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WATER SUPPLY NEEDS AND SOURCES ASSESSMENT
ALTERNATIVE WATER SUPPLY STRATEGIES INVESTIGATION
WATER SUPPLY AND WASTEWATER SYSTEMS COMPONENT COST INFORMATION

by

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Palatka, Florida
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EXECUTIVE SUMMARY

The St. Johns River Water Management District (SJRWMD) conducted a water supply needs and sources assessment (Vergara 1994) to estimate the year 2010 water resources conditions within SJRWMD. As a result of this assessment, SJRWMD identified areas referred to as water resource caution areas in which water resource problems have become critical or are anticipated to become critical by 2010. These areas include all or portions of Volusia, Brevard, Orange, Seminole, Osceola, Lake, St. Johns, and Flagler counties.

To address the future needs for the water resource caution areas, SJRWMD has initiated an alternative water supply strategies investigation. LAW was retained by SJRWMD, as part of the investigation, to perform an evaluation of interconnection strategies for water supply and wastewater treatment facilities, in particular reuse systems, within the caution areas.

The purpose of Task B.2.b. Information Development is to develop cost information relative to significant components of public water supply systems' facilities and wastewater systems' facilities by using the methodology developed in Technical Memorandum (TM) B.1.c. (Law 1996).

Cost information for public water supply and wastewater system components is presented in this document as a tool for estimating costs during the conceptual planning stage of potential facility projects relating to alternative water supply strategies. Although the information was collected from several different types of sources over a period of years, consideration was given to presenting the costs in 1996 dollars and converting the cost values into consistent cost parameters.

The component cost information will be utilized in the evaluation of the economic feasibility of various alternative water supply strategies including the potential interconnection of systems. An initial list of feasible interconnections with the associated costs will be developed as a part of Task B.3.a. This list will be an initial input into the decision model developed by the University of Florida as part of SJRWMD's alternative water supply strategies investigation and will be considered along with the other alternative water supply strategies.

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INTRODUCTION

The St. Johns River Water Management District (SJRWMD) conducted a water supply needs and sources assessment (Vergara 1994) to estimate the year 2010 water resources conditions within SJRWMD. As a result of this assessment, SJRWMD identified areas referred to as water resource caution areas in which water resource problems have become critical or are anticipated to become critical by 2010. These areas include all or portions of Volusia, Brevard, Orange, Seminole, Osceola, Lake, St. Johns, and Flagler counties.

To address the future needs for the water resource caution areas, SJRWMD has initiated an alternative water supply strategies investigation which addresses the following concepts:

- Surface Water Supply Source Development
- Artificial Recharge
- System Interconnection
- Development of Lower Quality Water Sources
- Aquifer Storage and Recovery
- Water Conservation and Reuse of Reclaimed Wastewater and Stormwater
- Mitigation of the Impact of Ground Water Withdrawals
- Optimization of Ground Water Withdrawals

LAW was retained by SJRWMD, as part of the investigation, to perform an evaluation of interconnection strategies for water supply and wastewater treatment facilities, in particular reuse systems, within the caution areas. Reclaimed water is any wastewater receiving at least secondary treatment that is used for beneficial purposes which may reduce potable demand or provide environmental enhancement.

This report addresses Task B.2.b. of the investigation. The technical requirements of the task include the development and presentation of cost information relative to selected water supply and wastewater treatment components. The cost estimates developed as part of this investigation are general costs which can be used as approximate costs for each of the system components. For specific sites or facilities, more detailed cost information will need to be developed.

LAW conducted a cost analysis for the water supply and wastewater treatment system components identified in Technical Memorandum B.1.c. The cost analysis included investigation of technical reports, master plans, and other documents, as well as collection of utility fiscal

information and contractor cost estimates . To allow for consistent and comparable cost planning, eight economic analysis criteria were developed for each of the system components. The economic analysis criteria are listed below.

- Construction Costs
- Non-Construction Capital Costs
- Land Costs
- Land Acquisition Costs
- Total Capital Costs
- Operation and Maintenance (O&M) Costs
- Equivalent Annual Costs
- Unit Costs
- Set Up Costs

METHODS

A Water Supply and Wastewater Questionnaire was distributed to selected water and wastewater utilities based on average daily demand or flow for each system. In addition to requesting information related to the existing system interconnections and source locations, the questionnaire included a section for fiscal information. The public water and wastewater utilities were asked to provide copies of current rate and fee schedules, O&M costs, and master plans if available. Also, costs associated with system components that have been constructed within the past three years were requested.

Recent documents which contain topics on public water supply and wastewater system components, such as, available master plans, studies from utilities, and other supplementary documents were collected and reviewed. Significant component cost information was noted, compared, and utilized in composing the cost tables and graphs within this document. The costs were adjusted by comparing the *Engineering News Record* Construction Cost Index (CCI) from the dates of the reports or documents to the six month average (January through June) 1996 value.

Some of the cost information was obtained by contacting appropriate component manufacturers and vendors who provided cost quotes for the equipment and its installation. The cost information was integrated into this document through the cost tables and graphs.

DISCUSSION

ECONOMIC ANALYSIS CRITERIA

Economic analysis criteria were created by SJRWMD to provide a consistent set of definitions and criteria for the development of comparable planning level life cycle cost estimates for water supply and wastewater treatment alternatives. As a result of letters from Barbara Vergara dated February 29, 1996 (presented in Appendix A) and April 5, 1996 (presented in Appendix B), eight economic analysis criteria were developed for each of the water supply and wastewater treatment system components.

Construction Costs

The construction costs developed for each of the water supply and wastewater treatment systems are the total amounts expected to be paid to a qualified contractor to build the required facilities. These values include all material costs, equipment costs, installation costs, and taxes. Unless otherwise noted, the construction costs for treatment components do not include factors for peak flow.

Non-Construction Capital Costs

The non-construction costs are 45 percent of the construction costs and account for engineering design, permitting, administration, and construction contingency associated with the constructed facilities. The 45 percent non-construction costs are divided into three parts, an engineering cost of 15 percent of the construction cost; an administrative cost of 10 percent of the construction cost; and a general contingency of 20 percent of the construction cost.

Land and Acquisition Costs

The land costs associated with the siting of water supply and wastewater treatment systems are presented in Table 2. Recommended values, determined by SJRWMD, are used for the purpose of land cost estimations and are in the form of dollars per acre or dollars per square foot. The values are divided into four categories based on parcel size and land usage. The land area required and the cost associated with the land is included as a part of the total capital cost for each of the water supply and wastewater system components. In addition to the cost of the land, a land acquisition cost of 25 percent

of the land value is included to account for the cost of engineering, administrative, and legal services associated with the land acquisition process.

Total Capital Costs

The total capital costs for each of the water supply and wastewater system components are the sum of the construction costs, non-construction costs, land value, and land acquisition costs.

Operation & Maintenance (O&M) Costs

The O&M costs are the estimated costs of operating and maintaining the water supply or wastewater treatment system components each year. These costs include all energy costs, chemical costs, labor costs, etc. The O&M costs are based on annual average flow conditions.

Equivalent Annual Costs

The equivalent annual costs are the total life cycle costs of the system component based on the service life of the component and the time value of money. The time value of money used for the purpose of this investigation is seven percent and the service lives of the components are presented in Appendix C. The annual O&M costs associated with the system component are also included in the equivalent annual cost.

Unit Costs

Unit costs include that portion of the annual O&M costs that vary with the production rate such as energy costs and chemical costs. The unit costs are expressed in terms of dollars per 1,000 gallons.

Set Up Costs

The set up costs are the annualized total capital costs plus that portion of the annual O&M costs not associated with production. These costs are determined by subtracting the unit costs times the design flow of the system from the equivalent annual costs.

A sample calculation for each of the eight economic analysis criteria is presented in Table 1.

PUBLIC WATER SUPPLY SYSTEM COMPONENTS

Public water supply system facilities are composed of several components which interact to treat raw water. Cost estimates were determined for the following components.

Source of Supply

Ground Water Supply

Ground water supply systems are composed of wellfields and their related features such as wells, pumps, and land. Wells are one of the major components of a ground water supply system. The cost of well construction is a function of diameter, depth, and screening. The well construction costs presented (Table 3, Figures 1 & 2) include the drilling, casing, and grout and are calculated for a range of well diameters and depths due to the variance in cost with these parameters.

The well equipment cost estimates presented in Table 4 include the pumps, valves, fittings, metering, a well house structure, and electrical controls. The construction costs include all equipment, installation, and taxes. The O&M costs include normal maintenance of the well equipment, energy, and labor.

Three alternative land costs were also calculated for well systems to account for the difference in land values between urban , suburban, and rural areas. The minimum parcel size required to accommodate the installation and maintenance of one well is 2,500 square feet; however, if land is available a 160,000 square foot parcel is desired to allow for the control of activities around the well.

Surface Water Supply

Lakes, streams, rivers, and springs are used as sources of surface water supply. Permitting for the construction of a new impoundment area or reservoir may be difficult in some cases. However, to determine the costs for the construction of a complete surface water supply system, the costs of an in-stream reservoir construction option as well as an off-stream option were included in the cost analysis.

Technical reports and master plans were reviewed to develop surface water supply cost estimates, presented in Table 5. The cost estimates were based on the size of the reservoir and whether the reservoir was

in-stream or off-stream. Reservoirs with working depths of both 6 feet and 20 feet were used in the cost estimates. Two sizes of reservoirs were also considered for the cost estimates, a 5,000 acre-foot reservoir and a 10,000 acre-foot reservoir. Included in the capital and O&M costs are all costs associated with the reservoir, pumps, raw water intake systems, and energy requirements.

Aquifer Storage and Recovery

Aquifer storage and recovery (ASR) systems use excess water when available beyond the needs of the system. The excess water is stored underground for retrieval when the system demands exceed the raw water supply capacity.

Two alternatives were used to develop the costs for ASR systems. One alternative considers a system which uses pressurized water from a utility system, while the other alternative considers a system which does not use the utility system's pressure and therefore requires pumping. The costs, presented in Table 6, include the water treatment system, control system, injection equipment, withdrawal system, and monitoring systems.

Water Treatment Components

Lime Softening

Lime softening is one of the most prevalently utilized water treatment processes today. Lime softening is used to not only remove hardness from water supplies, but to also remove heavy metals, metallic elements, and organic compounds and to kill bacteria, viruses, and algae.

Cost estimations for a lime softening treatment plant are presented in Table 7. The construction costs include the lime softening treatment components such as the head tank, aerator, clarifier, recarbonation vessel, and filter, and the cost associated with the other integral treatment plant components.

Conventional Water Treatment

Conventional water treatment is a basic water treatment purification process that is commonly used. It is comprised of treatment components, coagulation, flocculation, and sedimentation, to remove

suspended material and color. This treatment process may also be used as a pretreatment for other treatment processes or technologies such as reverse osmosis.

Cost estimations for a conventional water treatment plant are presented in Table 8. The construction costs include the treatment components such as the rapid mix, flocculation basin, sedimentation basin, and filters, and the cost associated with the other integral treatment plant components.

Aeration

One of the simplest processes used for the treatment of water supplies is aeration. Aeration is often used to treat high quality raw water in order to remove hydrogen sulfide through an oxidation and volatilization process.

The costs associated with aeration treatment are presented in Table 9. The costs include the equipment and installation costs of the aeration unit or degasifier. The costs do not include the cost of pumping and storage units.

Filtration

Filtration systems are used in water treatment to remove particulate matter from the water supply. The costs associated with a filtration system, presented in Table 10, include equipment and installation.

Reverse Osmosis and Desalination

Relatively recent technological advances regarding the treatment of raw water provide alternative strategies for projects with limiting site conditions where conventional systems may not offer the optimal solution for component selection. Reverse osmosis and desalination processes are considered to be some of the more recent advances.

Cost estimates for reverse osmosis were obtained from a series of technical reports and studies and were adjusted to reflect 1996 values. The reverse osmosis costs include those associated with the process and deep well disposal of the brine. The costs presented are for general reverse osmosis facilities, site specific concentrate disposal and raw water variations can significantly effect the cost estimates. Table 11 presents the costs determined for reverse osmosis.

Table 12 presents the costs associated with desalination. The construction costs include the water intake system, desalination plant, storage units, pumping and transmission systems, and brine disposal.

Disinfection

The purpose of disinfection is to kill pathogenic microorganisms in water supplies. Chlorination is the primary form of disinfection used in Florida.

The costs associated with a chlorination system are presented in Table 13. The construction costs include equipment and installation, and the O&M costs include energy, labor, chemical, and normal maintenance.

Water Storage and Transmission

Storage Facilities

Storage facility costs are presented in Table 14. The costs of the facilities include the tank with and without an aerator.

Pumping Facilities

An important part of the transportation and distribution systems for water supplies is the pumping system. The pumping capacities and pump types are dependent on the characteristics of the water supply.

The costs associated with a pump station are presented in Table 15. The construction costs include all equipment such as the pumps and the pumping facility. The pumping facilities are rated as listed in the table and do not include factors for peak conditions. However, the cost of a stand-by pump is included to provide for the capacity listed with one pump out of service. The O&M costs include normal maintenance, energy, and labor.

Metering and Backflow Prevention

Metering and backflow prevention are devices used to measure and maintain water flow. Meters are used to measure water consumption or usage. Backflow prevention devices prevent a reversal of flow within a water system which could lead to contamination of a treated supply.

Cost estimates for metering and backflow prevention devices are presented in Table 16. The construction costs include a meter and backflow prevention device and were developed for both six and eight inch devices. The O&M costs consist of annual maintenance to calibrate the devices.

Transmission Mains

Transmission mains are pipelines used to transport water to various areas of the water system. The pipes are primarily made of ductile iron pipe (DIP) and prestressed concrete cylinder pipe (PCCP) and typically vary in size from 12 inches to 60 inches in diameter.

The cost of transmission mains, presented in Table 17, varies with the length and diameter of pipe. Unit land costs and land requirements are also presented and are dependent on where the pipeline corridors are constructed and how many feet of pipeline are required. The costs include the complete installed pipe, but do not include jack and bore encasement , tunnels, and valves. Table 18 and Table 19 present the costs associated with butterfly valves and jack and bore encasements and tunnels, respectively. The combined costs of the transmission mains, valves, and jack and bores are presented in Table 20. To develop the combined costs, the assumption was made that valves would be added approximately every mile along the pipeline and jack and bores would occur approximately every 5 miles.

WASTEWATER SYSTEM COMPONENTS

Wastewater treatment facilities are composed of several components which interact to treat wastewater. Only components that would improve the treatment of the wastewater from secondary treatment to advanced secondary or advanced wastewater treatment were included in the cost analysis. Cost estimates were found for the following components.

Advanced Secondary Treatment

Filtration

Filtration is a common component in advanced secondary wastewater treatment which provides a higher quality effluent that can be utilized as reclaimed water. The costs associated with a gravity dual-media filter are presented in Table 21. The construction costs include all

equipment, material, and installation, and the O&M costs include all energy, labor and other maintenance.

High Level Disinfection

The purpose of disinfection is to kill pathogenic microorganisms in wastewater before it is discharged into the environment. To achieve high level disinfection in an advanced secondary treatment process, monitoring and chemical feed equipment also need to be included.

The costs associated with the construction of an upgraded disinfection system are presented in Table 22. The construction costs include the equipment and installation, and the O&M costs include energy, labor, chemicals, and normal maintenance.

Advanced Wastewater Treatment

Denitrification and Phosphorus Removal

When reuse water is disposed of in surface water or stored in reservoirs, wetlands, or groundwater recharge basins denitrification and phosphorus removal may be needed. Table 23 presents the costs associated with upgrading the treatment from advanced secondary to advanced wastewater treatment including high level disinfection. The costs include deep bed filters, the addition of methanol and alum to remove nitrogen and phosphorus from the wastewater, and high level disinfection components.

Wastewater Transmission Components

Force Mains

Force mains, which are pipelines used to transport wastewater from various areas of the wastewater system, are primarily made of Polyvinyl chloride (PVC) or ductile iron pipe (DIP) and typically vary in size from 6 to 16 inches in diameter.

The costs associated with force mains are presented in Table 24. The costs are in the form of dollars per foot of pipe. Included in the construction costs include the force main, fittings, and the installation of the main. The land costs are also presented in the form of dollars per foot of pipe and were calculated based on the recommended land area for specific pipe diameters.

Pumping Facilities

An important part of the transportation of wastewater is the pumping system. The pumping capacities and pump types are dependent on the wastewater composition.

The costs associated with a pump station are presented in Table 15. The construction costs include all equipment such as the pumps and the pumping facility. The pumping facilities are rated as listed in the table and do not include factors for peak conditions. However, the cost of a stand-by pump is included to provide for the capacity listed with one pump out of service. The O&M costs include normal maintenance, energy, and labor.

Metering and Backflow Prevention

Metering and backflow prevention are devices used to measure and maintain wastewater flow. Backflow prevention devices prevent a reversal of flow within a wastewater system which could lead to recontamination of treated wastewater.

Cost estimates for metering and backflow prevention devices are presented in Table 25. The construction costs include a meter and backflow prevention device and were developed for both six and eight inch devices. The O&M costs consist of annual maintenance to calibrate the devices.

Transmission Mains

Transmission mains, which are pipelines used to transport reuse water to various areas for use, are primarily made of ductile iron pipe (DIP) and prestressed concrete cylinder pipe (PCCP) and vary in size from 12 inches to 60 inches in diameter.

The cost of transmission mains, presented in Table 17, varies with the length and diameter of the pipe. Unit land costs and land requirements are also presented and are dependent on where the pipeline corridors are constructed and how many feet of pipeline are required. The costs include the complete installation of the pipe, but do not include jack and bore encasement, tunnels, and valves. Table 18 and Table 19 presents the cost associated with butterfly valves and jack and bore encasements and tunnels, respectively. The combined costs of the transmission mains, valves and jack and bores are presented in Table 20. To develop the combined costs, the assumption was made

that valves would be added approximately every mile along the pipeline and jack and bores would occur approximately every 5 miles.

CONCLUSIONS

The component cost information presented in this report should be sufficient to conduct a cost evaluation on possible system interconnections. Although the planning level cost information was collected from several different types of sources, the costs for the water and wastewater system components are presented in consist economic parameters. Therefore, the facility components can be compared on equivalent terms.

Because of the large number of facilities and the variation in facility design, the costs presented in this report represent general costs for the specified components. A range of facility sizes and facility components were incorporated into the cost estimates. Four specific plant sizes were considered for most of the facility components to make the cost ranges consistent and to allow for the application of the costs to the majority of the facilities selected for this investigation. For specific sites or facilities, more detailed costs may need to be developed.

The cost estimates are in a form that should be compatible with SJRWMD efforts to perform a planning level evaluation of alternative water supply strategies and suitable for use in the University of Florida's decision model which is being prepared for SJRWMD as part of the alternative water supply strategies investigation.

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TABLES AND FIGURES

Table 1. Sample Calculations for the Eight Economic Analysis Criteria

The cost estimates for the sample calculations below are for a 1mgd lime softening plant

Construction Costs

$1,916,767 Obtained from the sources listed at the bottom of each of the cost estimate tables

Non-Construction Costs

= .45 * $1,916,767 $862,545

Land Cost

2 acres is the estimated land area needed for this system component

	Urban	Suburban	Rural
Per acre cost	$100,000/acre	$20,000/acre	$5,000/acre
Total cost	$200,000	$40,000	$10,000

Land Acquisition Costs

=0.25 * Total Land Cost

	Urban	Suburban	Rural
Formula	=.25*$200,000	=.25*$40,000	=.25*$10,000
Total cost	$50,000	$10,000	$2,500

Total Capital Cost

=Construction Cost + Non-Construction cost + Land Cost + Land Acquisition Cost

	Urban	Suburban	Rural
Formula	=$1,916,767+ $862,545 + $200,000 + $50,000	=$1,916,767 + $862,545 + $40,000 + 10,000	=$1,916,767 + $862,545 + $10,000 + $2,500
Total cost	$3,029,312	$2,829,312	$2,791,812

O&M Costs

Obtained from the sources listed at the bottom of each cost estimate table

Chemical	$.08/1000 gal
Backfeed pumps	$.02/1000 gal
Labor	$.06/1000 gal
Electricity	$.021/1000 gal
Total	$.181/1000 gal

Total= ($.181/1000)*1e6*365

= $66,065

Equivalent Annual Cost

Capital cost is annualized based on its service life presented in Appendix C and a 7% time value of money.

Lime Softening process has a service life of 20 years. Land has an indefinite service life.

For an Urban System

Annual Cost = Capital recovery Factor * Capital Cost + O&M Cost

= .09439*($1.916,767 + $862,545)+ .07*($200,000 + $50,000)+ $66,065

= $345,904

Unit Costs

Chemical	$.08/1000 gal
Electricity	$.021/1000 gal
Backfeed pumps	$.02/1000 gal

Set Up Costs

Set up Costs = Equivalent Annual Cost- Unit Costs*Production Rate (1 mgd*365)

= $345,904-(.08/1000+.021/1000+.02/1000)*1e6*365

= $301,739

Table 2. Land Cost Estimates

	Parcel for Individual Wells, Booster Stations Small WTPs, etc. 2-50 acres ($/ac)	Parcels for Wellfields, Major WTPs, etc. 100-500 acres ($/ac)	Parcels for Reservoirs Mitigation areas, etc. 250-300 acres ($/ac)	Pipeline Corridors			
				Adjacent to Public ROW		New Areas	
				Easement ($/ sq ft)	ROW ($/sq ft)	Easement ($/sq ft)	ROW ($/sq ft)
Urban	$100,000	-	-	$4.00	$6.00	$3.00	$5.00
Suburban	$20,000	$10,000	-	$1.50	$3.00	$1.00	$2.00
Rural	$5,000	$3,000	$3,000	$0.75	$1.00	$0.50	$0.75

Sources:
Vergara, February 29, 1996

Table 3. Well Drilling Cost Estimates

	Cost in ($/ft) [1]				
Diameter (in)	10	12	16	18	24
Construction Costs	$77	$97	$125	$140	$199
Nonconstruction Costs	$35	$43	$56	$63	$90
Total Costs	$112	$140	$181	$203	$289

	Land Costs[2]	Land Aqcuisition	Total Land Costs
Urban	$100,000	$25,000	$125,000
Suburban	$37,400	$9,350	$46,750
Rural	$18,350	$4,588	$22,938

Table 4. Well Equipment Cost Estimates

Component Capacity (mgd)	Construction Costs[3]	Non-Construction Costs	Total Capital Costs	O&M Costs	Equivalent Annual Costs	Unit Costs Energy ($/1000 gal)	Set Up Costs
1	$39,229	$17,653	$56,882	$21,927	$26,823	$0.052	$7,961
2	$47,576	$21,409	$68,985	$34,310	$40,219	$0.047	$6,268
3	$55,387	$24,924	$80,311	$51,130	$58,016	$0.046	$7,897
4	$63,843	$28,729	$92,572	$68,497	$76,468	$0.046	$9,104
5	$72,100	$32,445	$104,545	$82,090	$91,128	$0.044	$10,291

(1). Well construction costs include drilling, casing, and grout

(2) The land costs are based on the following land areas: Urban-43,560 square feet, Suburban-81,000 square feet, and Rural-160,000 square feet.

(3). Well equipment costs include pumps, valves, fittings, metering, a well house structure, and electrical controls

Note: The construction costs include all equipment, installation, and taxes. The O&M costs include normal maintenance of the well equipment, energy, and labor.

Sources:

American Drilling, July 12, 1996

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Figure 1. Well Drilling Construction Cost Estimates

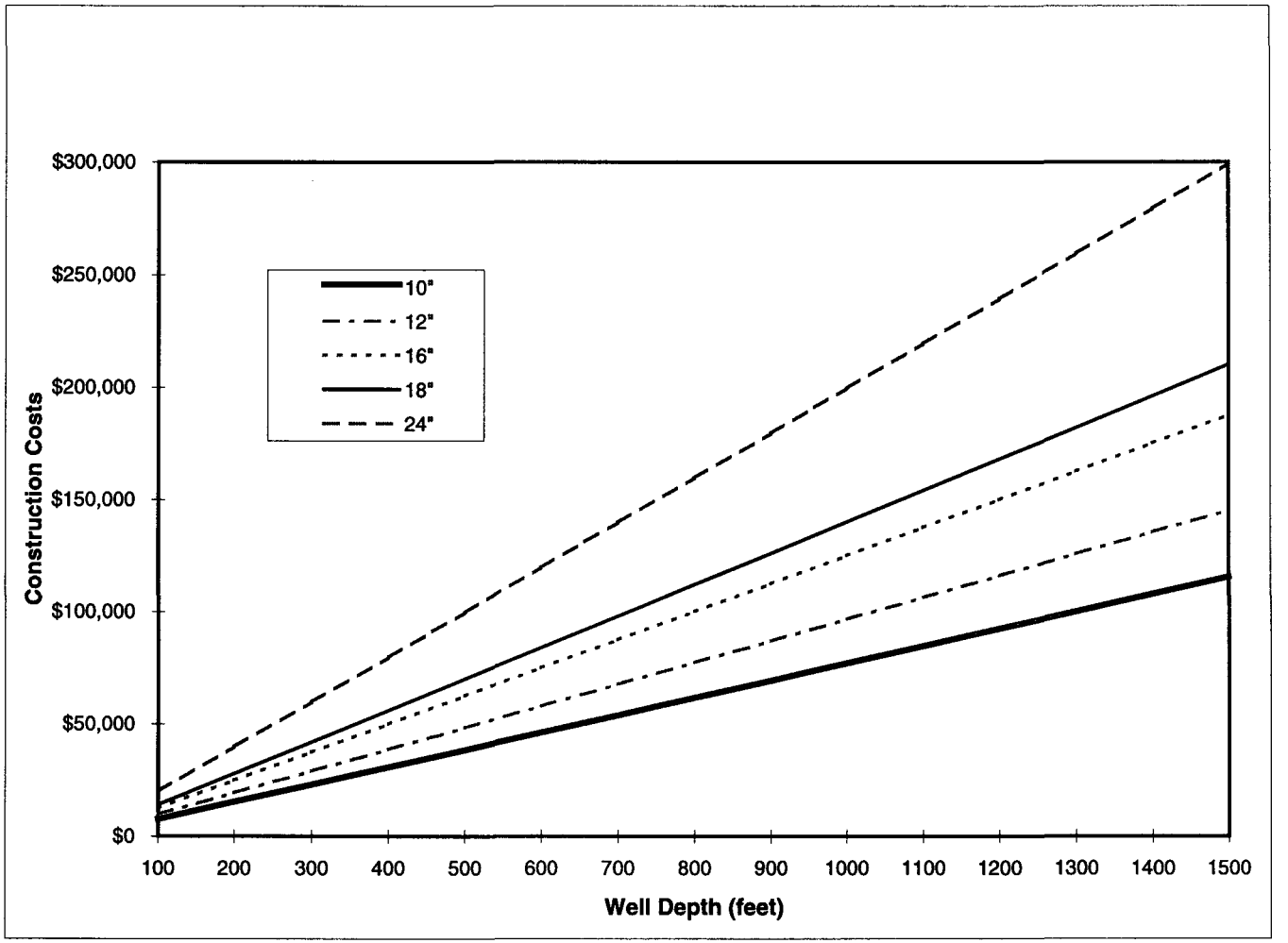

Figure 2. Well Drilling Non-Construction Cost Estimates

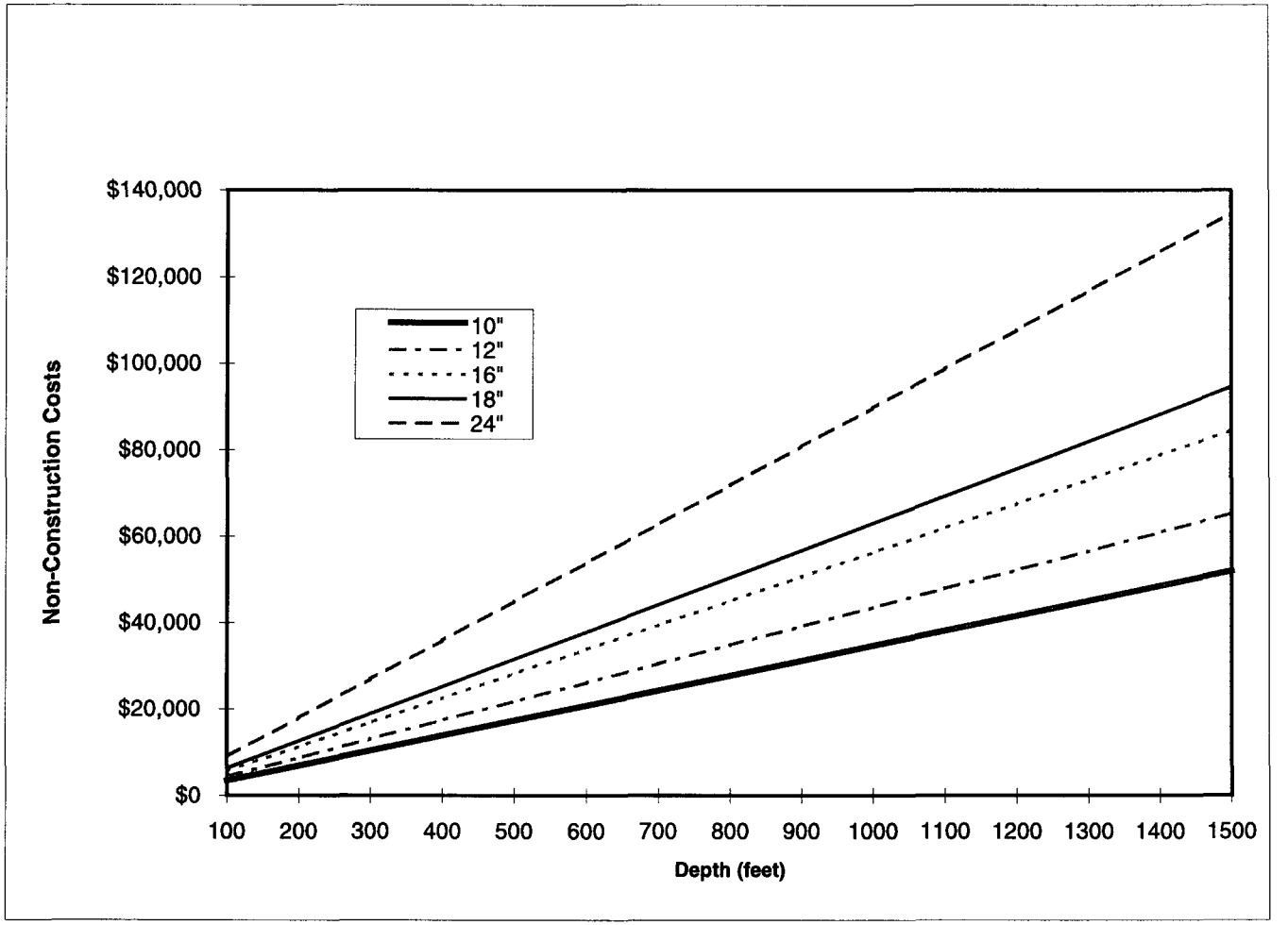

Table 5. Surface Water Supply Cost Estimates

Off- Stream							
Volume (acre-feet)	Construction Costs	Non-Construction Costs	Land Costs	Land Acquisition	Total Land Costs	Total Capital Costs	Reservoir O&M
Depth 6 ft							
5,000	$555,000	$249,750	$2,400,000	$600,000	$3,000,000	$3,804,750	$250,000
10,000	$1,110,000	$499,500	$4,800,000	$1,200,000	$6,000,000	$7,609,500	$500,000
Depth 20 ft							
5,000	$22,500,000	$10,125,000	$750,000	$187,500	$937,500	$33,562,500	$250,000
10,000	$30,000,000	$13,500,000	$1,500,000	$375,000	$1,875,000	$45,375,000	$500,000

In-Stream							
Volume (acre-feet)	Construction Costs	Non-Construction Costs	Land Costs	Land Acquisition	Total Land Costs	Total Capital Costs	Reservoir O&M
5,000	$5,500,000	$2,475,000	$2,100,000	$525,000	$2,625,000	$10,600,000	$375,000
10,000	$17,000,000	$7,650,000	$4,200,000	$1,050,000	$5,250,000	$29,900,000	$750,000

Capital Costs				
Component Capacity[1] (mgd)	Pumping	Raw Water Intake	Non-Construction	Total
1	$26,000	$32,000	$26,100	$84,100
5	$130,000	$160,000	$130,500	$420,500
10	$260,000	$320,000	$261,000	$841,000
20	$520,000	$640,000	$522,000	$1,682,000

Annual O&M Costs				
Component Capacity (mgd)	Off-Stream O&M Costs (5,000 ac-ft)	Off-Stream O&M Costs (10,000 ac-ft)	In-Stream O&M Costs (5,000 ac-ft)	In-Stream O&M Costs (10,000 ac-ft)
1	$256,935	$506,935	$381,205	$756,205
5	$284,675	$534,675	$406,025	$781,025
10	$319,350	$569,350	$437,050	$812,050
20	$388,700	$638,700	$499,100	$874,100

Equivalent Annual Costs[2]							
	Off-Stream				In-Stream		UNIT COSTS ($/1000 gal)
Component Capacity (mgd)	Depth 6 ft		Depth 20 ft		Depth 20 ft		
	5,000 acre-ft	10,000 acre-ft	5,000 acre-ft	10,000 acre-ft	5,000 acre-ft	10,000 acre-ft	Off-Stream / In-Stream
1	$537,024	$1,059,175	$2,850,127	$4,005,628	$1,188,802	$3,035,363	$0.019 / $0.017
5	$596,517	$1,118,668	$2,909,620	$4,065,121	$1,245,375	$3,091,935	$0.019 / $0.017
10	$670,883	$1,193,034	$2,983,986	$4,139,487	$1,316,091	$3,162,651	$0.019 / $0.017
20	$819,615	$1,341,766	$3,132,718	$4,288,219	$1,457,523	$3,304,083	$0.019 / $0.017

Set Up Costs						
	Off-Stream				In-Stream	
Component Capacity (mgd)	Depth 6 ft		Depth 20 ft		Depth 20 ft	
	5,000 acre-ft	10,000 acre-ft	5,000 acre-ft	10,000 acre-ft	5,000 acre-ft	10,000 acre-ft
1	$530,089	$1,052,240	$2,843,192	$3,998,693	$1,182,597	$3,029,158
5	$561,842	$1,083,993	$2,874,945	$4,030,446	$1,214,350	$3,060,910
10	$601,533	$1,123,684	$2,914,636	$4,070,137	$1,254,041	$3,100,601
20	$680,915	$1,203,066	$2,994,018	$4,149,519	$1,333,423	$3,179,983

(1) Does not include factors for peak capacity

(2) Includes capital costs of reservoir, capital costs associated with pumping, raw water intake, and operation and maintenance costs

Sources:

Boyle Engineering Corporation, 1990, Water Supply Master Water Plan for Peace River
Camp Dresser & McKee, Inc., 1993
Camp Dresser & McKee, Inc., 1982
CH2M Hill, 1991
CH2M Hill, 1987
Post, Buckley, Schuh & Jernigan, Inc., 1991
Southwest Florida Water Management District, 1992
Dycas, September 26, 1996

Table 6. Aquifer Storage & Recovery Cost Estimates

Treated at System Pressure							
System Capacity (mgd)	Construction Costs	Non-Construction Costs	Total Capital Costs	O&M Costs	Equivalent Annual Costs	Unit Costs - Energy Costs ($/1000 gal)	Set Up Costs
7	$267,427	$120,342	$387,769	$191,625	$213,658	$0.07	$34,808

Treated Water Requiring Pumping							
System Capacity (mgd)	Construction Costs[1]	Non-Construction Costs	Total Capital Costs	O&M Costs	Equivalent Annual Costs	Unit Costs - Energy Costs ($/1000 gal)	Set Up Costs
7	$348,817	$156,968	$505,785	$191,625	$221,341	$0.07	$42,491

(1). The costs include the water treatment system, control system, injection equipment, withdrawal system, and monitoring equipment

Sources:
Post, Buckley, Schuh & Jernigan, 1991

Table 7. Lime Softening Cost Estimates

Urban Land Settings								
Plant Capacity (mgd)[1]	Construction [2]	Non-Construction	Land Cost	Land Acquisition	Total Capital	O&M Costs	Equivalent Annual Costs	Set Up Costs
1	$1,916,767	$862,545	$200,000	$50,000	$3,029,312	$124,439	$404,278	$360,139
5	$4,926,780	$2,217,051	$300,000	$75,000	$7,518,831	$622,195	$1,322,752	$1,102,056
10	$7,685,100	$3,458,295	$450,000	$112,500	$11,705,895	$1,244,391	$2,335,591	$1,898,444
20	$12,201,456	$5,490,655	$850,000	$212,500	$18,754,611	$2,488,782	$4,233,115	$3,367,309

Suburban Land Settings								
Plant Capacity (mgd)	Construction	Non-Construction	Land Cost	Land Acquisition	Total Capital	O&M Costs	Equivalent Annual Costs	Set Up Costs
1	$1,916,767	$862,545	$40,000	$10,000	$2,829,312	$124,439	$390,278	$346,139
5	$4,926,780	$2,217,051	$60,000	$15,000	$7,218,831	$622,195	$1,301,752	$1,081,056
10	$7,685,100	$3,458,295	$90,000	$22,500	$11,255,895	$1,244,391	$2,304,091	$1,866,944
20	$12,201,456	$5,490,655	$170,000	$42,500	$17,904,611	$2,488,782	$4,173,615	$3,307,809

Rural Land Settings								
Plant Capacity (mgd)	Construction	Non-Construction	Land Cost	Land Acquisition	Total Capital	O&M Costs	Equivalent Annual Costs	Set Up Costs
1	$1,916,767	$862,545	$10,000	$2,500	$2,791,812	$124,439	$387,653	$343,514
5	$4,926,780	$2,217,051	$15,000	$3,750	$7,162,581	$622,195	$1,297,814	$1,077,119
10	$7,685,100	$3,458,295	$22,500	$5,625	$11,171,520	$1,244,391	$2,298,185	$1,861,038
20	$12,201,456	$5,490,655	$42,500	$10,625	$17,745,236	$2,488,782	$4,162,459	$3,296,653

Unit Costs			
Average Annual Daily Flow (mgd)	Energy ($/1000 gal)	Chemical ($/1000 gal)	Pumping ($/1000 gal)
1	$0.021	$0.08	0.02
5	$0.021	$0.08	0.02
10	$0.020	$0.08	0.02
20	$0.019	$0.08	0.02

(1) Plant capacity does not include factors for peak conditions.

(2). The construction costs include the head tank, aerator, clarifier, recoarbonation vessel, and filter, and the costs associated with other integral treatment plant components.

Sources:
CBI Walker, Inc., June 16, 1996
Southwest Florida Water Management District, 1990

Table 8. Conventional Water Treatment Process Cost Estimates

Urban Land Settings								
Plant Capacity (mgd)[1]	Construction [2]	Non-Construction	Land Cost	Land Acquisition	Total Capital	O&M Costs	Equivalent Annual Costs	Set Up Costs
1	$1,913,000	$860,850	$200,000	$50,000	$3,023,850	$100,349	$379,673	$359,624
5	$5,658,000	$2,546,100	$300,000	$75,000	$8,579,100	$501,745	$1,302,380	$1,202,135
10	$9,043,500	$4,069,575	$450,000	$112,500	$13,675,575	$1,003,491	$2,280,609	$2,084,362
20	$15,080,000	$6,786,000	$850,000	$212,500	$22,928,500	$2,006,982	$4,145,288	$3,761,282

Suburban Land Settings								
Plant Capacity (mgd)	Construction	Non-Construction	Land Cost	Land Acquisition	Total Capital	O&M Costs	Equivalent Annual Costs	Set Up Costs
1	$1,913,000	$860,850	$40,000	$10,000	$2,823,850	$100,349	$365,673	$345,624
5	$5,658,000	$2,546,100	$60,000	$15,000	$8,279,100	$501,745	$1,281,380	$1,181,135
10	$9,043,500	$4,069,575	$90,000	$22,500	$13,225,575	$1,003,491	$2,249,109	$2,052,862
20	$15,080,000	$6,786,000	$170,000	$42,500	$22,078,500	$2,006,982	$4,085,788	$3,701,782

Rural Land Settings								
Plant Capacity (mgd)	Construction	Non-Construction	Land Cost	Land Acquisition	Total Capital	O&M Costs	Equivalent Annual Costs	Set Up Costs
1	$1,913,000	$860,850	$10,000	$2,500	$2,786,350	$100,349	$363,048	$342,999
5	$5,658,000	$2,546,100	$15,000	$3,750	$8,222,850	$501,745	$1,277,443	$1,177,197
10	$9,043,500	$4,069,575	$22,500	$5,625	$13,141,200	$1,003,491	$2,243,203	$2,046,956
20	$15,080,000	$6,786,000	$42,500	$10,625	$21,919,125	$2,006,982	$4,074,632	$3,690,626

Unit Costs			
Average Annual Daily Flow (mgd)	Energy ($/1000 gal)	Chemical ($/1000 gal)	Pumping ($/1000 gal)
1	$0.021	$0.014	0.02
5	$0.021	$0.014	0.02
10	$0.020	$0.014	0.02
20	$0.019	$0.014	0.02

(1) Plant capacity does not include factors for peak conditions.
(2). The construction costs include costs for flocculation, coagulation, sedimentation, filtration

Sources:
Southwest Florida Water Management District, 1990

Table 9. Aeration Cost Estimates

Component Capacity (mgd)[1]	Construction Costs	Non-Constrction Costs	Total Capital Costs	O&M Costs	Equivalent Annual Costs	Unit Cost Energy ($/1000 gal)	Set Up Costs
1	$74,011	$33,305	$107,316	$3,620	$13,750	$0.0014	$13,226
5	$281,477	$126,665	$408,142	$5,718	$44,242	$0.0014	$41,620
10	$399,635	$179,836	$579,471	$10,188	$64,884	$0.0014	$59,640
20	$509,359	$229,212	$738,571	$17,879	$87,593	$0.0014	$77,106

(1) Component Capacity does not include factors for peak conditions

Note: the costs include the equipment and installation of an aeration unit or degasifier, but they do not include the cost of pumping or storage units.

Sources:

Southwest Florida Water Management District, 1990

Table 10. Water Filtration Cost Estimates

Urban Land Siting									
Component Capactiy [1] (mgd)	Construction Costs[2]	Non-Construction Costs	Land Costs	Land Acquisition	Total Capital Costs - Urban	O&M Costs [3]	Equivalent Annual Costs	Unit Costs Energy ($/1000 gal)	Set Up Costs
1	$570,938	$256,922	$10,000	$2,500	$840,360	$2,772	$82,094	$0.005	$80,234
5	$845,998	$380,699	$20,000	$5,000	$1,251,697	$9,188	$127,335	$0.005	$119,060
10	$1,876,295	$844,333	$32,000	$8,000	$2,760,628	$17,252	$277,828	$0.004	$262,400
20	$3,015,876	$1,357,144	$63,000	$15,750	$4,451,770	$31,804	$452,006	$0.004	$423,227

Suburban Land Siting									
Component Capacity (mgd)	Construction Costs	Non-Construction Costs	Land Costs	Land Acquisition	Total Capital Costs - Suburban	O&M Costs	Equivalent Annual Costs	Unit Costs Energy ($/1000 gal)	Set Up Costs
1	$570,938	$256,922	$2,000	$500	$830,360	$2,772	$81,150	$0.005	$79,290
5	$845,998	$380,699	$4,000	$1,000	$1,231,697	$9,188	$125,448	$0.005	$117,172
10	$1,876,295	$844,333	$6,400	$1,600	$2,728,628	$17,252	$274,807	$0.004	$259,379
20	$3,015,876	$1,357,144	$12,600	$3,150	$4,388,770	$31,804	$446,060	$0.004	$417,280

Rural Land Siting									
Component Capacity (mgd)	Construction Costs	Non-Construction Costs	Land Costs	Land Acquisition	Total Capital Costs - Rural	O&M Costs	Equivalent Annual Costs	Unit Costs Energy ($/1000 gal)	Set Up Costs
1	$570,938	$256,922	$500	$125	$828,485	$2,772	$80,973	$0.005	$79,113
5	$845,998	$380,699	$1,000	$250	$1,227,947	$9,188	$125,094	$0.005	$116,818
10	$1,876,295	$844,333	$1,600	$400	$2,722,628	$17,252	$274,241	$0.004	$258,813
20	$3,015,876	$1,357,144	$3,150	$788	$4,376,958	$31,804	$444,945	$0.004	$416,165

(1) Component capacity does not include factors for peak conditions

(2) The construction costs include all equipment, materials, and installation

(3) The O&M costs include all energy, labor , and other maintenance costs

From:

Post, Buckley, Schuh & Jernigan, 1991

Southwest Florida Water Management District, 1990

Table 11. Reverse Osmosis Cost Estimates

Urban Land Siting									
Plant Capacity[1] (mgd)	Construction	Non-Construction	Land Cost	Land Acquisition	Total Capital Costs	O&M Costs	Equivalent Annual Costs	Unit Costs Energy ($/1,000 gal)	Set Up Costs
3	$6,900,000	$3,105,000	$100,000	$25,000	$10,130,000	$919,800	$3,368,669	$0.27	$3,073,019
5	$9,950,000	$4,477,500	$200,000	$50,000	$14,677,500	$1,460,000	$4,996,223	$0.27	$4,503,473
10	$18,300,000	$8,235,000	$350,000	$87,500	$26,972,500	$2,810,500	$9,312,746	$0.27	$8,327,246
20	$34,000,000	$15,300,000	$700,000	$175,000	$50,175,000	$4,599,000	$16,684,027	$0.27	$14,713,027

Suburban Land Siting									
Plant Capacity (mgd)	Construction	Non-Construction	Land Cost	Land Acquisition	Total Capital Costs	O&M Costs	Equivalent Annual Costs	Unit Costs Energy ($/1,000 gal)	Set Up Costs
3	$6,900,000	$3,105,000	$20,000	$5,000	$10,030,000	$919,800	$3,361,669	$0.27	$3,066,019
5	$9,950,000	$4,477,500	$40,000	$10,000	$14,477,500	$1,460,000	$4,982,223	$0.27	$4,489,473
10	$18,300,000	$8,235,000	$70,000	$17,500	$26,622,500	$2,810,500	$9,288,246	$0.27	$8,302,746
20	$34,000,000	$15,300,000	$140,000	$35,000	$49,475,000	$4,599,000	$16,635,027	$0.27	$14,664,027

Rural Land Siting									
Plant Capacity (mgd)	Construction	Non-Construction	Land Cost	Land Acquisition	Total Capital Costs	O&M Costs	Equivalent Annual Costs	Unit Costs Energy ($/1,000 gal)	Set Up Costs
3	$6,900,000	$3,105,000	$5,000	$1,250	$10,011,250	$919,800	$3,360,357	$0.27	$3,064,707
5	$9,950,000	$4,477,500	$10,000	$2,500	$14,440,000	$1,460,000	$4,979,598	$0.27	$4,486,848
10	$18,300,000	$8,235,000	$17,500	$4,375	$26,556,875	$2,810,500	$9,283,652	$0.27	$8,298,152
20	$34,000,000	$15,300,000	$35,000	$8,750	$49,343,750	$4,599,000	$16,625,840	$0.27	$14,654,840

(1) Plant capacity does not include factors for peak conditions

NOTE: Assumed TDS = 3,500 - 4,500 ppm ; 80-85% recovery

The cost include those associated with the reverse osmosis process and deep well disposal of the brine

Sources:

Camp Dresser & McKee, 1991

Post, Buckley, Schuh, & Jernigan, 1989

Post, Buckley, Schuh, & Jernigan, 1991

Table 12. Desalination Cost Estimates

Plant Capacity [1] (mgd)	Construction[2]	Non-Construction	Land	Land Acquisition	Total Capital Costs	O&M Costs[3]	Equivalent Annual Cost	Unit Costs Energy ($/1000gal)	Set Up Costs
20	$76,127,421	$34,257,339	$200,000	$50,000	$110,634,761	$26,383,741	$36,820,459	$1.60	$25,140,459
30	$111,704,355	$50,266,960	$300,000	$75,000	$162,346,315	$39,128,430	$54,443,152	$1.60	$36,923,152

(1) Plant Capacity does not include factors for peak conditions

(2) The construction costs the water intake system, desalination plant, storage units, pumping and transmission systems, and brine disposal

(3) The O&M costs include energy, labor, chemicals, and normal maintenance

From:

LAW, 1994

Horne, 1991

Table 13. Disinfection Cost Estimates

Component Capacity[1] (mgd)	Construction[2]	Non-Construction	Total Capital	O&M Costs[3]	Equivalent Annual Cost	Unit Costs Chemical ($/1000 gal)	Unit Costs Energy ($/1000 gal)	Set up Costs
1	$59,066	$26,580	$85,646	$13,156	$21,240	$0.017	$0.003	$14,187
5	$91,047	$40,971	$132,018	$38,325	$50,786	$0.017	$0.003	$15,521
10	$152,407	$68,583	$220,990	$69,350	$90,209	$0.016	$0.001	$28,976
20	$275,000	$123,750	$400,750	$131,400	$169,227	$0.016	$0.001	$48,190

(1) Component capacity does not include factors for peak conditions
(2) The construction costs include equipment and installation
(3) The O&M costs include energy, labor, chemicals, and normal maintenance

Sources:
Post, Buckley, Schuh & Jernigan, 1991
Southwest Florida Water Management District, 1990

Table 14. Storage Facility Cost Estimates

Storage Tanks				
Volume (million gallons)	Construction Costs	Non-Construction Costs	Total Capital Cost	Equivalent Annualized Cost
1	$267,917	$120,563	$388,480	$30,002
2	$412,180	$185,481	$597,661	$46,157
3	$515,225	$231,851	$747,076	$57,697
4	$628,574	$282,858	$911,433	$70,390
5	$741,924	$333,866	$1,075,790	$83,083

Storage Tanks with 1300 GPM Aerator				
Volume (million gallons)	Construction Costs	Non-Construction Costs	Total Capital Cost	Equivalent Annualized Cost
1	$280,282	$126,127	$406,409	$31,686
2	$424,545	$191,045	$615,591	$47,841
3	$527,590	$237,416	$765,006	$59,380
4	$640,940	$288,423	$929,363	$72,073
5	$754,289	$339,430	$1,093,719	$84,767

Storage Tanks with 750 GPM Aerator				
Volume (million gallons)	Construction Costs	Non-Construction Costs	Total Capital Cost	Equivalent Annualized Cost
1	$309,135	$139,111	$448,246	$35,613
2	$453,398	$204,029	$657,427	$51,768
3	$556,443	$250,399	$806,842	$63,308
4	$669,792	$301,407	$971,199	$76,001
5	$783,142	$352,414	$1,135,556	$88,694

Sources :
Boyle Engineering Corporation, 1990, Comprehensive Master Water System Plan
Crom Corporation, January 5, 1996

Table 15. Pump Station Cost Estimates

Urban Land Siting									
Component Capacity[1] (mgd)	Construction Costs[2]	Non-Construction Costs	Land Costs[3]	Land Acquisition	Total Capital Costs	O&M Costs[4]	Equivalent Annual Cost	Unit costs Energy ($/1000 gal)	Set Up Costs
1	$300,000	$135,000	$300,000	$75,000	$810,000	$21,334	$88,644	$0.052	$69,782
5	$600,000	$270,000	$300,000	$75,000	$1,245,000	$97,407	$205,776	$0.052	$111,465
10	$1,000,000	$450,000	$300,000	$75,000	$1,825,000	$192,965	$356,081	$0.052	$167,460
20	$1,500,000	$675,000	$300,000	$75,000	$2,550,000	$381,586	$613,134	$0.052	$235,892

Suburban Land Siting									
Component Capacity[1] (mgd)	Construction Costs[2]	Non-Construction Costs	Land Costs[3]	Land Acquisition	Total Capital Costs	O&M Costs[4]	Equivalent Annual Cost	Unit costs Energy ($/1000 gal)	Set Up Costs
1	$300,000	$135,000	$60,000	$15,000	$510,000	$21,334	$67,644	$0.052	$48,782
5	$600,000	$270,000	$60,000	$15,000	$945,000	$97,407	$184,776	$0.052	$90,465
10	$1,000,000	$450,000	$60,000	$15,000	$1,525,000	$192,965	$335,081	$0.052	$146,460
20	$1,500,000	$675,000	$60,000	$15,000	$2,250,000	$381,586	$592,134	$0.052	$214,892

Rural Land Siting									
Component Capacity[1] (mgd)	Construction Costs[2]	Non-Construction Costs	Land Costs[3]	Land Acquisition	Total Capital Costs	O&M Costs[4]	Equivalent Annual Cost	Unit costs Energy ($/1000 gal)	Set Up Costs
1	$300,000	$135,000	$15,000	$3,750	$453,750	$21,334	$63,706	$0.052	$44,844
5	$600,000	$270,000	$15,000	$3,750	$888,750	$97,407	$180,838	$0.052	$86,528
10	$1,000,000	$450,000	$15,000	$3,750	$1,468,750	$192,965	$331,143	$0.052	$142,522
20	$1,500,000	$675,000	$15,000	$3,750	$2,193,750	$381,586	$588,197	$0.052	$210,955

(1)Component capacity does not include factors for peak conditions.
(2) The construction costs include all equipment and installation.
(3) The land costs are based on 3 acres of land
(4) The O&M costs include normal maintenance, energy, chemicals, and labor.

Sources:
Greeley & Hansen, October 3, 1996

Table 16. Water Metering & Backflow Prevention Cost Estimates

Size	Construction Cost[1]	Non-Construction Costs	Total Capital Cost	O&M Costs[2]	Equivalent Annual Cost	Set Up Cost
Insertion Paddle Wheel						
6"	$6,133	$2,760	$8,893	$500	$1,339	$1,339
8"	$8,048	$3,622	$11,670	$500	$1,601	$1,601
Venturi						
6"	$7,133	$3,210	$10,343	$500	$1,476	$1,476
8"	$9,848	$4,432	$14,280	$500	$1,848	$1,848
Turbine						
6"	$10,633	$4,785	$15,418	$500	$1,955	$1,955

(1) Construction Costs include the meter and backflow prevention devices.

(2) The O&M costs consist of an annual maintenance call to calibrate the devices.

Sources:

Badger Meter, Inc., June 19, 1996

CLA-VAL Company, January 5, 1996

Table 17. Transmission Main Cost Estimates

Pipe Size (in dia)	Construction Costs ($/ft)	Non-construction Costs ($/ft)	Total ($/ft)	Land Requirement (sq ft /ft pipe)
12	31	14	45	15
16	44	20	63	15
20	56	25	81	15
24	69	31	100	15
30	87	39	127	20
36	106	48	154	20
42	125	56	181	25
48	161	73	234	25
54	191	86	276	30
60	220	99	319	30

Note: The costs include the complete installed pipe, but do not include jack and bore encasement, tunnels, or valves.

Land Costs

	Adjacent to Public ROW			
	Easement ($/sq ft)		ROW ($/sq ft)	
	Land	Acquisition	Land	Acquisiton
Urban	$4.00	$1.00	$6.00	$1.50
Suburban	$1.75	$0.44	$3.00	$0.75
Rural	$0.75	$0.19	$1.00	$0.25
	New Areas			
	Easement ($/sq ft)		ROW ($/sq ft)	
	Land	Acquisition	Land	Acquisiton
Urban	$3.00	$0.75	$5.00	$1.25
Suburban	$1.00	$0.25	$2.00	$0.50
Rural	$0.50	$0.13	$0.75	$0.19

Sources:
West Coast Regional Water Supply Authority, 1995

Table 18. Valve Cost Estimates

Valve Size (in)	Construction Costs	Nonconstruction Costs	Total
12	$1,956	$880	$2,836
16	$4,148	$1,866	$6,014
20	$6,339	$2,853	$9,192
24	$8,531	$3,839	$12,370
30	$11,818	$5,318	$17,136
36	$15,106	$6,797	$21,903
42	$18,393	$8,277	$26,670
48	$24,936	$11,221	$36,157
54	$36,082	$16,237	$52,319
60	$47,229	$21,253	$68,482

(1) The costs are for butterfly valves

(2) The cost include the complete installed cost of the valves

Source:

West Coast Regional Water Supply Authority, 1995

Table 19. Jack and Bore Cost Estimates

Size (in)	Construction Costs ($/ft)	Nonconstruction Costs ($/ft)	Total ($/ft)
30	$164	$74	$237
36	$349	$157	$507
42	$535	$241	$776
48	$721	$324	$1,045
54	$906	$408	$1,314
60	$1,092	$491	$1,583
66	$1,277	$575	$1,852
72	$1,463	$658	$2,121
78	$1,648	$742	$2,390
84	$1,834	$825	$2,659
90	$2,020	$909	$2,928
96	$2,205	$992	$3,197
102	$2,391	$1,076	$3,467
108	$2,576	$1,159	$3,736

(1) The costs include the complete installed bore and tunnel lining bulkhead, and/or grout. Also included are the costs of the carrier pipe installation

Source:

West Coast Regional Water Supply Authority, 1995

Table 20. Total Transmission Main Cost Estimates

Pipe Size (in. dia)	Construction Costs	Nonconstruction Costs	Total
12	$33	$15	$48
16	$46	$21	$67
20	$61	$27	$88
24	$75	$34	$109
30	$96	$43	$140
36	$118	$53	$171
42	$139	$62	$201
48	$178	$80	$258
54	$211	$95	$306
60	$244	$110	$354

(1) The costs include the pipeline, valves, and jack and bores

(2) A valve was assumed to occur once per mile of pipeline

(3) Jack and bores were assumed to occur once every 5 miles.

Source:
West Coast Regional Water Supply Authority, 1995

Table 21. Wastewater Filtration System Cost Estimates

Urban Land Setting									
Component Capacity (mgd) (1)	Construction Costs(2)	Non-Construction Costs	Land Costs	Land Acquisition	Total Capital Costs	O&M Costs(3)	Equivalent Annual Costs	Unit Costs Energy ($/1000 gal)	Set Up Costs
1	$822,789	$370,255	$10,000	$2,500	$1,205,544	$5,666	$119,457	$0.012	$115,015
5	$2,206,913	$993,111	$20,000	$5,000	$3,225,024	$20,080	$324,490	$0.010	$305,634
10	$3,644,514	$1,640,031	$32,000	$8,000	$5,324,545	$37,318	$539,901	$0.010	$504,720
20	$5,217,838	$2,348,027	$63,000	$15,750	$7,644,615	$68,707	$790,282	$0.009	$724,599

Suburban Land Siting									
Component Capacity (mgd)	Construction Costs	Non-Construction Costs	Land Costs	Land Acquisition	Total Capital Costs	O&M Costs	Equivalent Annual Costs	Unit Costs Energy ($/1000 gal)	Set Up Costs
1	$822,789	$370,255	$2,000	$500	$1,195,544	$5,666	$118,513	$0.012	$114,071
5	$2,206,913	$993,111	$4,000	$1,000	$3,205,024	$20,080	$322,603	$0.010	$303,746
10	$3,644,514	$1,640,031	$6,400	$1,600	$5,292,545	$37,318	$536,881	$0.010	$501,699
20	$5,217,838	$2,348,027	$12,600	$3,150	$7,581,615	$68,707	$784,335	$0.009	$718,653

Rural Land Siting									
Component Capacity (mgd)	Construction Costs	Non-Construction Costs	Land Costs	Land Acquisition	Total Capital Costs	O&M Costs	Equivalent Annual Costs	Unit Costs Energy ($/1000 gal)	Set Up Costs
1	$822,789	$370,255	$500	$125	$1,193,669	$5,666	$118,336	$0.012	$113,894
5	$2,206,913	$993,111	$1,000	$250	$3,201,274	$20,080	$322,249	$0.010	$303,392
10	$3,644,514	$1,640,031	$1,600	$400	$5,286,545	$37,318	$536,315	$0.010	$501,133
20	$5,217,838	$2,348,027	$3,150	$788	$7,569,803	$68,707	$783,220	$0.009	$717,538

(1) The component capacity does not include factors for peak conditions
(2) The construction costs include all equipment, material, and installation
(3) The O&M costs include all energy, labor, and other maintenance
Note: The costs presented above are for a gravity dual-media filter

Sources:
Southwest Florida Water Mnagement District, 1990

Table 22. High Level Disinfection Cost Estimates

Component Capacity(1)	Construction(2)	Non-Construction	Total Capital	O&M Costs(3)	Equivalent Annual Cost	Unit Costs Chemical ($/1000 gal)	Unit Costs Energy ($/1000 gal)	Set up Costs
1	$134,562	$60,553	$195,115	$17,520	$35,937	$0.034	$0.003	$22,565
5	$245,895	$110,653	$356,547	$69,350	$103,004	$0.034	$0.003	$36,146
10	$347,820	$156,519	$504,339	$127,750	$175,355	$0.032	$0.001	$55,027
20	$517,141	$232,713	$749,854	$248,200	$318,979	$0.032	$0.001	$79,755

(1) The component capacity does not include factors for peak conditions
(2) The construction costs include the equipmnet and installation
(3) The O&M costs include energy, labor, chemicals, and normal maintenance
Note:The costs are for upgrading the disinifection system to high level disinfection

Sources:
Southwest Florida Water Management Distruct, 1990
EPA, 1979

Table 23. Cost Estimates for Upgrading Wastewater Treatment from Advanced Secondary to Advanced Wastewater Treatment

Component Capacity (mgd) [1]	Construction Costs	Non-construction Costs	Total Capital Costs	O&M Costs	Equivalent Annualized Costs
1	$1,134,562	$510,553	$1,645,115	$109,500	$264,782
5	$5,245,895	$2,360,653	$7,606,547	$547,500	$1,265,482
10	$10,347,820	$4,656,519	$15,004,339	$1,095,000	$2,511,260
20	$20,517,141	$9,232,713	$29,749,854	$2,190,000	$4,998,089

(1) Component capacity does not include factors for peak conditions

Note: The costs include deep bed filters, the addition of methanol and alum, and high level disinfection components

Sources:

Greeley & Hansen, October 3, 1996

EPA, 1979

Southwest Florida Water Management District, 1990

Table 24. Force Main Cost Estimates

Construction Cost[1] ($/ft) Diameter (in)				
6	8	10	12	16
$15	$19	$24	$27	$37

Non-Construction($/ft) Diameter (in)				
6	8	10	12	16
$7	$9	$11	$12	$17

	Land Cost ($/ft) Adjacent to Public ROW Diameter (in)					Land Cost ($/ft) New Areas Diameter (in)				
	6	8	10	12	16	6	8	10	12	16
Easement										
Urban	$48	$48	$48	$60	$60	$36	$36	$36	$45	$45
Suburban	$18	$18	$18	$23	$23	$12	$12	$12	$15	$15
Rural	$9	$9	$9	$11	$11	$6	$6	$6	$8	$8
ROW										
Urban	$72	$72	$72	$90	$90	$60	$60	$60	$75	$75
Suburban	$36	$36	$36	$45	$45	$24	$24	$24	$30	$30
Rural	$12	$12	$12	$15	$15	$9	$9	$9	$11	$11

	Land Acquisition ($/ft) Adjacent to Public ROW Diameter (in)					Land Acquisition ($/ft) New Areas Diameter (in)				
	6	8	10	12	16	6	8	10	12	16
Easement										
Urban	$12	$12	$12	$15	$15	$9	$9	$9	$11	$11
Suburban	$5	$5	$5	$6	$6	$3	$3	$3	$4	$4
Rural	$2	$2	$2	$3	$3	$2	$2	$2	$2	$2
ROW										
Urban	$18	$18	$18	$23	$23	$15	$15	$15	$19	$19
Suburban	$9	$9	$9	$11	$11	$6	$6	$6	$8	$8
Rural	$3	$3	$3	$4	$4	$2	$2	$2	$3	$3

	Total Capital Cost($/ft) Adjacent to Public ROW Diameter (in)					Total Capital Cost($/ft) New Areas Diameter (in)				
	6	8	10	12	16	6	8	10	12	16
Easement										
Urban	$82	$88	$95	$114	$129	$67	$73	$80	$95	$110
Suburban	$44	$50	$57	$67	$82	$37	$43	$50	$58	$72
Rural	$33	$39	$46	$53	$68	$29	$35	$42	$49	$63
ROW										
Urban	$112	$118	$125	$152	$166	$97	$103	$110	$133	$147
Suburban	$67	$73	$80	$95	$110	$52	$58	$65	$77	$91
Rural	$37	$43	$50	$58	$72	$33	$39	$46	$53	$68

	Equivalent Annual Cost ($/ft) Adjacent to Public ROW Diameter (in)					Equivalent Annual Cost ($/ft) New Areas Diameter (in)				
	6	8	10	12	16	6	8	10	12	16
Easement										
Urban	$6	$6	$7	$8	$9	$5	$5	$6	$7	$8
Suburban	$3	$4	$4	$5	$6	$3	$3	$4	$4	$5
Rural	$2	$3	$3	$4	$5	$2	$3	$3	$4	$5
ROW										
Urban	$8	$8	$9	$11	$12	$7	$7	$8	$9	$11
Suburban	$5	$5	$6	$7	$8	$4	$4	$5	$6	$7
Rural	$3	$3	$4	$4	$5	$2	$3	$3	$4	$5

(1) The construction costs include the force main, fittings, anf the installation of the main

Note:
Hartman & Associates, July 2,1996

Table 25. Wastewater Metering & Backflow Prevention Cost Estimates

Ulta Sonic-Spool						
Size	Construction Cost[1]	Non-Construction Costs	Total Capital Cost	O&M[2]	Equivalent Annual Cost	Set Up Cost
6"	$8,933	$4,020	$12,953	$500	$1,721	$1,721
8"	$11,148	$5,017	$16,165	$500	$2,024	$2,024

(1) The construction costs include a meter and a backflow prevention device
(2) The O&M costs consist of an annual maintenance call to calibrate the devices

Sources:
Badger Meter Inc., July 19, 1996
CLA-VAL Company, June 18, 1996

APPENDIX A

FEBRUARY 29, 1996
LETTER STATING ECONOMIC ANALYSIS CRITERIA

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

Henry Dean, Executive Director
John R. Wehle, Assistant Executive Director
Charles T. Myers III, Deputy Assistant Executive Director

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February 29, 1996

Mr. C. Edwin Copeland, P.E.
Law Engineering and Environmental Services
4919 Laurel Street
Tampa, Florida 33607

Re: SJRWMD Contract No. 95W166A, Alternative Water Supply Strategies Investigation, economic analysis criteria

Dear Mr. Copeland:

Thank you for your participation in the February 16, 1996, project team meeting. Based on the discussions held at that meeting the following economic analysis criteria are to be used in association with the referenced contract. Using these criteria, capital costs, annual operation and maintenance costs, and total annualized costs should be developed.

- Construction cost index - Construction and subsequent capital cost should be expressed in current (1996) dollars.

- Land cost- Land costs from the following table should be used plus a land acquisition factor of 25 percent of the estimated land cost. This 25 percent includes the cost of engineering, administrative, and legal services, etc. associated with the land acquisition process.

	Parcels for Individual Wells, Booster Stations, Small WTPs, etc. 2 - 50 acres (ac) ($/ac)	Parcels for Wellfields, Major WTPs, etc. 100 - 500 ac ($/ac)	Parcels for Reservoirs, Mitigation areas, etc. 250-3000 ac ($/ac)	Pipeline Corridors			
				Adjacent to Public ROW		New Areas	
				Easement ($/sq ft)	ROW ($/sq ft)	Easement ($/sq ft)	ROW ($/sq ft)
Urban	$100,000	-	-	$4.00	$6.00	$3.00	$5.00
Suburban	$20,000	$10,000	-	$1.50	$3.00	$1.00	$2.00
Rural	$5,000	$3,000	$3,000	$0.75	$1.00	$0.50	$0.75

- Non-construction capital cost allowance - An allowance of 45 percent should be used with the following breakdown of percent by category.

Category	Percent
engineering and permitting	15 percent
administration	10 percent
contingency	20 percent

- Time value of money - A time value of money of 7 percent should be used.

- Cost escalation - None - all cost comparisons and economic optimization should be developed in current(1996) dollars.

- Economic life of facilities - The following economic service life guidelines for water resources system components should be used.

Component Type	Service Life
Land	permanent
Water conveyance structures (including pipelines, collection and distribution systems, interceptors, force mains, drop shafts, tunnels, spillways, etc.)	50 years
Other structures (including buildings, concrete tankage, pumping station structures, and site improvements, etc.)	40 years
Process and auxiliary equipment (including treatment equipment such as clarifier mechanisms and filters, steel process tankage, chemical storage facilities, standby electrical generating equipment, pumps and motors, instrumentation and control facilities, mechanical equipment such as compressors, aeration systems, chlorinators, other eletctical equipment in regular service, etc.)	20 years
Wells	40 years
Reverse osmosis membranes	5 years

Please contact me if you have questions concerning this matter.

Sincerely,

Barbara A. Vergara, P.G., Director
Division of Needs and Sources

BAV

cc: JoAnn Jackson, P.E.
Ron Wycoff, P.E.
Donald Hearn, Ph.D.
Kirk Hatfield, Ph.D
Carol Demas
Hal Wilkening, P.E.
Doug Munch, P.G.
Don Brandes, Ph.D.
Cynthia Moore
Patrick Burger

APPENDIX B

APRIL 5, 1996
LETTER SUPPLEMENTING ECONOMIC ANALYSIS CRITERIA

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

Henry Dean, Executive Director
John R. Wehle, Assistant Executive Director
Charles T. Myers III, Deputy Assistant Executive Director

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April 5, 1996

Mr. C. Edwin Copeland, Jr., P.E.
Law Engineering and Environmental Services, Inc.
491 West Laurel Street
Tampa, Florida 33607

Re: SJRWMD Contract No. 95W166C, Alternative Water Supply Strategies Investigation, economic analysis criteria

Dear Mr. Copeland:

The following definitions supplement the economic analysis criteria cited in my February 29, 1996, letter to you. This array of cost parameters should be developed for each alternative water supply option.

1. **construction cost** - The total amount expected to be paid to a qualified contractor to build the required facilities.
2. **non-construction capital cost** - An allowance for engineering design, permitting, administration and construction contingency associated with the constructed facilities. In this project non-construction capital cost will equal 45 percent of the estimated construction cost.
3. **land cost** - The market value of the land required to implement the water supply option.
4. **land acquisition cost** - The estimated cost of acquiring the required land. In this project land acquisition cost will equal 25 percent of the land market value.
5. **total capital cost** - Construction cost plus non-construction capital cost plus land cost plus land acquisition cost (the sum of items 1 through 4).
6. **operation and maintenance (O&M) cost** - The estimated annual cost of operating and maintaining the water supply option when operating at design capacity. The average daily flow (production or transport) associated with the annual O&M cost should also be reported.
7. **equivalent annual cost** - Total annual life cycle cost of water supply option based on service life and time value of money criteria established in the economic analysis criteria letter dated February 29, 1996.
8. **unit cost** - That portion of the annual O&M cost that varies with production (or transport) rate. For example, energy and chemical costs are components of the unit cost, whereas routine maintenance and base level labor are not. The unit cost should be expressed in terms of dollars per 1,000 gallons.

Each of these cost categories were addressed in the economic analysis criteria letter with the exception of the unit cost. This cost parameter will allow representation of a variable production rate from a given option in the decision model which is being prepared by the University of Florida.

Sincerely,

Barbara A. Vergara, P.G., Director
Division of Needs and Sources

BAV
cc: Hal Wilkening, P.E.
Patrick Burger
Alan Weaver

APPENDIX C

JUNE 5, 1996
LETTER SUPPLEMENTING WATER SUPPLY FACILITIES SERVICE LIFE

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

Henry Dean, Executive Director
John R. Wehle, Assistant Executive Director
Charles T. Myers III, Deputy Assistant Executive Director

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June 5, 1996

Mr. C. Edwin Copeland, Jr., P.E.
Law Engineering and Environmental Services, Inc.
4919West Laurel Street
Tampa, Florida 33607

Re: SJRWMD Contract No. 95W166C, Alternative Water Supply Strategies Investigation, economic analysis criteria

Dear Mr. Copeland:

As a result of issues raised by Jerry Salsano, Sanlando Utilities Corp., at a recent Public Water Supply Advisory Group meeting, revisions to the water supply facilities service life criteria appear to be necessary for the purpose of consistency with Public Service Commission (PSC) requirements. Attached is a table comparing the current service life criteria, PSC service life criteria, and proposed revised service life criteria. Please use the proposed revised service life criteria in place of the current criteria which is set forth in my February 29, 1996, letter to you.

Please contact me if you have questions concerning this matter.

Sincerely,

Barbara A. Vergara, P.G., Director
Division of Needs and Sources

BAV
Attachment
cc: Public Water Supply Advisory Group
Donald Hearn, Ph.D.
Kirk Hatfield, Ph.D.
Carol Demas
Hal Wilkening, P.E.
Don Brandes, Ph.D.
Patrick Burger

Water Supply Facilities Service Life Criteria Comparison

Component Type	Current Service Life Criteria (established by project team)	PSC - Service Life Criteria (from Sanlando Utilities annual report)	Proposed Revised Service Life Criteria
Land	permanent	na	permanent
Water Conveyance Structures (pipelines, collection and distribution systems)	50 years	35 to 43 years	40 years
Other Structures (buildings, tankage, site improvements etc.)	40 years	33 years	35 years
Wells	40 years	30 years	30 years
Process and Auxiliary Equipment (treatment equipment, pumps motors, mechanical equipment etc.)	20 years	20 to 22 years	20 years
Reverse Osmosis Membranes	5 years	na	5 years