.com/Utilities/eng_cip_updates_butler.asp
9 Enviroquip, Inc, Construction Cost of MBR WWTPs

Comments

a High capital cost is due to high peaking factors for flow rate during cold weather. Number of membrane modules is based upon meeting the design flux at the peak flow rate in order to avoid equalization. High peaking factors increase the number of modules required.
b High capital cost because the plant was designed to meet design flux rate during peak flows.
c Construction cost includes influent pumping, fine screens, grit removal, MBR, aerobic digestion, UV system, building
d Design Build Project
e Construction cost includes preliminary treatment, primary clarification, MBR system, disinfection, odor control, thickening, anaerobic digestion, dewatering, buildings
f Construction cost includes influent sewer, influent pump station, preliminary treatment, primary treatment, MBR units, disinfection, aerobic digestion, outfall structure, laboratories, and buildings.
g Engineering Estimate. The plant is 95 % design and will start construction in 2006
h Includes building and dewatering
i Retrofit of existing conventional activated sludge plant
j Cost include MBR facility only

Appendix H
Youngquist Brothers, Inc., Deep Injection Well Construction Costs

YOUNGQUIST BROTHERS , INC.

MAJOR WELL CONSTUCTION CONTRACTS :

Below are the Major [$ 500,000 +] Well Construction projects awarded to Youngquist Brothers , Inc. in the past [appx.] Ten [10] year period. Project Status and % Complete are shown at the right.

SUBMISSION DATE **9/14/2006**

Additional Information is available upon request.

OWNER / LOCATION	CONSULTANT	CONTACT	WELL TYPE ~> I. W.	M. W.	MISC	A. S. R.	APPX. VALUE	PROJECT STATUS	% COMPLETE AS OF 9/14/2006
Florida Power & Light Juno Beach, Florida	McNabb Hydrogeologic Consulting, Inc Jupiter, FL 33458	David McNabb (772) 286-3883	1				4,656,800	Open	0%
City of Cape Coral Cape Coral, Florida	MWH Constructors, Inc, Cape Coral, Florida	Jack Currie 239-573-5959		2			1,275,000	Open	2%
Deerfield Beach Deerfield Beach, Florida	Camp Dresser & McKee, Inc /Missimer Fort Lauderdale	Danny Weiss. 954-776-1731	1 TP	1			5,700,000	Open	7%
City of Belle Glade Belle Glade, Florida	LBF&H Palm City, Florida 34990	David McNabb (772) 286-3883		1			422,400	Open	87%
Florida Power & Light Juno Beach, Florida	LBF&H Palm City, Florida 34990	David McNabb (772) 286-3883		1			3,332,950	Open	76%
City of Clewiston Clewiston, Florida	Camp Dresser & McKee, Inc /Missimer Fort Lauderdale	Frank Brinson 407- 660-2552	1 TP	1			4,943,153	Open	62%
City of Key West Fleming Key WWTP	LBF&H Palm City, Florida 34990	David McNabb (772) 286-3883	1				3,735,226	Complete	100%
Palm Beach County (Lake Regic W.Palm Beach, Florida 33413	Palm Beach County W.Palm Beach, Florida 33413	Stephen McGrew P. E. (561) 493-6110	1 TP	1			2,847,722	Complete	100%
City of Hallandedale Beach Hallandale Beach, Florida 33009	Hazen & Sawyer Hollywood, FL	Albert Muniz 561-997-8070	1 TP	1			4,434,337	Open	80%
Palm Beach County (Liner Repl) W.Palm Beach, Florida 33413	Palm Beach County W.Palm Beach, Florida 33413	Tom Uram. (561) 493-6105			1 Liner		877,469	Complete	100%
City of Miramar Miramar, Florida 33027	City of Miramar Miramar, Florida 33028	Antoine Rabbat 954-538-6812			2 Liner		1,800,000	Complete	100%
Ft.Lauderdale-Peele Dixie Ft.Lauderdale, Florida	Hazen & Sawyer Hollywood, Florida	Albert Muniz 561-997-8070	1				5,458,389	Complete	100%
St. Lucie West Services Dist. St. Lucie,Florida	St. Lucie West Services Dist. Longwood, Florida	Charles L. Sweat 407-629-6900	1 TP	1			3,440,757	Complete	100%
Tropicana Products, Inc. Ft. Pierce, Florida	L.S. Sims & Associates Rockledge, Florida	Larry Simms 321-504-4046	1 TP	1			3,908,800	Complete	100%
Lee County Lee County, Florida(Three Oaks)	MWH Americas, Inc . Tampa, Florida	Mark Chandler 813-221-1981	1 TP	1			4,191,800	Complete	100%

YOUNGQUIST BROTHERS , INC.

MAJOR WELL CONSTUCTION CONTRACTS :

OWNER / LOCATION	CONSULTANT	WELL TYPE ~ > CONTACT	I. W.	M. W.	M I S C	A. S. R.	APPX. VALUE	PROJECT STATUS	% COMPLETE AS OF 9/14/2006
Village of Wellington Wellington, Florida	Reese,Macon & Associates 561-433-3226	Jim Macon 561-433-3226	1 TP	1			3,947,350	Complete	100%
City of Palm Bay Palm Bay, Florida	Hartman & Associates Orlando, Florida	Douglas Dufresne 407-839-3955	1 TP	1			5,056,015	Complete	100%
Lee County Lee County, Florida(Pinewood)	Water Resource Solution Cape Coral , Fl.	Dan Aquaviva 239-574-1919	1 TP	1			3,933,000	Open	100%
Collier County North Collier County, FL	Collier County Vanderbuilt I/W-1	Steve Messner 239-352-7001			1 Liner		1,064,000	Complete	100%
Collier County S. Collier County, FL	Camp Dresser & McKee, Inc /Missimer Fort Myers, Florida	Bob Maliva 239-432-9494	1				2,775,780	Complete	100%
City of N.Miami Beach, FL North Miami Beach, Florida	MWH Americas, Inc . Tampa, Florida	Mark Chandler 813-221-1981	1 TP				4,700,000	Complete	100%
Greater Pine Island Water Assoc. Bokeelia, Florida	Water Resource Solution Cape Coral , Fl.	Dan Aquaviva 239-574-1919	1 TP	1			4,876,000	Complete	100%
Martin County, FL Martin County (Tropical Farms)	LBFH, Inc. Palm City, FL	David McNabb 772-286-3883	2 TP	1			8,999,900	Complete	100%
City of West Palm Beach West Palm Beach,FL	Camp Dresser & McKee, Inc /Missimer West Palm Beach, Florida	Greg Shaw 561-689-3336	1	2			4,692,000	Complete	100%
Englewood Water District Englewood, FL	PBS&J Tampa, Florida 33607	Tom Farkas 813-282-7275	1 TP	2			2,658,955	Complete	100%
Lee County, N.Fort Myers, FL	MWH Constructors, Inc. Sunrise, Florida	Mark R. Chandler 813-221-1981	1 TP	1			3,896,388	Complete	100%
Island Water Association Sanibel , Fl. WTP	Missimer International Ft. Myers , Fl.	Dr Charles Walker , P.G (239) 432-9494			1 Liner		589,700	Complete	100%
Collier County North Collier County, FL	Collier County Vanderbuilt I/W-2	Steve Messner 239-352-7001			1 Liner		649,500	Complete	100%
Bonita Springs Utilities Bontia Springs, Florida	CH 2M Hill Tampa, Florida	Bill Beddow 813-874-0777	2 1-TP	2			6,770,000	Complete	100%
Collier County North Collier County, FL	Water Resource Solutions Cape Coral , Fl.	Dr. Mark Pearce (239) 574 - 1919	2	1			6,106,261	Complete	100%
City Of Port St. Lucie Port St. Lucie	Reese, Macon & Associates 561-433-3226	Jim Macon 561-433-3226	2 TP	2			8,175,000	Complete	100%
City of Hollywood Hollywood, Florida	Hazen & Sawyer Hollywood, Florida	Glen Cunningham 954-920-2208	2	1			7,336,510	Complete	100%

YOUNGQUIST BROTHERS , INC.

MAJOR WELL CONSTUCTION CONTRACTS :

OWNER / LOCATION	CONSULTANT	CONTACT	WELL TYPE ~> I. W.	M. W.	M I S C	A. S. R.	APPX. VALUE	% COMPLETE PROJECT STATUS	AS OF 9/14/2006
City of Fort Pierce Fort Pierce, Florida	CH 2M Hill Tampa, Florida	Sean Skehan 954-426-4008	1 TP	1			3,348,750	Complete	100%
City of Fort Myers Fort Myers, Florida	CH 2M Hill Tampa, Florida	Bill Beddow 813-874-0777	1 TP	1			3,484,000	Complete	100%
Collier County South Collier County, FL	Hazen & Sawyer Hollywood, FL	Albert Muniz 561-997-8070	2 TP	1	1 MIT		6,559,840	Complete	100%
Immokalee Immokalee, FL	CH 2M Hill Deerfield Beach , Fl.	Sean Skehan , P.G. 954-426-4008	1				4,328,613	Open	100%
Pompano Beach Pompano Beach, FL	Hazen & Sawyer Hollywood, FL	Albert Muniz 561-997-8070	1 TP	1	1 MIT	0	3,799,010	Complete	100%
Gasparilla Island Water Boca Grande, FL	CH 2M Hill Tampa, FL	Bill Beddow 813-874-0777	1 TP	2	0	0	2,745,284	Complete	100%
Martin, County Jensen Beach, FL	Reese, Macon, & Associates Lake Worth, Florida	Jim Macon 561-433-8011	1 TP	0	1 MIT	0	3,498,450	Open	100%
Cooper City Cooper City, FL	Hazen & Sawyer Hollywood, FL	Micahael Wengrenovich 954-987-0066	1 TP	1	0	0	3,719,132	Complete	100%
Town Of Jupiter Jupiter, FL	Stemle,Anderson & Associates, Inc. Jupietr, FL	James Anderson 561-745-9545	0	0	2 RO	0	657,640	Complete	100%
City of Ft.Lauderdale Fort Lauderdale, FL	Hazen & Sawyer Boca Raton, Fl	Albert Muniz 561-997-8070	0	0	4 RO	0	297,525	Complete	100%
Manatee County Manatee, FL	Montgomery Watson Tampa, FL	Mark Abbott 813-221-1981	0	2	0	1	948,400	Complete	100%
City of Punta Gorda Punta Gorda, FL	Water Resource Solutions Cape Coral , Fl.	Dr. Mark Pearce (239) 574 - 1919	1	0	0	0	1,950,000	Complete	100%
Palm Beach County West Palm Beach, FL	Palm Beach County West Palm Beach, FL	Tom Uram (561) 434-5356		0	1 TP	0	800,398	Complete	100%
Martin County Stuart, FL 34996	Hutcheon Engineers West Palm Beach, FL	Dana Branscum (561) 845-0666	0	0	1 RO	0	335,790	Complete	100%
City of Punta Gorda Punta Gorda, FL	Water Resource Solutions Cape Coral , Fl.	Dr. Mark Pearce (239) 574 - 1919	0	0	1	0	804,985	Complete	100%
Florida Water Corp. Marco Lakes WTP	Water Resource Solutions Cape Coral , Fl.	Dr. Mark Pearce (941) 574 - 1919	0	0	0	2	625,000	Complete	100%
Island Water Association Sanibel , Fl. WTP	Missimer International Ft. Myers , Fl.	Dr Charles Walker , P.G (239 432-9494	1 TP	1	0	0	2,555,000	Complete	100%

YOUNGQUIST BROTHERS, INC.

MAJOR WELL CONSTUCTION CONTRACTS :

OWNER / LOCATION	CONSULTANT	WELL TYPE ~> CONTACT	I. W.	M. W.	M I S C	A. S. R.	APPX. VALUE	PROJECT STATUS	% COMPLETE AS OF 9/14/2006
City of Key West Fleming Key WWTP	CH2M Hill, Inc. Deerfield Beach, Fl.	Dave McNab, P.G. (954) 426 - 4008	1	1	0	0	4,850,000	Complete	100%
Sarasota County Venice Gardens WTP	P.B.S. & J Sarasota, Fl	Mike Micheau, P.G. 813-877-7272	1 TP	1	0	0	3,000,000	Complete	100%
City of Plantation Plantation East WTP	Missimer International Ft. Myers, Fl.	Dr Charles Walker, P.G (941) 432-9494	1 TP	1	0	0	3,200,000	Complete	100%
Miami - Dade County N.W. Wellfield W-802	M.D.W.A.S.D. Miami, Fl.	Gene McLoughlin, P.E. 305-669-7646	0	0	3 XX	0	800,000	Complete	100%
City of Sunrise T & P Sawgrass WTP	Montgomery - Watson Lake Worth, Fl.	Helen Madeksho-Hickman, P.G. 561-586-8830	1 TP	1	0	0	4,200,000	Complete	100%
Miami - Dade County So. District WWTP S-673	Ft. Myers, Fl. Collier County	Gene McLoughlin, P.E. 305-669-7616	0	3	17 MIT	0	3,000,000	Complete	100%
Collier County No. Regional WTP	Missimer International Ft. Myers, Fl.	Kirk Martin, P.G. 561-997-8070	0	0	11 RO	0	1,270,000	Complete	100%
Lee County Ft. Myers Beach WWTP	CH2M Hill, Inc. Tampa, Fl.	Bill Beddow, P.G. 813-281-0777	1	1	0	0	2,700,000	Complete	100%
Broward County No. Regional WTP	Hazen & Sawyer Hollywood, Fl.	Pat Davis, P.E. 954-987-0066	2	2	0	0	6,450,000	Complete	100%
City of Ft. Lauderdale Fiveash WTP	Montgomery-Watson Lake Worth, Fl.	Ann Murray, P.G. 561-586-8830	0	2	0	1	1,300,000	Complete	100%
City of Punta Gorda Punta Gorda WTP	Montgomery-Watson Tampa, Fl.	Mark Abbot, P.G. 813-221-1981	0	0	0	1	500,000	Complete	100%
City of Stuart Stuart WWTP	Montgomery-Watson Lake Worth, Fl.	Helen Madeksho-Hickman, P.G. 561-586-8830	1	1	0	0	2,900,000	Complete	100%
City of Sunrise ASR Sprintree WTP	Montgomery-Watson Lake Worth, Fl.	Ann Murray, P.G. 561-586-8830	0	0	0	1	1,050,000	Complete	100%
City of Ft. Lauderdale G.T. Lohmeyer WWTP	CH2M Hill, Inc. Deerfield Beach, Fl.	Sean Skehan, P.G. 954-426-4008	1	1	0	0	3,300,000	Complete	100%
Miami - Dade County West Wellfield W-740A	M.D.W.A.S.D. Miami, Fl.	Gene McLoughlin, P.E. 305-669-7646	0	0	0	3	3,700,000	Complete	100%
Collier County South Collier WWTP	Missimer International Ft. Myers, Fl.	Dr Charles Walker, P.G. 941-432-9494	1	1	0	0	2,500,000	Complete	100%
Collier County IW-2 No. Regional WTP	Missimer International Ft. Myers, Fl.	Dr Charles Walker, P.G. 941-432-9494	1 TP	0	0	0	2,350,000	Complete	100%

YOUNGQUIST BROTHERS, INC.

MAJOR WELL CONSTUCTION CONTRACTS :

OWNER / LOCATION	CONSULTANT	WELL TYPE ~> CONTACT	I. W.	M. W.	MISC	A. S. R.	APPX. VALUE	PROJECT STATUS	% COMPLETE AS OF 9/14/2006
City of Delray Beach Delray Beach WTP	CH2M Hill , Inc. Deerfield Beach , Fl.	Rick Nevulis , P.G. 95-426-4008	0	0	0	1	800,000	Complete	100%
City of Miramar Miramar WWTP	Hazen & Sawyer Hollywood , Fl.	Pat Davis , P.E. 954-987-0066	2	2	0	0	5,500,000	Complete	100%
Acme Improvement Dist. Wellington WWTP	Camp Dresser McKee Miami , Fl.	Stew Magenheimer 305-372-7171	0	1	0	0	550,000	Complete	100%
Charlotte County Eastport WWTP	ViroGroup , Inc Cape Coral , Fl.	Lloyd Horvath . P.E. 941-574-1919	1	0	0	0	2,700,000	Complete	100%
Charlotte County Westport WWTP	Montgomery-Watson Lake Worth , Fl.	Helen Madeksho-Hickman , P.G. 561-586-8830	1	1	0	0	3,200,000	Complete	100%
Miami - Dade County No. District WWTP S-604	M.D.W.A.S.D Miami , Fl.	Gene McLoughlin , P.E. 305-669-7646	4	4	0	0	14,800,000	Complete	100%
Southern States Utilities Burnt Store WTP	Water Resource Solutions Cape Coral , Fl.	Lloyd Horvath . P.E. 941-574-1919	1 TP	1	0	0	2,200,000	Complete	100%
Sarasota County Sarasota WWTP	CH2M Hill , Inc. Tampa , Fl.	Mike Micheau , P.G. 813-281-0777	1 TP	1	0	0	2,800,000	Complete	100%
City of Sunrise Sunrise WWTP	Camp Dresser McKee Ft. Lauderdale , Fl.	Bill Pitt , P.G. 954-776-1731	1	3	0	0	4,150,000	Complete	100%
City of Miramar Miramar RO WTP	Montgomery-Watson Lake Worth , Fl.	Helen Madeksho-Hickman , P.G. 561-586-8830	2 TP	1	0	0	4,400,000	Complete	100%
City of Ft. Lauderdale G.T. Lohmeyer WWTP	CH2M Hill , Inc. Deerfield Beach , Fl.	Sean Skehan , P.G. 954-426-4008	0	3	0	0	2,000,000	Complete	100%
Miami - Dade County So. District WWTP S-409	M.D.W.A.S.D. Miami , Fl.	Gene McLoughlin , P.E. 305-669-7646	5	12	0	0	17,500,000	Complete	100%
Collier County No. Regional WTP	Water Resource Solutions Cape Coral , Fl.	Lloyd Horvath . P.E. 941-574-1919	1	1	0	0	2,950,000	Complete	100%
Charlotte County Zemel Road Landfill	P.B.S.& J. Sarasota , Fl.	Bill Pitt , P.G. 813-877-7275	1 TP	1	0	0	1,850,000	Complete	100%
City of Ft. Pierce Ft. Pierce WWTP	CH2M Hill , Inc. Deerfield Beach , Fl.	Sean Skehan , P.G. 954-426-4008	1	1	0	0	2,550,000	Complete	100%
City of Pembroke Pines Pembroke Pines WWTP	Geraghty & Miller No. Palm Beach , Fl.	Mike Waldron , P.G. 561-694-0300	1	1	0	0	2,800,000	Complete	100%

YOUNGQUIST BROTHERS, INC.

MAJOR WELL CONSTUCTION CONTRACTS :

TOTAL	73 85 49 10	$ 285,528,979.10

LEGEND :

>	I W	Injection Well (U.I.C. Class 1)
>	M W	Monitor Well (U.I.C. Class 1)
>	T P	Tube & Packer (U.I.C. Class 1)
>	R O	Reverse Osmosis Production Well
>	M I T	Mechanical Integrity Testing
>	A S R	Aquifer Storage & Recovery (U.I.C. Class 5)
	X X	Other , Details available on request

ADDITIONAL PROJECT INFORMATION AVAILABLE UPON REQUEST.