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WATER SUPPLY NEEDS AND SOURCES ASSESSMENT ALTERNATIVE WATER SUPPLY STRATEGIES INVESTIGATION REPLACEMENT OF POTABLE QUALITY WATER FOR LANDSCAPE IRRIGATION

by

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EXECUTIVE SUMMARY

As part of the St. Johns River Water Management District (SJRWMD) Investigation of Alternative Water Supply Strategies, Post Buckley, Schuh & Jernigan, Inc. (PBS&J) was tasked with estimating the cost of replacing potable quality water used for landscape irrigation with alternative supplies. More specifically, the assignment was to determine the quantity of publicly supplied potable water that could effectively be replaced with water from shallow, self-supply irrigation wells or with reclaimed water and to estimate the costs associated with each of these alternative supplies.

This study was divided into two phases. In Phase I, which was completed in 1996, PBS&J conducted an assessment of data availability and established a methodology for performing the Phase II work. The Phase I results were presented in the report *Phase I: Replacement of Potable Quality Water for Landscape Irrigation* (Talton et al. 1996). Based on the methodology outlined in Phase I, PBS&J conducted Phase II of the assignment. The Phase II scope of services included the following subtasks:

- Estimate the quantity of publicly supplied water used for landscape irrigation that can be replaced with alternative water supplies using a methodology that compares minimum month water withdrawals to annual average water withdrawals for the 25 largest utilities in the Priority Water Resource Caution Area (PWRCA).

- Estimate the amount of reclaimed water available (based on a 1995 inventory conducted by SJRWMD) for landscape irrigation on an annual average and seasonal basis.

- Estimate the cost of replacing publicly supplied landscape irrigation water with shallow, self-supply irrigation wells.

- Estimate the cost of replacing publicly supplied landscape irrigation water with reclaimed water.

The results of the Phase II analysis are presented in this report.

A minimum month water use analysis was used to estimate the replaceable portion of publicly supplied landscape irrigation. The replaceable portion approximates irrigation water supplied from in-ground irrigation systems as opposed to portable hoses and sprinklers.

Using the "minimum month" methodology, it was estimated that approximately 20 percent of the publicly supplied water potentially could be replaced with alternative supplies. This amounts to a potential estimated savings of 93.71 million gallons per day (mgd) based on 2010 water use projections for the 25 largest utilities in the PWRCA. Achieving this maximum potential is limited, however. Quality and quantity concerns with water from the surficial aquifer limit the amount that can be replaced by self-supply irrigation wells by 50 percent (limited to 46.86 mgd in 2010). Replacement with reclaimed water is limited by the seasonal availability of reclaimed water. Although on an annual average basis there appears to be adequate reclaimed water supply (112 mgd of available reclaimed water in 1995 compared to a 50.5 mgd estimated 1995 replaceable quantity), on a seasonal basis, the average reclaimed water supply available could be limited by as much as 50 percent, with even less available to meet maximum day demands, unless large storage volumes are provided.

To determine the cost of using self-supply irrigation wells to replace the publicly supplied water used for landscape irrigation, it was necessary to determine the number of wells needed. This was determined by estimating a unit residential (per lot) irrigation rate and dividing this amount into the estimated replaceable quantity. Using this method, a total of 120,773 wells would be needed by 2010 to replace an estimated 46.86 mgd.

The unit cost of using reclaimed water is variable depending on the location of the wastewater treatment facilities and additional levels of treatment needed to serve public access reuse customers. Component unit costs were developed for the various elements of a reclaimed system, including additional treatment, pumping, storage, transmission, macro-distribution, and micro-distribution. An example cost calculation was performed to illustrate the recommended reclaimed water replacement cost estimation method.

Mapping was developed to illustrate the proximity of the wastewater treatment facilities to the public water supply service areas, availability of reclaimed water based on the 1995 reuse inventory prepared by SJRWMD, and treatment levels provided based on the 1995 reuse inventory. The mapping and unit cost information can be utilized by SJRWMD in the decision modeling process to determine the estimated costs of various reclaimed water options. Because of the seasonal variation in reclaimed water availability, it is recommended that a factor of 50 percent be applied to the annual average availability to determine the amount that would be available to serve the seasonal peak needs of the estimated replaceable landscape irrigation quantities. Because many utilities may have seasonal or future commitments for reclaimed water shown as "available" in the 1995 inventory, it is recommended that a more detailed analysis of availability be conducted should this alternative prove to be a viable strategy in the decision modeling process.

Caution should be exercised regarding conclusions about the impacts of replacing potable water for irrigation with water from other sources. Total water consumption may increase because non-potable water sources generally come to the consumer at lower cost than potable water. Therefore, reclaimed water sources must generally provide a greater volume than the potable water source they replace. In some instances where a flat rate is charged for reclaimed water for residential landscape irrigation, reclaimed water use may be several times greater than potable water use for irrigation.

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INTRODUCTION

BACKGROUND

St. Johns River Water Management District (SJRWMD) is responsible for managing ground water resources in a nineteen-county area of northeastern Florida. Ground water aquifers are currently the primary sources of potable water supply in SJRWMD. The most dependable ground water source is the Floridan aquifer. However, Vergara (1994) projected shortfalls in available water supply in certain critical areas throughout SJRWMD boundaries by the year 2010. Areas with existing or 2010 projected water supply problems were designated as Priority Water Resource Caution Areas (PWRCAs).

As a result of the *Water Supply Needs and Sources Assessment*, SJRWMD embarked on an Investigation of Alternative Water Supply Strategies. Strategies being investigated include using lower quality ground water supplies, surface water, reclaimed water, aquifer recharge, aquifer storage and recovery, mitigation and avoidance, and various water conservation techniques.

SJRWMD contracted with Post, Buckley, Schuh & Jernigan, Inc. (PBS&J) to perform various tasks for the purpose of assessing water conservation and reuse of reclaimed water as effective alternative water supply strategies. This report specifically addresses Task I - *Replacement of Potable Quality Water for Landscape Irrigation*.

The task was divided into two phases. The first phase, completed in 1996 by PBS&J, was summarized by Talton et al. (1996). The purpose of Phase I was to conduct a data assessment and develop a scope of services for Phase II. The purpose of Phase II was to estimate the quantities of publicly supplied potable water used for landscaped irrigation that could be replaced by alternate supplies and estimate the cost of replacement with surficial ground water and with reclaimed water. The information provided herein presents the findings of Phase II of the project.

PURPOSE

Scope Of Services

The scope of services for Phase II was developed as part of the Phase I investigations. In Phase I, it was determined that the most complex portion of the study would be the estimation of quantities of publicly supplied potable water for landscape irrigation. Multiple methods to estimate these quantities were evaluated to select the simplest methodology that would provide meaningful results for a planning-level study. Based on the Phase I evaluation, a method that uses monthly water use data from representative utilities was developed. The following summarizes the specific scope of services for Phase II:

- Subtask 1 - Estimates of Landscape Irrigation - Utilize monthly water use data from representative utilities in the study area to provide an estimate of potable water used for landscape irrigation.

- Subtask 2 - Determination of Total Quantity of Landscape Irrigation Water Used by 25 Largest Utilities in Study Area - Apply data developed in Subtask 1 to the largest 25 utilities to estimate a total quantity of public water supply used for landscape irrigation.

- Subtask 3 - Reclaimed Water Availability - Estimate the amount of reclaimed water currently available to replace public water supply for landscape irrigation.

- Subtask 4 - Estimated Cost for Landscape Irrigation with Self Supply Irrigation Wells - Determine the cost of replacing public water supply for landscape irrigation with individual self-supply irrigation wells.

- Subtask 5 - Estimated Cost for Landscape Irrigation with Reclaimed Water - Determine the cost of replacing public water supply for landscape irrigation with reclaimed water.

- Subtask 6 - Report Preparation - Prepare a report summarizing the findings of the study.

- Subtask 7 - Project Progress Meetings - Conduct progress meetings as needed throughout the course of the project.

METHODS

GENERAL

The following methodology was performed to investigate the feasibility of replacing publicly supplied potable water used for landscape irrigation with reclaimed water and shallow self-supply wells. The methodology was based on the recommendations of Talton et al. (1996).

The methodology consists of developing estimates for:

- Volume of publicly supplied water used for landscape irrigation for the 25 largest utilities in the PWRCA by evaluating the difference in monthly low and monthly average water use,
- Reclaimed water availability from existing data provided by SJRWMD,
- General costs for serving landscape irrigation demands with self-supply irrigation wells, and
- General costs for serving landscape irrigation demands with reclaimed water.

LANDSCAPE IRRIGATION QUANTITIES

The estimation of landscape irrigation quantities was based on an analysis of monthly water use data for the 25 largest water utilities in the PWRCA.

Six years of public water supply use data were taken from SJRWMD public supply water use data base (File name: *short96j.xls 10/8/96*), for the following thirteen utilities:

Orange County Utilities
Orlando Utilities Commission
City of Cocoa
City of Daytona Beach
City of Winter Park
Florida Water Service (formerly Southern States Utilities)
City of Sanford
City of Titusville
City of Ormond Beach
City of New Smyrna Beach
City of Port Orange
City of Leesburg
City of Oveido

At least three years of public water supply use data were acquired by PBS&J for the following five utilities:

Seminole County Utilities (4 years)
City of Altamonte Springs (6 years)
City of DeLand (3 years)
City of Maitland (3 years)
Sanlando Utilities (3 years)

At least one year of public water supply use data or the average and minimum monthly public water supply use was acquired by PBS&J for the following six utilities:

City of Ocoee
City of Apopka (2 years)
Villages of Lake/Sumter
City of Winter Springs
City of Casselberry (average annual only)
City of Eustis

No additional data were collected for the one remaining utility (the City of Mt. Dora). Average monthly water use for the City of Mt. Dora was taken from data obtained in Phase I Talton et al. (1996).

The amount of landscape irrigation used by each utility was estimated by analyzing each year of data to determine the minimum month and average month water withdrawal. The difference between the average month and the minimum month flow was presumed to represent the quantity of publicly supplied potable water that could be replaced by an alternate supply. The methodology in greater detail is as follows:

- **Data Base -** The analysis used the 25 largest water withdrawing utilities (90 percent of the flow) to represent the total PWRCA study area.

- **Individual Utility Analysis -** Calculations were performed on the monthly water withdrawal data for each of the utilities as follows:

  - For each year calculate:

    Average month water withdrawn - Minimum month = Replaceable public supply irrigation

  - For each year calculate:

    Replaceable public supply irrigation/Average annual water withdrawn x 100 = Replaceable public supply irrigation percentage

  - Identify the highest irrigation percentage of all years calculated.

  - Apply the highest irrigation percentage to the 1995 annual average water withdrawals to estimate the existing quantity of replaceable irrigation water.

  - Apply the highest irrigation percentage to projected 2010 water withdrawals to estimate future quantities of replaceable landscape irrigation.

- **Six-Year Analysis -** Sum the replaceable irrigation results from the individual utility analysis (described above) to analyze the yearly variations for the 14 utilities having six years of data. Sum the yearly replaceable irrigation totals and divide by the six-year total water withdrawn to obtain the six years' replaceable percentages.

- **One to Four Year Analysis** - For the ten utilities with one to four years of monthly water withdrawal data, sum the 1995 and highest replaceable irrigation quantities for each utility then divide by the sum of the 1995 average annual withdrawals to obtain the 1995 and highest replaceable irrigation percentage for the group.

- **Data Assumption** - The City of Casselberry did not give the minimum month flow. The irrigation percentage for Casselberry was based on the City of Winter Park results.

- **Data Assumption** - The City of Mount Dora did not respond to the survey. Irrigation percentage for Mount Dora was based on 1995 water use information obtained in Phase I and the City of Eustis results.

- **Twenty-Five Utility Analysis** - For all 25 utilities, sum the 1995 and highest replaceable irrigation quantities for each utility then divide by the sum of the 1995 average annual water withdrawals to obtain the 1995 and highest replaceable irrigation percentage for the 25 utilities.

- **2010 Projections** - Apply the highest percentage to the projected 2010 water withdrawals (Vergara 1994) to estimate future replaceable quantities.

For additional insight into minimum flows, the minimum daily flows were studied for the City of Maitland and Sanlando Utilities. Eight years of data were analyzed to determine the relationship between the minimum daily flow and the average daily flow for each year. For the minimum day analysis, the flow portion between the minimum day flow and average day flow was tabulated and compared to the minimum month method.

RECLAIMED WATER AVAILABILITY

Based on direction from SJRWMD, available reclaimed water was defined as reclaimed water currently not reused plus flows going to wetlands or ground water recharge systems.

PBS&J was provided a wastewater treatment plant (WWTP) spreadsheet data base by SJRWMD in Phase I that was determined to be acceptable for estimating current annual average reclaimed water availability. An updated spreadsheet was obtained from SJRWMD in Phase II based on a 1995 wastewater treatment and reuse inventory data base (File name: *reusable.wk3 10/3/96*).

The spreadsheet includes information by WWTP for each county in SJRWMD boundaries. Pertinent information provided includes facility name; location; treatment level provided; permitted treatment plant capacity; permitted reuse capacity; 1995 mean flow; 1995 annual average reused and unreused flow (per Florida Department of Environmental Protection [FDEP] definitions); and 1995 annual average unreused flow plus flow delivered to wetlands or ground water recharge systems.

In addition, in Phase II SJRWMD provided a geographical information system (GIS) data base including WWTP and reclaimed water availability data. The GIS data base did not include the unreused flow plus flow delivered to wetlands or ground water recharge systems or treatment levels. The GIS data base was updated accordingly.

The spreadsheet data were tabulated by facility and by county for total reclaimed water availability. From the GIS data base, mapping was developed to illustrate 1995 total unreused flow plus flow currently being delivered to wetlands or ground water recharge systems.

A separate GIS data base was obtained from SJRWMD that defined public water supply utility boundaries. This data base was modified to illustrate the 25 largest utilities within the study area and their proximity to WWTPs with reported availability of reclaimed water. Several service area boundaries within Seminole County were updated or corrected based on PBS&J in-house information.

An evaluation was conducted to account for the seasonal variability in reuse flows and, consequently, the seasonal availability of reclaimed water. Monthly reuse flow data were collected for the City of Altamonte Springs (6 years), the City of Cocoa Beach (1 year), the City of Cocoa (4 years), and the City of Sanford (1 year). In addition, 1995 daily flow data for the City of Cocoa were collected. These data were evaluated to identify seasonal trends in reclaimed water demand and to determine the ratio between the peak monthly and peak daily demand to average reuse flows. A factor was developed based on this ratio to determine water needed to serve the estimated replaceable irrigation supply.

SELF-SUPPLY IRRIGATION WELLS

Maximum Replaceable Percentage of Landscape Irrigation

Based on discussions with well contracting and utility representatives, a maximum percentage of the replaceable landscape irrigation quantity which could effectively be replaced with surficial aquifer self-supply irrigation wells was estimated.

Average Unit Well Usage

To estimate the cost of replacing public supply landscape irrigation with water from self supply irrigation wells, the landscape irrigation water usage for a typical single family unit was developed. This was estimated using a one-inch per week (in/wk) irrigation rate over the irrigable portion of a typical residential lot as specified in the scope of services.

A typical residential lot size was established by reviewing Seminole County's residential lot data using the property appraiser's GIS. The irrigable portion of a residential lot was estimated using engineering judgment, Natural Resource Conservation Service (formerly Soil Conservation Service or SCS) data, and past project experience.

The unit landscape irrigation water usage for a typical single family residence was calculated as follows:

Unit residential irrigation = Irrigation rate x Average lot size x Irrigable percent

Where:

Unit residential irrigation = Irrigation usage for a typical single family residential home

Irrigation rate	=	*Average irrigation rate applied to residential landscape*
Average lot size	=	*Average residential lot size in the study area*
Irrigable percent	=	*Percent of an average residential lot assumed to be irrigated*

Quantity Of Wells

To calculate the number of self-supply irrigation wells needed to supply the replaceable quantity of irrigation water in the study area, the following was used:

*Number of self-supply wells = Replaceable public irrigation * Maximum Self Supply Well Percentage/Unit residential irrigation*

Where:

Replaceable public irrigation = Estimated portion of the publicly supplied water used for landscape irrigation which could be replaced by an alternate source

Maximum Self Supply Well Percentage = Estimated maximum percentage of the replaceable landscape irrigation which could be replaced with self supply wells.

Unit residential irrigation = Irrigation usage for a typical single family residential home

Well Depth And Cost

Irrigation well contractors were contacted throughout the study area to gather information on self-supply wells. In addition to cost information, inquiries were made regarding well type, size, capacity, depth, and prevalence. A one-page questionnaire was prepared to use for the telephone survey of well contractors (Appendix A).

ESTIMATED COST FOR LANDSCAPE IRRIGATION WITH RECLAIMED WATER

Maximum Replaceable Percentage of Landscape Irrigation

The methodology for estimating the amount of irrigation that can potentially be replaced by reclaimed water is the minimum month estimate described previously.

General Cost Information

The cost estimates developed were planning-level costs which could be used as approximate costs for system cost components. The costs are not intended to be used for specific sites or facilities. Cost information consistent with other Investigation of Alternative Water Supply Strategies projects was used (Law Engineering 1996). Cost estimates were given in 1996 dollars and include total capital costs, operation and maintenance (O&M) costs, and equivalent annual costs. The time value of money was assumed to be seven percent and the service life of components was consistent with the procedures established for the Investigation of Alternative Water Supply Strategies described in Appendix B.

Wastewater Treatment Plant Improvement Costs

Planning-level cost data were developed for treatment plant improvements needed to meet FDEP public access reuse requirements, operational storage needs, and pumping requirements. The FDEP requirements consist of filtration and high-level disinfection. For consistency, the planning-level cost data were based on Law Engineering (1996).

Reclaimed Water Distribution System Costs

The distribution system cost estimates were divided into macro-distribution and micro-distribution costs. The macro-distribution system consists of the main network pipelines which distribute reclaimed water throughout the service area. The micro-distribution consists of the smaller network of pipes used to deliver reclaimed water to individual users within the service area.

Macro-distribution pipes were considered to be generally 12-inch in diameter and larger. Costs for the macro-distribution system were developed on a per gallon basis. Pipe diameters and lengths for macro-distribution were based on a reclaimed water system plan developed for the City of Pinellas Park, Florida (PBS&J 1993). Unit costs were taken from the transmission system pipe costs given in Law Engineering (1996).

Micro-distribution pipes were assumed to be 8-inch in diameter and smaller, mostly consisting of 4-inch diameter pipe. Pipe diameters and lengths for micro-distribution were also based on the reclaimed water system plan developed for the City of Pinellas Park, Florida (PBS&J 1993). Unit costs were extrapolated to smaller pipe sizes from the transmission system pipe costs given in Law Engineering (1996).

Reclaimed Water Transmission System Costs

The reclaimed water transmission system brings reclaimed water from the source to the area being served. A transmission system consists of large diameter pipelines which move large quantities of water several miles. Transmission system costs were based on data developed from Law Engineering (1996).

DISCUSSION

LANDSCAPE IRRIGATION

The minimum month method used to estimate publicly supplied landscape irrigation is based on the assumption that an insignificant amount of irrigation occurs during the minimum flow month. Although this approach may have some inherent inaccuracies, it provides a reasonable approximation for a broad planning-level evaluation. The method does not provide an estimate of all water used for landscape irrigation because some irrigation does occur during the month of minimum flow, especially in Florida. For the study area, the minimum month withdrawals occurred mostly in January or February. Minimum irrigation flow would be expected in these months due to low irrigation requirements in the winter; however, the winter months represent the peak household occupancy in many service areas due to the "snowbird" transient residency. The higher population in the winter could inflate the minimum month value. Additionally, in-ground irrigation systems operated on timers frequently continue to operate through the winter. These factors cause an underestimation of the total amount of publicly supplied water used for irrigation.

It would be impractical to presume that all or even close to all irrigation water could be replaced with alternative supplies. Delivery of reclaimed water to every irrigated area is not practical. Not all irrigated areas would be expected to install self-supply wells for irrigation. The minimum month method may more accurately represent the replaceable quantity of irrigation water. Additionally, the largest irrigation percentage of the six years was assumed to represent average landscape irrigation. Using the largest percentage helps to account for some of the year-round irrigation.

For the utilities with six years of data, the highest percentage over the six years was used to estimate the replaceable landscape irrigation quantity. Since 1995 was a high irrigation usage year (15.7 percent as compared to an average of 13.9 percent for the 14 utilities with six years of data), the use of 1995 as the highest irrigation percentage year was considered acceptable for those utilities with only one year of data. Percentages for the cities of Casselberry and Mt. Dora were made based on other nearby utilities (Winter Park and Eustis, respectively) because these utilities did not provide sufficient water use data for the methodology. A summary of the data analysis is presented in Appendix C.

Due to yearly changes in rainfall and temperature, the amount of landscape irrigation was expected to vary from year to year. Analyzing six years of data for 14 utilities and approximating the publicly supplied replaceable landscape irrigation quantity with the minimum month method results in a range of replaceable irrigation from 7.5 percent (14.17 million gallons per day [mgd]) of the total public supply water flow in 1991 to 16.1 percent (32.17 mgd) of the flow in 1993. For the 14 utilities, the average irrigation percentage for the six years was 13.2 percent and the highest irrigation percentage was 18.7 percent of the total public supply water withdrawn.

Based on the 25 utilities in this analysis and 1995 water use data, the estimated existing replaceable landscape irrigation quantity is 50.51 mgd, or 19.6 percent of total public supply water withdrawn. Applying the same percentages to projected 2010 water needs for the same 25 utilities (Vergara 1994) results in an estimated 93.7 mgd that could be replaced with alternate supplies. Results by utility are presented in Table 1.

Several nonweather related factors govern the variations in irrigation quantities including:

- Utility size
- Geographic location
- Conservation measures
- Existence of alternative irrigation sources; i.e., individual wells or reclaimed water

The results for several utilities were compared to the total for the 14 utilities with six years of data to illustrate the effects of these factors. This analysis is summarized in Table 2. Because all utilities analyzed practice some form of conservation, no comparison was made regarding the impact of water conservation. This very general

Table 1. Estimated 1995 and 2010 replaceable landscape irrigation quantities

Utility Name	1995 Annual Average Water Use (mgd)[1]	1995 Estimated Replaceable Landscape Irrigation Quantity (mgd)[1]	Projected 2010 Annual Average Water Use (mgd)[2]	2010 Estimated Replaceable Landscape Irrigation Quantity (mgd)[3]
Orlando Utilities Commission	79.61	14.09	128.49	22.74
Orange County	31.49	6.17	79.00	15.48
City of Cocoa	23.96	4.85	39.07	7.89
City of Daytona Beach	12.42	1.54	19.81	2.56
City of Winter Park	11.35	1.64	15.28	2.20
Florida Water Service/Deltona Plant	9.03	2.75	24.89	7.57
City of Altamonte Springs	6.26	0.90	10.19	1.46
City of Titusville	4.90	1.14	9.80	2.28
City of Sanford	5.74	0.81	7.53	1.06
City of Port Orange	5.27	0.90	9.43	1.61
City of Ormond Beach	4.90	0.93	7.63	1.44
City of New Smyrna Beach	4.29	0.94	8.35	1.83
City of Leesburg	4.87	1.41	12.10	3.51
City of Oviedo	2.83	0.69	9.64	2.34
Seminole County	10.39	2.60	18.62	4.66
Sanlando Utilities	7.61	2.27	10.76	3.22
City of Casselberry	5.12	0.74	6.33	0.91
City of Apopka	5.96	1.35	14.90	3.38
City of DeLand	5.08	1.02	8.39	1.69
City of Winter Springs	1.48	0.19	5.80	0.73
Villages of Lake Sumter, Inc.	3.57	0.87	3.48	0.85
City of Ocoee	3.68	1.04	5.48	1.55
City of Maitland	2.82	0.65	2.60	0.60
City of Mt. Dora	2.26	0.50	4.46	0.99
Town of Eustis	2.40	0.53	5.78	1.28
Total	257.30	50.50	467.81	93.71

[1]Reference Appendix C
[2]From Vergara (1994)
[3]Based on highest percentage per utility as presented in Appendix C

Table 2. Comparison of public supply irrigation percentages for various utilities in the six year analysis

Utility Name	Category	6 Year Average Replaceable Irrigation Percentage	6 Year Highest Replaceable Irrigation Percentage
14 Utilities including those listed below	Baseline	13.2	18.7
Utility Size			
Orlando Utilities Commission	Large Size	11.9	17.7
Oviedo	Small Size	19.6	24.3
Alternate Source			
Florida Water Service	Minimal alternate sources	23.4	30.4
Daytona Beach	Alternate Source = Self-supply Wells	9.6	12.4
Altamonte Springs	Alternate Source = Reclaimed Water	8.5	14.3
Geographic Location			
Orange County	Inland	15.1	19.6
Cocoa	Coastal	12.9	20.2

comparison shows that larger utilities, such as Orlando Utilities Commission, have a lower percentage of their water used for landscape irrigation than smaller utilities. The impact of alternative water supplies can be seen with lower irrigation percentages, such as for Daytona Beach, which reportedly has a significant number of self-supply wells, and Altamonte Springs, which has a comprehensive reclaimed water program.

As a comparison to the minimum month method, an analysis was performed using daily flow relationships. The minimum day study was performed for the City of Maitland and Sanlando Utilities. Daily flow data were not readily available from other utilities. The minimum day method may more accurately represent the total irrigation percentage used by the utility. There is a greater possibility that no irrigation would occur on a single day than for a whole month. There may be some high rainfall event days when no irrigation occurs. Also, due to greater variations in daily flow as opposed to monthly flows, lower minimum flows should occur. The minimum day method, therefore, was expected to give higher irrigation estimates than the minimum month method. Eight years of daily water treatment plant output data were analyzed for both utilities.

The results of the minimum day study are compared to the minimum month analysis in Table 3. The minimum day analysis shows irrigation quantities ranging from 28 to 49 percent of the total water used and eight-year averages of 40 and 41 percent for Maitland and Sanlando, respectively. This is higher than the minimum month results which ranged from 17 to 30 percent and had eight-year averages of 17 and 22 percent for Maitland and Sanlando, respectively. Assuming that the minimum day percentage represents total irrigation and the maximum month percentage represents the replaceable irrigation, the amount of total irrigation that is replaceable was calculated to average 42 and 54 percent over the eight-year period for Maitland and Sanlando, respectively.

Table 3. Comparison of minimum day to minimum month estimations of public supply landscape irrigation

MAITLAND-Ratio of minimum flow minus average annual flow (AAF) to AAF									
Method	1988	1989	1990	1991	1992	1993	1994	1995	Average 1988 - 1995
Minimum Month	19.6%	16.4%	17.2%	13.8%	10.9%	17.4%	17.3%	22.9%	17.0%
Minimum Day	41.2%	40.2%	40.1%	31.6%	38.5%	40.7%	40.2%	49.0%	40.2%
Estimated Percent of Total Irrigation that is Replaceable[1]									
	48%	41%	43%	44%	28%	43%	43%	47%	42%

SANLANDO-Ratio of minimum flow minus average annual flow (AAF) to AAF									
Method	1988	1989	1990	1991	1992	1993	1994	1995	Average 1988 - 1995
Minimum Month	34.6%	17.7%	13.7%	16.7%	16.2%	29.9%	20.9%	27.7%	22.2%
Minimum Day	46.4%	43.2%	32.8%	41.7%	28.3%	45.7%	46.6%	42.1%	40.9%
Estimated Percent of Total Irrigation that is Replaceable[1]									
	75%	41%	42%	40%	57%	65%	45%	66%	54%

[1]Estimated using the ratio of minimum month method to minimum day method.

RECLAIMED WATER AVAILABILITY

Average Availability

SJRWMD 1995 wastewater treatment and reuse inventory data were used to estimate the average availability of reclaimed water. The data base was developed by the SJRWMD through a questionnaire sent to each utility. No modifications to the data were made.

These data are based on 1995 mean flows and do not consider additional reclaimed water that may become available as the WWTPs approach their permitted capacities or are expanded. It also does not consider that commitments may exist for the unreused flows (both seasonally and long-term) that would limit the availability of the reclaimed water. Based on this analysis, a total of 112 mgd of reclaimed water is available within Brevard, Lake, Orange, Seminole, and Volusia counties. The total estimated availability by county is presented in Table 4. Since there are seasonal fluctuations that must be considered, this availability cannot be used at face value.

Seasonal Variations in Reclaimed Water Demand

Similar to a ground or surface water supply system, reclaimed water system supplies must exceed the annual average demand in order to meet peak seasonal needs. To evaluate the peak seasonal needs of reclaimed water systems, PBS&J evaluated monthly data from four reclaimed water systems: the City of Altamonte Springs, the City of Cocoa, the City of Cocoa Beach, and the City of Sanford. One to six years of data were collected and seasonal trends were examined. To evaluate peak daily trends, one year of daily reclaimed water use data was collected for the City of Cocoa.

The City of Altamonte Springs provided nearly six years of monthly reclaimed water usage data, from January 1990 through August 1996. In 1995, the City began supplementing reclaimed water supplies with ground water from a potable well no longer in service for potable supply and from Lake Orienta in order to meet peak seasonal needs. Therefore, their reclaimed water usage since 1995 has not been restricted by the

Table 4. Summary of potential reclaimed water availability by county[1]

County	1995 Mean Flow (mgd)	1995 Unreused Flow plus Wetlands and Percolation Ponds (mgd)
Brevard	39.70	25.55
Lake	8.28	2.91
Orange	60.32	24.37
Seminole	47.84	37.69
Volusia	31.23	21.48
Total	**187.37**	**112.00**

[1]The availability is based on 1995 annual flows and does not account for seasonal needs or future reuse commitments.

availability of supply. A summary of the average monthly reclaimed water usage for the six year period is presented in Figure 1. Altamonte Springs' reclaimed water demand is generally lower in the winter, non-growing season months, peaks in the dry spring months, remains high during the hot summer, then tapers off during the fall. Although average reclaimed water usage was 3.63 mgd over the seven-year period, the peak monthly demand, which occurred in May, was 5.35 mgd, exceeding the monthly average by 47 percent.

The City of Cocoa provided nearly four years of monthly reclaimed water usage data, from January 1993 through September 1996. A summary of the average monthly reclaimed water use for this period is presented in Figure 2. Like Altamonte Springs, the City of Cocoa's reclaimed water usage is lowest during the winter months and begins to rise during the dry spring. Cocoa's usage continues to increase to a peak in July, then begins dropping again in the fall. Average reclaimed water use during this period was 1.29 mgd with a peak month usage of 1.58 mgd for the month of July. The peak month demand exceeded the average demand by 22 percent.

The City of Cocoa Beach provided 18 months of monthly reclaimed water usage data. Twelve months were utilized (November 1995 through October 1996) to evaluate the annual trend. A summary for this period is presented in Figure 3. The trends for Cocoa Beach appear different from the other reclaimed water utilities evaluated. Cocoa Beach also had its lowest reclaimed water utilization in the winter, but did not see a peak until September. May, which was typically a high reclaimed water usage month for the other utilities, was among the lowest for Cocoa Beach. Since only one year of data was provided for this reuse system, the anomaly could be due to localized weather patterns for that reclaimed water service area. Also, expansion of the reclaimed water system could have been occurring in the late summer. The average monthly reclaimed water usage for Cocoa Beach during the 12 month period was 2.44 mgd. The September peak of 3.82 mgd represents a 57 percent increase over the average monthly flow.

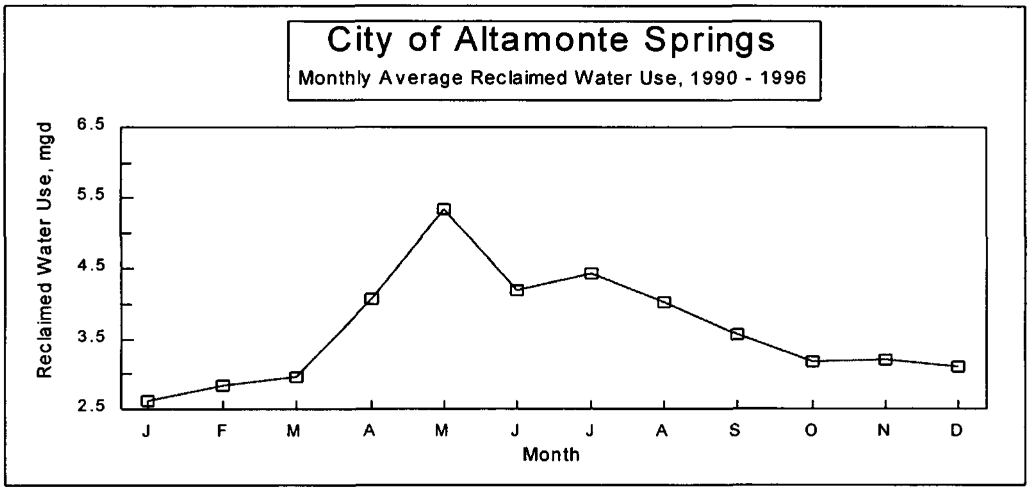


Figure 1. Altamonte Springs monthly average reclaimed water use, 1990 - 1996

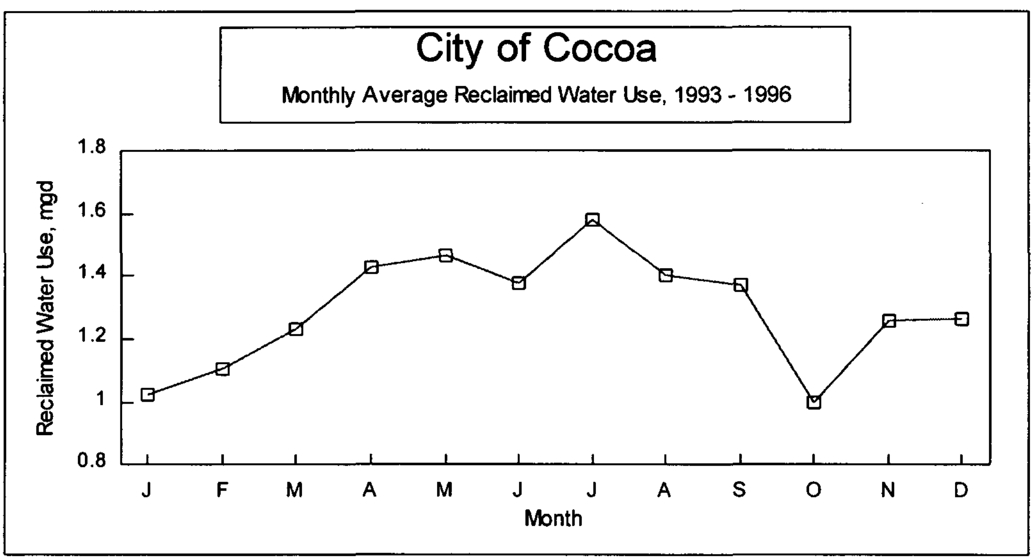


Figure 2. City of Cocoa Monthly Average Reclaimed Water Use, 1993 - 1996

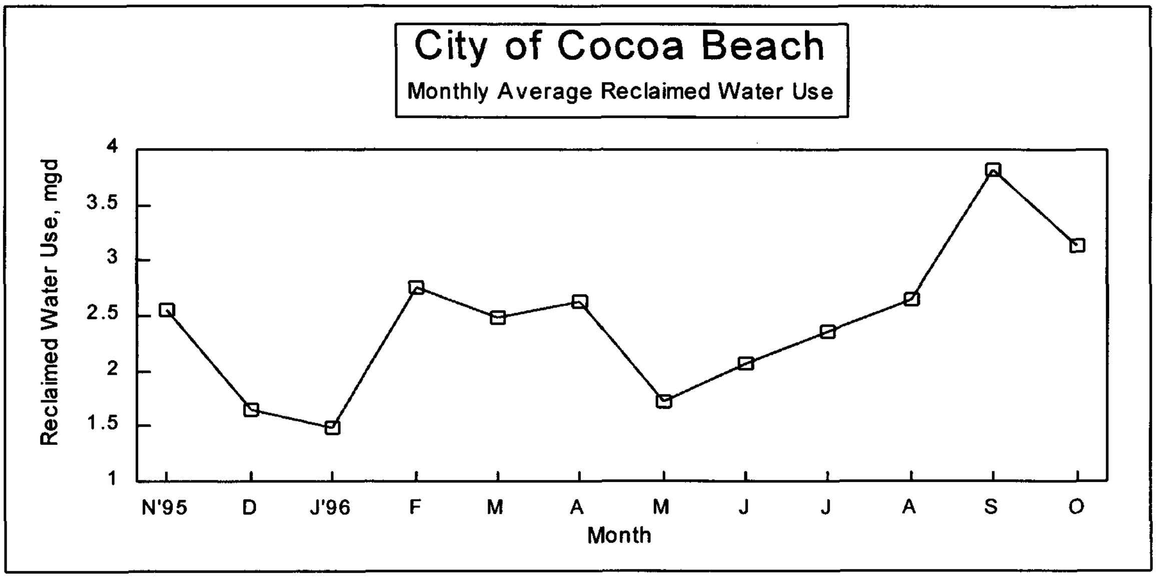


Figure 3. City of Cocoa Beach monthly average reclaimed water use

One year of reclaimed water data (1995) was reviewed for the City of Sanford. The summary for the City is presented in Figure 4. Sanford's reclaimed water system appears to have less extreme fluctuations in demands. This may be due to the agricultural irrigation component of their reuse system. Flows ranged between 4.36 mgd to 4.89 mgd from January 1995 through August 1995 then peaked at 5.49 mgd in September. The average for the year was 4.71 mgd. The maximum month represents a 16 percent increase over the average monthly flow.

This analysis looked at monthly trends only. Maximum day flows would be expected to be considerably higher. To consider the daily fluctuations in demands, 1995 daily reclaimed water usage data for the City of Cocoa were evaluated. The average reclaimed water demand for the City during this period was 1.68 mgd in comparison to a 2.70 mgd peak daily flow in July 1995. This maximum day flow represents a 60 percent increase over the average daily flow.

To meet peak needs (monthly and daily), it appears from this analysis that an irrigation supply will need to have excess capacity in the range of 16 to 60 percent. There are many alternatives to serve this excess demand. Large volumes can be stored during periods of low demand to meet the needs or other supplies (ground water or stored stormwater) can be used to augment the reclaimed water system. Changes in irrigation patterns could be enforced to dampen the peaks.

The effect of seasonal demands impacts the availability of reclaimed water in two ways. First, many utilities in the study area have existing reuse programs. The amount of reclaimed water shown as available on the 1995 wastewater and reuse inventory is based on annual averages and does not take into account that 16 to 60 percent of the "available" supply may be needed to meet existing needs. Second, when looking at the use of reclaimed water to replace publicly supplied water for landscape irrigation, 16 to 60 percent excess is needed.

For this study, it is assumed that an excess capacity of 50 percent is needed. For example, to serve a 10 mgd replaceable irrigation demand, 15 mgd of unreused flow will be needed. In the City of Cocoa evaluation, there were only two days when a peak in excess of 50 percent would be needed to meet demands.

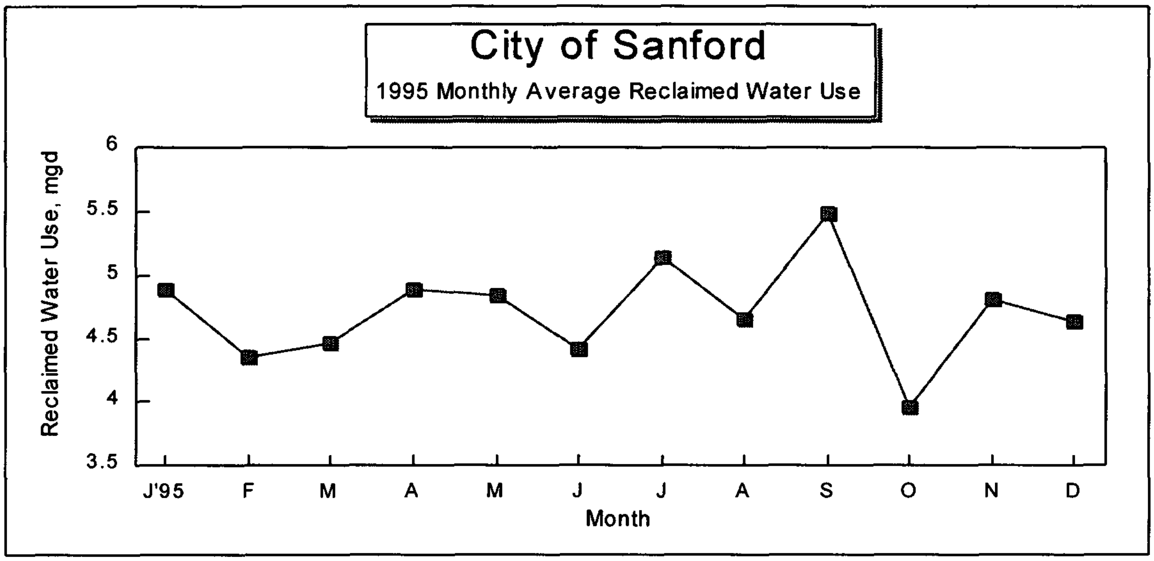


Figure 4. City of Sanford 1995 monthly average reclaimed water use

SELF-SUPPLY IRRIGATION WELLS

Maximum Replaceable Percentage of Landscape Irrigation

Based on discussions with utility and well contracting personnel, information regarding self-supply irrigation wells was collected. There are two basic types of irrigation wells prevalent in the PWRCA:

> Floridan aquifer - Wells averaging from 150 to 220 feet deep penetrating the Floridan aquifer. These wells are generally four inches in diameter with a submersible pump.
>
> Surficial aquifer - Generally shallow wells averaging 30 to 80 feet deep in the sandy surficial aquifer. Surficial aquifer wells are generally two inches in diameter and require a screen to restrain sand and can use a submersible or an above ground pump.

This project included an evaluation of replacing landscape irrigation with surficial aquifer wells only. The results of the interview with well contractors are given in Table 5.

The interview with well contractors showed that in the coastal regions of the PWRCA consisting of eastern Volusia and northern Brevard counties, self-supply irrigation wells are common. It is estimated that 50 to 75 percent of homes in the various service areas are equipped with self-supply irrigation wells. The prevalent type of self-supply irrigation well in this region is the shallow, surficial aquifer type, with estimates ranging from 50 to 100 percent of all irrigation wells. Depending on the hydrogeology, shallow surficial aquifer wells are not feasible in some coastal areas. Water quality and yield were listed as negative factors with shallow wells in the coastal regions. Surficial aquifer wells averaged 25 to 40 feet in depth with a cost ranging from $600 to $900. Deeper Floridan aquifer irrigation wells averaged 120 feet with costs ranging from $1,400 to $2,100.

Table 5. Self-supply well contractor survey results

			Deep Irrigation Well				Shallow Irrigation Well			
County	Number of Contractors Contacted	Percent of residences with irrigation wells	Percent	Size (in.)	Depth (ft.)	Cost (dollars)	Percent	Size (in.)	Depth (ft.)	Cost (dollars)
East Volusia	1	75	50	4	125	2,100	50	2	25	700
West Volusia	0	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data
North Brevard	2	No estimate	20	2	80-120	800-1,400	80	2	30	600-900
Central Brevard	1	50 or more	N/A	N/A	N/A	N/A	100	2	45	825
Orange	1	No estimate	100	4	150	2,000	0	N/A	N/A	N/A
Seminole	2	No estimate	100	4	150-225	2,900-3,500	0	N/A	N/A	N/A
Lake	1	No estimate	95	4	200	2,400	5	2	40-100	No Data

Note: N/A = Not applicable

In the inland portion of the PWRCA, consisting of Lake, Orange, west Volusia, and Seminole counties, the deeper, Floridan aquifer self-supply irrigation wells are more prevalent. No firm estimates were given for the prevalence of irrigation wells in the inland area of the PWRCA although it was generally stated that they are less prevalent than in coastal areas. In coastal areas, higher public water supply costs encourage self-supply irrigation wells. Also, greater well depths required in inland areas result in inland wells being more costly than coastal wells. The Floridan aquifer wells were estimated to account for a large percentage of all the irrigation wells in the inland areas. Reasons cited for the avoidance of surficial aquifer wells in inland areas were water quality, unreliable yield, and excessive maintenance of well screens. Floridan well depths averaged 150 feet (200 feet in Lake County) with costs ranging from $2,000 to $3,500.

Based on discussions with well contractors, the feasibility of the use of surficial aquifer wells is variable throughout the study area. While there is no firm basis for estimating the percentage of properties where surficial aquifer wells are technically feasible, for planning purposes, a maximum of 50 seems reasonable for the study area.

Average Unit Well Usage

The irrigation rate of one-inch per week for a typical residential lot was proposed in the scope of work. This rate may be accurate for use during the growing season, however, the rate may overestimate average annual irrigation for a large study area. For central Florida, the net irrigation requirement for pasture grasses during an average rainfall year was estimated at 22-inches per year or 0.46-inches per week on a 48 week basis (SCS 1967). For west central Florida, the net irrigation requirement for turf grasses during an average rainfall year was estimated at 23-inches per year or 0.48-inches per week on a 48 week basis (Brown & Caldwell and Whitcomb 1993). Irrigation efficiency would increase this number 20 to 40 percent but would be significantly less than the one inch per week value.

In defense of the given irrigation rate, a typical home with an in-ground irrigation system may actually use one-inch per week of irrigation water during the year. Generally, homes with in-ground irrigation systems irrigate more frequently and more than is required than homes without in-ground systems. The replaceable irrigation was assumed to represent the amount of irrigation supplied through in-ground irrigation systems as opposed to portable hoses and sprinklers. Therefore, one-inch per week may be more representative of areas with in-ground irrigation systems than an average of all areas.

The average residential lot size calculated by the Seminole County Property Appraisers Office was limited because the analysis only covered Seminole County. The Seminole County analysis did cover a large sampling of lots (entire Seminole County). The resulting average lot size was 0.236 acres or approximately 1/4 acre (Johnson 1996). The 1/4-acre lot size is consistent with previous PBS&J experience in the service area.

To determine the average percentage of a typical residential lot that is irrigable, Natural Resources Conservation Service's recommendation, PBS&J's project experience, and engineering judgment were used. GIS and stormwater personnel were contacted in Seminole and Orange counties, but no information was available on irrigable, pervious, or impervious areas for a typical residential lot.

The Natural Resources Conservation Service estimates a 62 percent pervious area for a typical 1/4-acre residential lot (SCS 1986). Based on past project experience, PBS&J has used a 40 percent irrigable factor to account for the fact that not all pervious surfaces are irrigated and to provide a more conservative estimate (PBS&J 1992; PBS&J 1993). The lower value (40 percent) was used to provide a conservative estimate.

The resulting calculation of the unit landscape irrigation water usage for a typical single family residence follows:

Unit residential irrigation = Irrigation rate x Average lot size x Irrigable percent

Where:

Irrigation rate = 1-in/wk
Average lot size = 0.25 acre
Irrigable percent = 40

Unit residential irrigation = 1-in/week x 0.25 acre x 0.4 x 1/12 ft/in x 43,560 ft^2/acre x 1/7 week/day x 7.48 gal/ft^3 = 388 gallons per day

Quantity of Wells

The number of equivalent residential wells needed to supply the replaceable publicly supplied landscape irrigation was calculated by dividing the adjusted replaceable irrigation quantity by the unit residential irrigation rate calculated above.

The resulting calculation of the number of self-supply irrigation wells needed to supply the replaceable quantity of irrigation water in the study area follows:

Self-supply wells = Surficial aquifer self-supply replaceable public irrigation/Unit residential irrigation

Where:

Surficial aquifer self-supply replaceable public irrigation (1995) = 50 % x 50.51 mgd = 25.25 mgd

Surficial aquifer self-supply replaceable public irrigation (2010) = 50 % x 93.71 mgd = 46.85 mgd

Unit residential irrigation (1-inch/week) = 388 gpd/well

1995 - Self-supply Wells (1-inch/week) = 25.25 mgd/388 gpd/well x 1 x 10^6 *gpd/mgd = 65,077 wells*

2010 - Self-supply wells (1-inch/week) = 46.85 mgd/388 gpd/well x 1 x 10^6 *gpd/mgd = 120,773 wells*

Based on the above calculations, approximately 120,773 self-supply irrigation wells would be required to offset the projected year 2010 irrigation quantities that could be replaced with self-supply wells.

Well Depth and Cost

Based on the well contractor data, an average surficial aquifer well depth of 80 feet was assumed. A total capital cost of $2,000 was assumed for a typical surficial aquifer well. The estimated total costs include permitting, well drilling, pumps, basic controls, hydropneumatic tank, minor electrical work, overhead, and profit. The surficial aquifer well would also require an annual maintenance cost of $200 a year to maintain the screen and well. The service life of a surficial aquifer well was estimated to be eight years. Pump energy, maintenance, and chemical costs were estimated to be $100 per year based on 141,620 gallons per year of operation at 50 percent total efficiency.

ESTIMATED COST FOR LANDSCAPE IRRIGATION WITH RECLAIMED WATER

Reclaimed water systems are possible, although not always practical, in any location which is served by a potable water distribution system. Therefore, it was assumed that 100 percent of the publicly supplied, replaceable landscape irrigation water could be replaced with reclaimed water.

The costs used in this project were based on the individual costs for the reclaimed water system components. System components for reclaimed water irrigation include reclaimed water filtration, high-level disinfection, operational storage, pumping, transmission, and distribution. The total capital costs for each system component were the sum of the construction, non-construction, land, and land acquisition costs. O&M costs were based on the annual average wastewater flow and include all energy, chemical and labor costs. The equivalent annual costs were the total life cycle costs of the component.

The results of the cost estimation task present a basis and recommended methodology for estimating planning-level reclaimed water system costs. The unit component costs given in the Law Engineering study (1996) were not given in terms of a common flow basis, such as average annual flow (AAF). They were based on nominal capacities varying according to common practice. The component unit costs were given by unique component "nominal" capacities such as pumping rate, storage volume, and filtration rate. Pipe costs were given in dollars per linear foot. The unit costs as taken from Law Engineering (1996) are tabulated in Appendix D.

To use the cost information for planning purposes, it is convenient to convert the unit costs to a common flow basis, such as AAF. Capacity peaking factors would be established for each component to convert the unit costs from a nominal capacity basis to an AAF basis. A sample cost calculation for replacing publicly supplied landscape irrigation water with reclaimed water is performed in Appendix E. The sample represents a general planning-level cost estimate.

Example assumptions for component peaking factors are also given in Appendix E. The peaking factor assumptions may be changed for a particular project. The sample calculation is presented as a means to assist future cost estimation efforts related to decision modeling to be conducted by SJRWMD.

CONCLUSIONS

Of the 257.30 mgd of water withdrawn by the 25 largest utilities in the study area in 1995, 50.51 mgd (19.6 percent) was estimated to be the quantity that was used for landscape irrigation that potentially could be replaced with alternate supplies. Based on projections in Vergara (1994), estimated withdrawals for these same 25 utilities in the year 2010 are 467.81 mgd. Applying the same percentage, approximately 93.71 mgd represents the 2010 replaceable irrigation usage.

Alternate supplies evaluated in this study were the surficial aquifer (using self-supply irrigation wells) and reclaimed water. Because a suitable surficial aquifer water supply is not always available, it was assumed that only 50 percent of the replaceable irrigation could be replaced with individual self-supply wells. A total of 120,773 wells in 2010 would be needed to replace 46.85 mgd (50 percent) of publicly supplied water for landscape irrigation. The total estimated costs for this alternate supply on the basis of gallons per day of water replaced are summarized in Table 6.

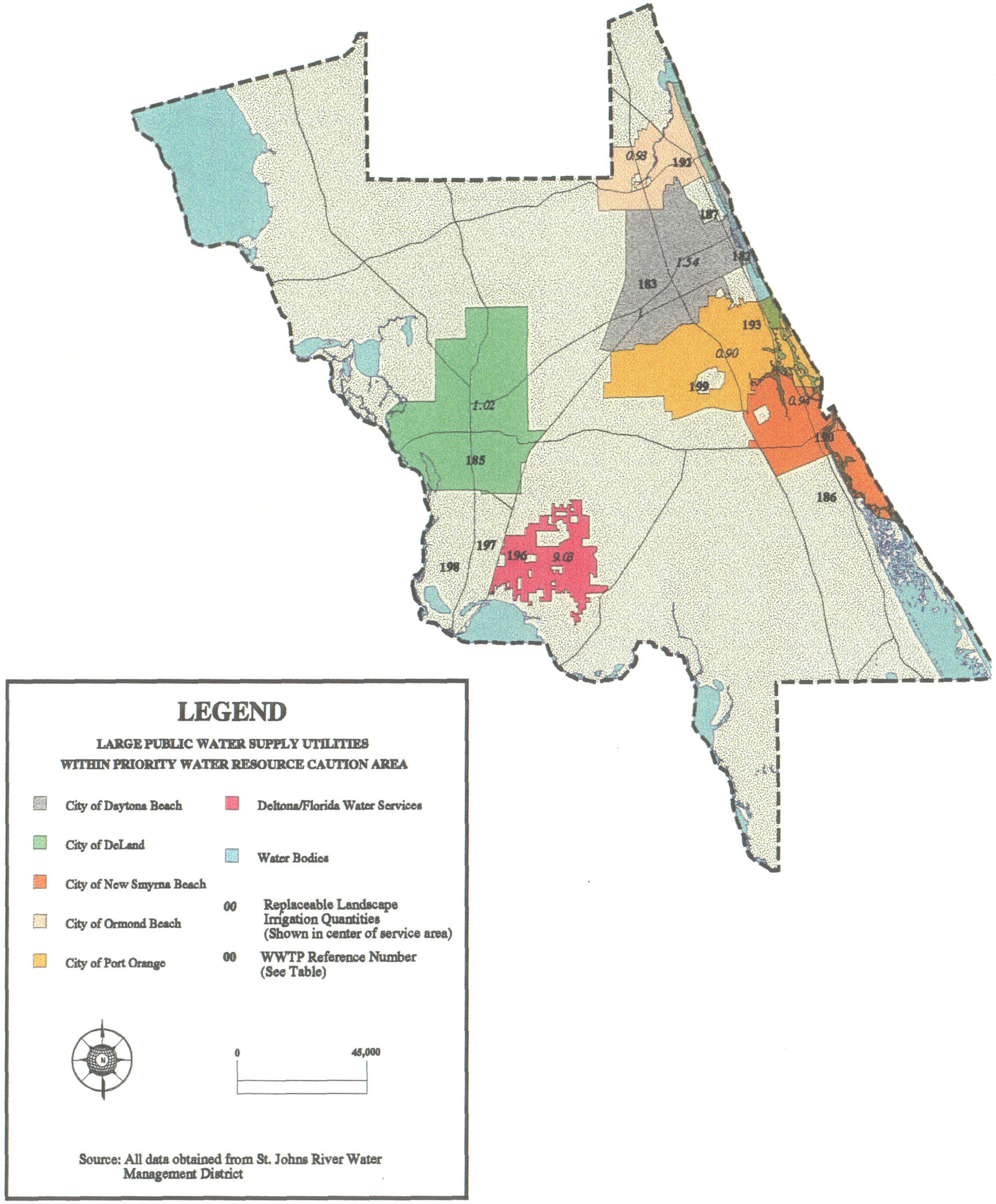
Based on 1995 data, there appears to be sufficient quantities of uncommitted reclaimed water to supply the estimated replaceable landscape irrigation quantities on an average annual basis. However, seasonal availability and the proximity of the supply to the demand are important considerations. Maps with corresponding tables that illustrate public water supply service area boundaries in relation to the reclaimed water availability are presented in Figures 5 through 9. These maps and data can be used in decision modeling to assist in developing costs for specific alternatives.

Because of the seasonality of reclaimed water demands, a direct relationship should not be used between replaceable landscape irrigation quantities and available reclaimed water supply. From the data reviewed for Altamonte Springs, Cocoa, Cocoa Beach, and Sanford, additional reclaimed water supply in the range of 16 to 57 percent may be needed to satisfy the monthly seasonal peaks and 60 percent for daily peaks. For example, to replace an annual average irrigation demand of 10 mgd, as much as 11.6 to 16.0 mgd of irrigation

Table 6. Estimated cost for the use of self-supply wells to replace publicly supplied potable water for landscape irrigation.

Item	Construction Cost	Non-Construction Cost	Capital Cost	Annual O&M Cost	Equivalent Annual Cost
Well - 80 feet deep	$1,500	$675	$2,175	--	$238.79
Water Service Backflow Prevention			$100		$7.50
Well & Screen Maintenance	--	--	--	$100	$100.00
Energy, Chemicals, and Pump Maintenance	--	--	--	$90	$90.00
Totals Per Well			$2,275	$190	$436.29
Totals for 120,773 Wells (46.85 mgd)			$274,758,600		$52,692,600.00
Equivalent Cost, $/1,000 gallons					$3.08

Note: Non-construction cost = 0.45 x construction cost
Service life of a surficial aquifer well = 15 years
Interest rate for equivalent annual cost analysis = 7.0 %
Annual flow per well = 388 gpd/unit * 365 day/year = 141,620 gallons per year



VOLUSIA COUNTY RECLAIMED WATER AVAILABILITY DATA

WWTP Reference Number[1]	WWTP Name	Disinfection Level[2]	Filters[2] (Y or N)	Reclaimed Water[2] Availability, mgd[3]
182	Daytona - Bethune Pt.	High	Y	6.33
183	Daytona - Regional	High	Y	1.50
185	Deland - Regional	High	Y	2.39
186	Edgewater	High	Y	0.87
187	Holly Hill	Low	Y	0.28
190	New Smyrna Beach Util. Comm.	High	N	1.74
192	Ormond Beach	High	Y	3.35
193	Port Orange	High	Y	4.04
196	Volusia County - Deltona North	Basic	N	0.31
197	Volusia County - Four Townes	Basic	N	0.20
198	Volusia County - Southwest Regional	High	Y	0.30
199	Volusia County - Spruce Creek	Basic	N	0.17

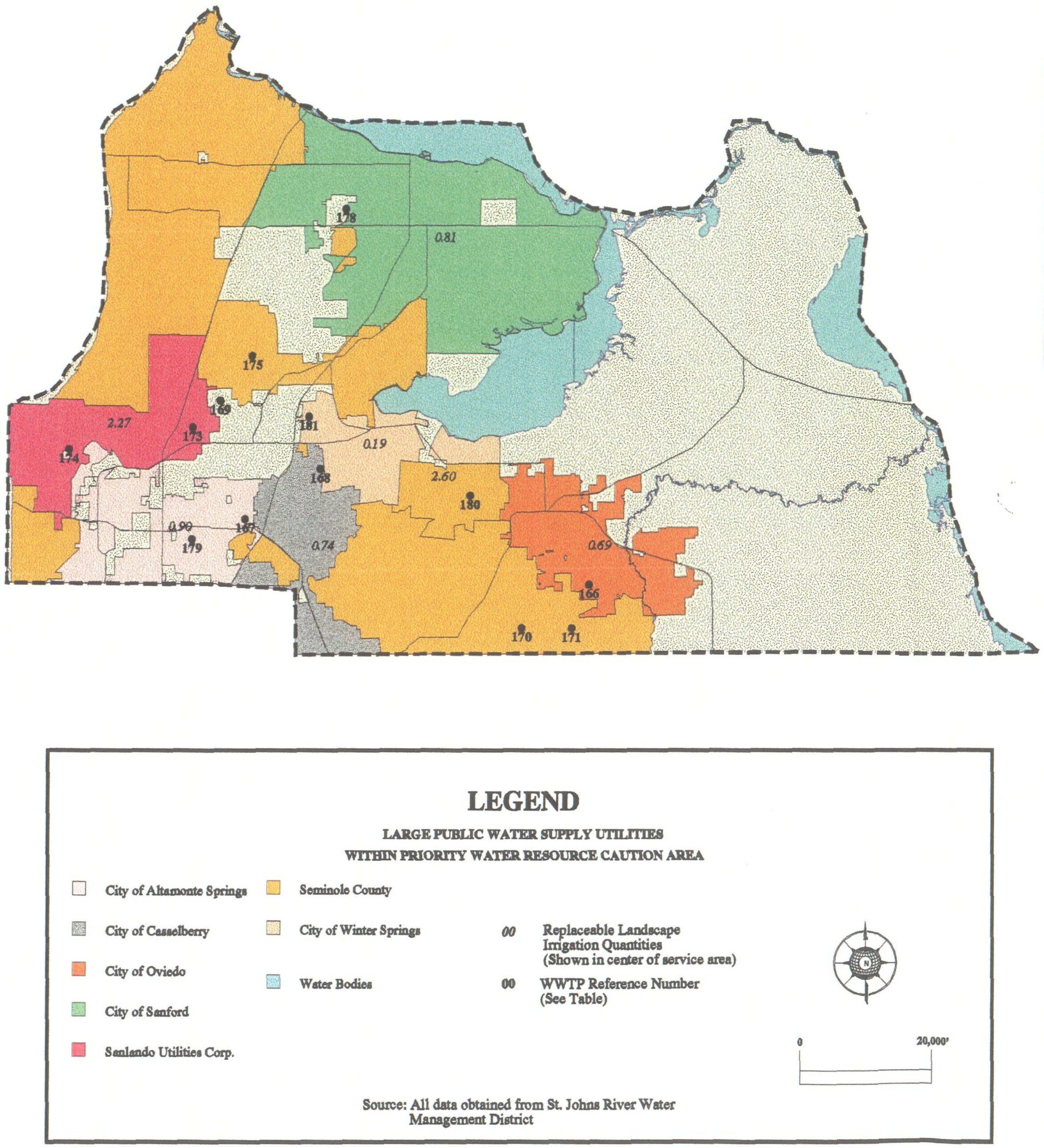
[1] Refer to Figure for location.

[2] Data as provided by SJRWMD in 1995 Wastewater Treatment and Reuse Inventory.

[3] Reclaimed Water Availability is based on unreused flow plus flows to wetlands and ground water recharge, as indicated in the 1995 Wastewater Treatment And Reuse Inventory (SJRWMD).

FIGURE 9. ESTIMATED REPLACEABLE LANDSCAPE IRRIGATION QUANTITIES AND RECLAIMED WATER AVAILABILITY IN VOLUSIA COUNTY

PBSJ



SEMINOLE COUNTY RECLAIMED WATER AVAILABILITY DATA

WWTP Reference Number[1]	WWTP Name	Disinfection Level[2]	Filters[2] (Y or N)	Reclaimed Water[2] Availability, mgd[3]
166	Alafaya Utilities, Inc.	High	Y	0.18
167	Altamonte Springs	High	Y	3.74
168	Casselberry	High	N	0.41
169	Longwood Utilities, Inc.	Basic	N	0.43
170	Orlando - Iron Bridge	Basic	Y	27.16
171	Palm Valley Association	Basic	N	0.11
173	Sanlando Utilities - Des Pinar/Woodlands	Basic	N	0.48
174	Sanlando Utilities - Wekiva Hunt Club	Basic	N	2.25
175	Seminole County - Greenwood Lakes	High	Y	1.37
178	Utilities Inc. - Lincoln Heights	Basic	N	0.08
179	Utilities Inc. - Weathersfield	Basic	N	0.11
180	Winter Springs	High	Y	0.50
181	Winter Sprngs	High	Y	0.88

[1] Refer to Figure for location.

[2] Data as provided by SJRWMD in 1995 Wastewater Treatment and Reuse Inventory.

[3] Reclaimed Water Availability is based on unreused flow plus flows to wetlands and ground water recharge, as indicated in the 1995 Wastewater Treatment And Reuse Inventory (SJRWMD).

FIGURE 8. ESTIMATED REPLACEABLE LANDSCAPE IRRIGATION QUANTITIES AND RECLAIMED WATER AVAILABILITY IN SEMINOLE COUNTY

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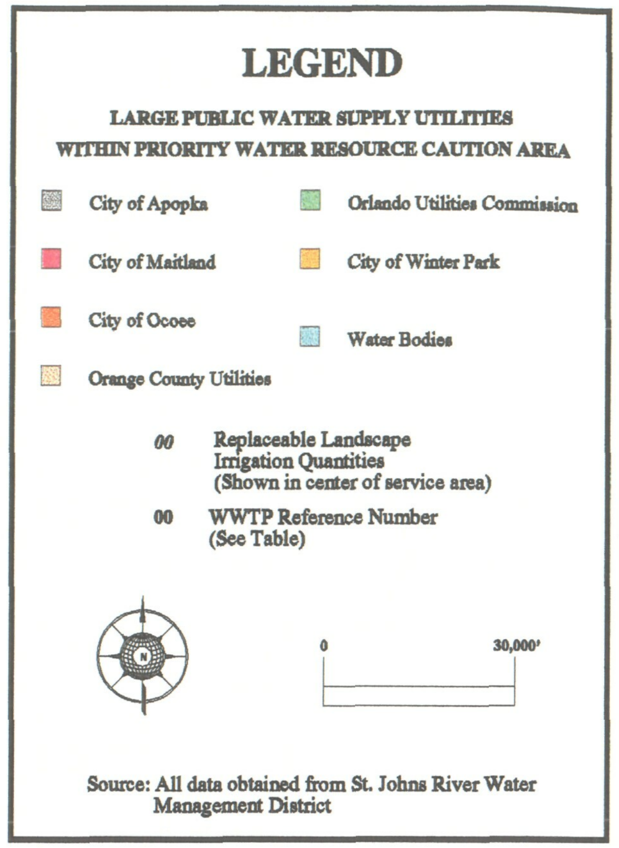

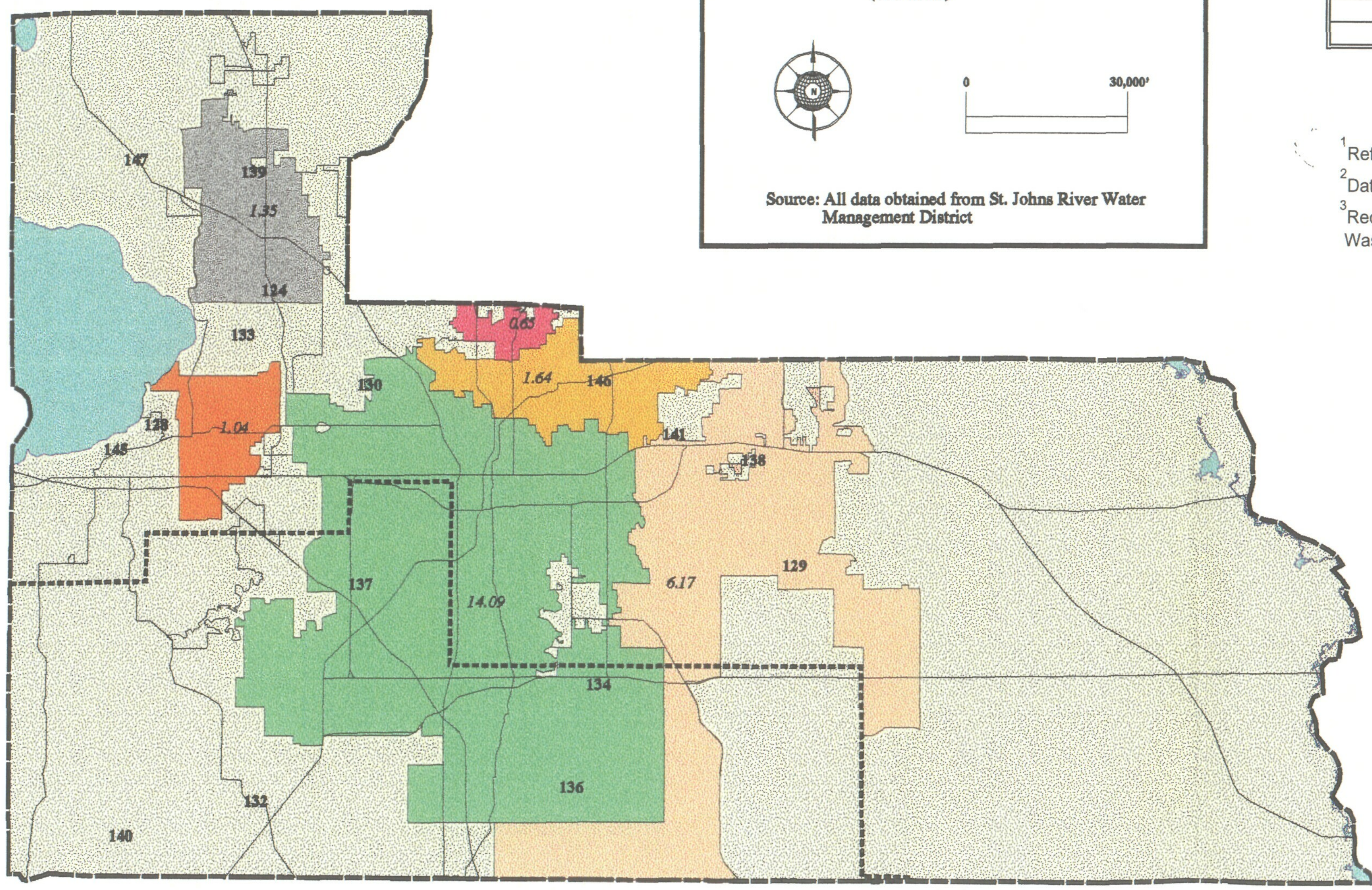

ORANGE COUNTY RECLAIMED WATER AVAILABILITY DATA

WWTP Reference Number[1]	WWTP Name	Disinfection Level[2]	Filters[2] (Y or N)	Reclaimed Water[2] Availability, mgd[3]
124	Apopka	High	Y	0.40
128	Ocoee	Basic	N	0.80
129	Orange County - Eastern	High	Y	5.12
130	Orange County Meadow Woods	High	Y	0.10
132	Orange County - Cypress Walk	High	Y	0.10
133	Orange County - Northwest	Basic	N	2.82
134	Orlando FL. Hotel Ltd.	Basic	N	0.09
136	Orlando - Conserv I	High	Y	1.41
137	Orlando - Conserv II	High	Y	4.70
138	Park Manor Water Wks.	Basic	Y	0.28
139	Reeco Properties	Basic	N	0.12
140	Reedy Creek Impr. Dist.	High	Y	6.73
141	Florida Water Service/Univ. Shores #1	Basic	Y	0.17
145	Winter Garden	Basic	Y	1.37
146	Winter Park	High	N	0.10
147	Zellwood Station Coop.	Basic	N	0.10

[1] Refer to Figure for location.

[2] Data as provided by SJRWMD in 1995 Wastewater Treatment and Reuse Inventory.

[3] Reclaimed Water Availability is based on unreused flow plus flows to wetlands and ground water recharge, as indicated in the 1995 Wastewater Treatment And Reuse Inventory (SJRWMD).

FIGURE 7. ESTIMATED REPLACEABLE LANDSCAPE IRRIGATION QUANTITIES AND RECLAIMED WATER AVAILABILITY IN ORANGE COUNTY

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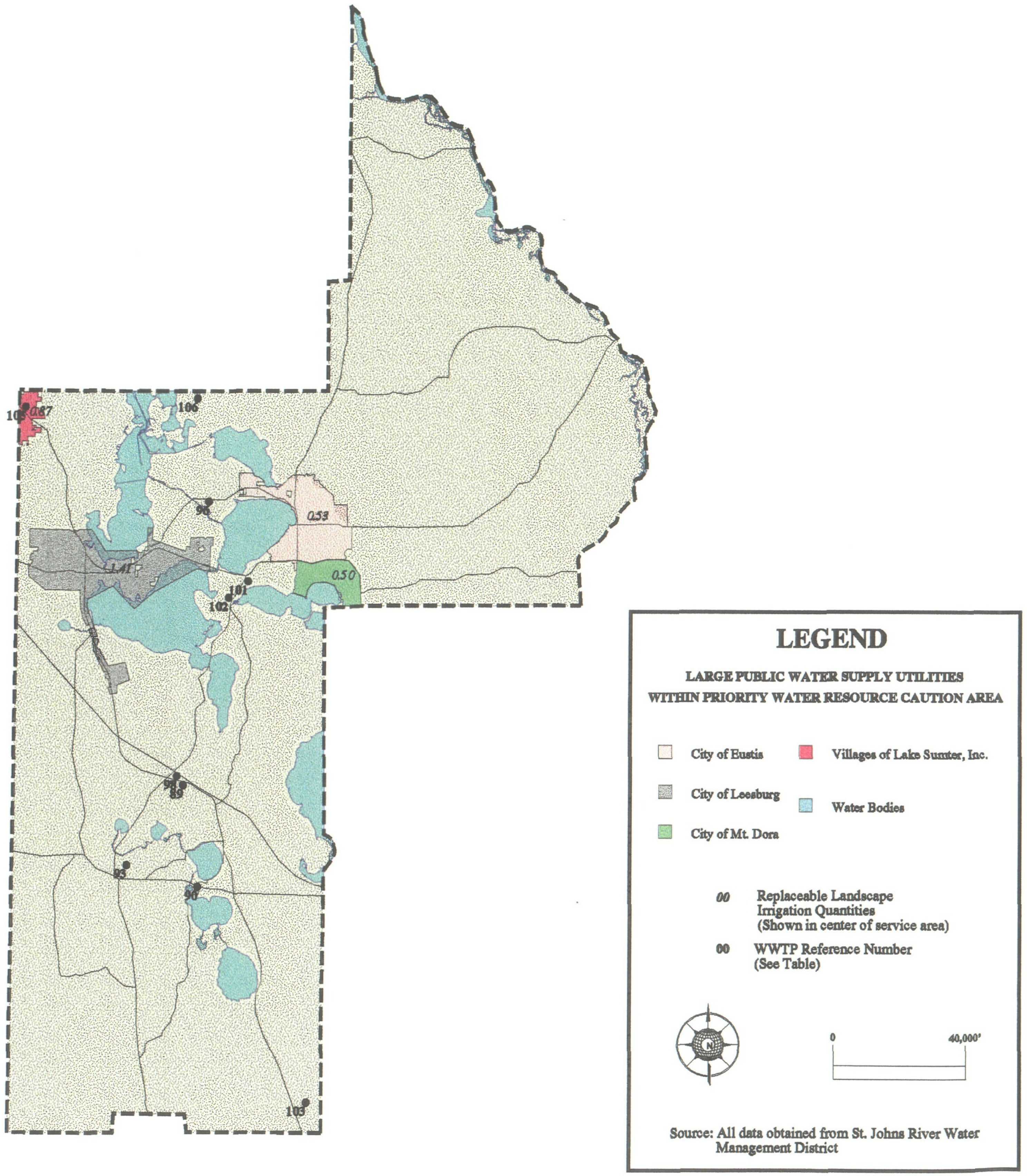

LAKE COUNTY RECLAIMED WATER AVAILABILITY DATA

WWTP Reference Number[1]	WWTP Name	Disinfection Level[2]	Filters[2] (Y or N)	Reclaimed Water[2] Availability, mgd[3]
89	Clerbrook RV Resorts	Basic	N	0.05
90	Clermont	Basic	N	0.77
93	Groveland	Basic	N	0.04
96	M.H.C. Corporation	Basic	N	0.13
98	Florida Water Services	Basic	N	0.09
101	Tavares	Basic	N	0.54
102	Tavares	Basic	N	0.38
103	Thousand Trails Inc.	Basic	N	0.03
105	Village Center Comm. Dev. Dist.	High	Y	0.68
106	Wilder Corporation	Basic	N	0.02

[1] Refer to Figure for location.

[2] Data as provided by SJRWMD in 1995 Wastewater Treatment and Reuse Inventory.

[3] Reclaimed Water Availability is based on unreused flow plus flows to wetlands and ground water recharge, as indicated in the 1995 Wastewater Treatment And Reuse Inventory (SJRWMD).

FIGURE 6. ESTIMATED REPLACEABLE LANDSCAPE IRRIGATION QUANTITIES AND RECLAIMED WATER AVAILABILITY IN LAKE COUNTY

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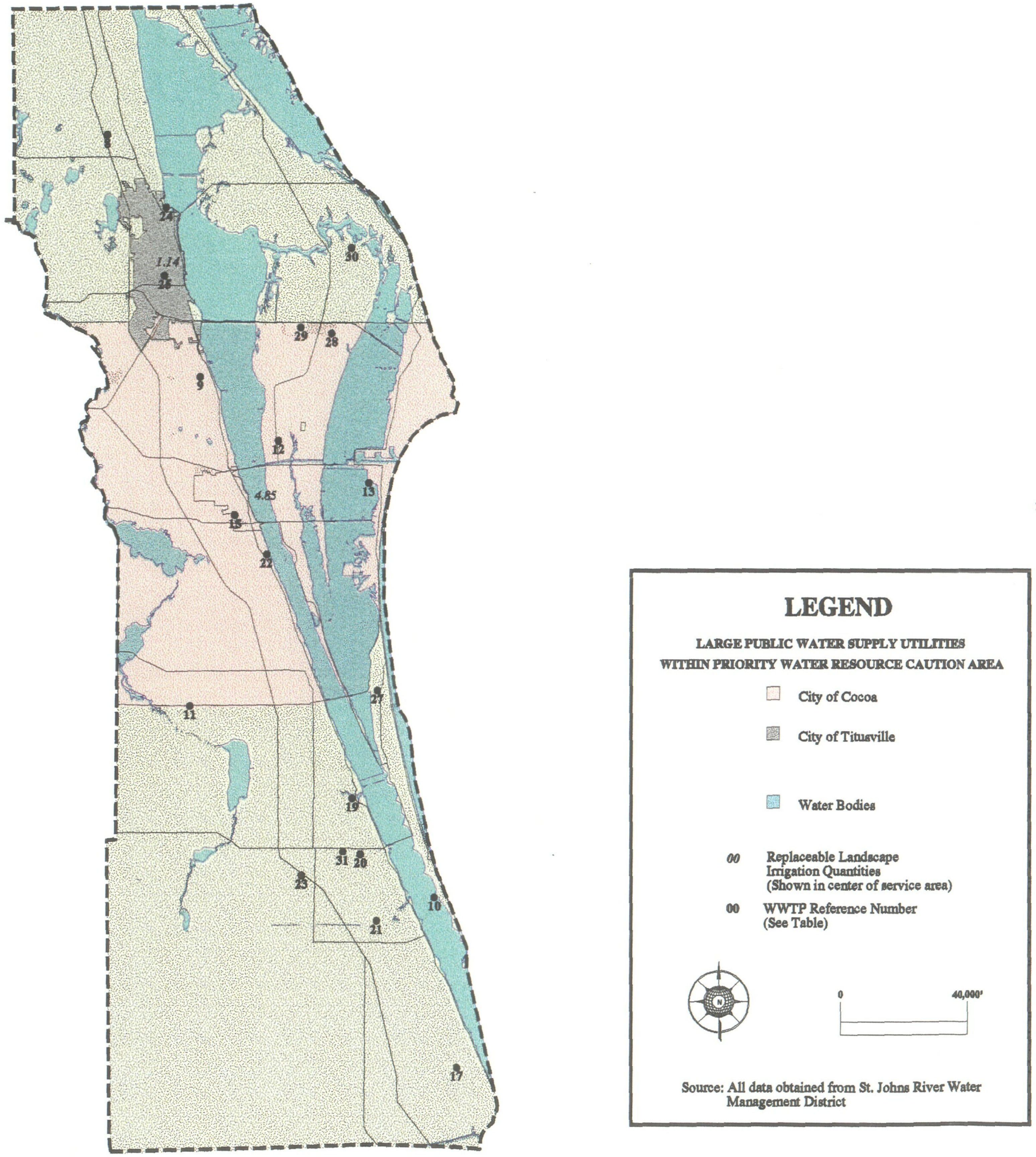

BREVARD COUNTY RECLAIMED WATER AVAILABILITY DATA

WWTP Reference Number[1]	WWTP Name	Disinfection Level[2]	Filters[2] (Y or N)	Reclaimed Water[2] Availability, mgd[3]
8	Brevard County - North	Basic	N	0.27
9	Brevard County - Port St. John	Intermediate	N	0.24
10	Brevard County - South Beaches	High	Y	5.92
11	Brevard County - South Central	High	Y	0.83
12	Brevard County - Sykes Creek	High	Y	2.91
13	Cape Canaveral	Basic	N	1.16
15	Cocoa	High	Y	1.67
17	Florida Cities Water Co.	Basic	N	0.60
19	Melbourne	High	N	2.32
20	Melbourne	High	Y	3.53
21	Palm Bay Utility Commission	High	Y	1.67
22	Rockledge	Basic	N	1.00
23	The Lakes of Melbourne	Basic	N	0.06
24	Titusville	High	N	0.06
25	Titusville	Basic	N	1.80
27	United States Air Force	Basic	N	0.13
28	Walter T. Murphy (NASA)	Basic	N	0.18
29	Walter T. Murphy (NASA)	Basic	N	0.04
30	Walter T. Murphy (NASA)	Basic	N	0.11
31	West Melbourne	Basic	N	1.06

[1] Refer to Figure for location.

[2] Data as provided by SJRWMD in 1995 Wastewater Treatment and Reuse Inventory.

[3] Reclaimed Water Availability is based on unreused flow plus flows to wetlands and ground water recharge, as indicated in the 1995 Wastewater Treatment And Reuse Inventory (SJRWMD).

FIGURE 5. ESTIMATED REPLACEABLE LANDSCAPE IRRIGATION QUANTITIES AND RECLAIMED WATER AVAILABILITY IN BREVARD COUNTY

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water may need to be available seasonally. The seasonal peak can be served directly from the water reclamation facility, a reclaimed water aquifer storage and recovery system, surface storage, or by supplementation with other water sources (such as Altamonte Springs use of ground water and lake water to meet peak seasonal needs). The reclaimed water availabilities shown on Figures 5 through 9 are based on 100 percent of the estimated 1995 annual average available supply. To account for seasonal availabilities, it should be assumed that only 50 percent of the available reclaimed water can be used on an average annual basis to ensure adequate supply during peak day seasonal usage. Provision of large storage capacities, such as aquifer storage and recovery would allow more efficient use of the potentially available reclaimed water supply.

The estimated costs for replacing publicly supplied water with reclaimed water for landscape irrigation were developed on a general basis so that they can be used by SJRWMD and utilities to develop planning-level estimates for varying amounts of reclaimed water usage within specific water service areas. The costs components for reclaimed water systems include reclaimed water filtration, high level disinfection, pumping, storage, transmission, and distribution. A summary of estimated component costs are presented in Table 7. The need for additional filtration and disinfection can be determined from the tables on Figures 5 through 9 for individual facilities. Transmission system unit costs will depend on the location of the water reclamation facility (wastewater treatment plant) in relation to a public water supply service area (reference Figures 5 through 9). A sample reclaimed water system cost calculation and cost tables and curves are provided in Appendix E.

Caution should be exercised regarding conclusions about the impacts of replacing potable water for irrigation with water from other sources. Total water consumption may increase because non-potable water sources generally come to the consumer at lower cost than potable water. Therefore, reclaimed water sources must generally provide a greater volume than the potable water source they replace. In some instances where a flat rate is charged for reclaimed water for residential landscape irrigation, reclaimed water use may be several times greater than potable water use for irrigation.

Table 7. Estimated cost for the use of reclaimed water to replace publicly supplied potable water for landscape irrigation for a 1 mgd average annual flow (AAF) example.

Item	Storage	Pumping	Filtration	High Level Disinfection	Transmission[1]	Macro-Distribution	Micro-Distribution[2]	Totals
Construction Cost	$267,917	$581,591	$831,380	$137,930	$320,440	$862,070	$3,732,670	6,733,998
Non-Construction Cost[3]	$120,563	$261,716	$374,120	$62,070	$144,200	$387,930	$1,679,701	3,030,300
Capital Non-Land Cost	$388,480	$843,307	$1,205,500	$200,000	$464,640	$1,250,000	$5,412,371	$9,764,298
Land & Land Acquisition Cost	$0	$75,000	$2,218	$0	$0[4]	$0[4]	$0[4]	$77,218
Total Capital Cost	$388,480	$918,307	$1,207,718	$200,000	$464,640	$1,250,000	$5,412,371	$9,841,516
Annual O&M Cost $/year	$0	$78,518	$6,509	$25,936	$0	$0	$62,050	$173,013
Equivalent Annual Cost[5], $/year	$30,002	$163,368	$120,452	$44,814	$34,853	$93,763	$468,032	$955,284
Equivalent Cost[5], $/1,000 gallons	$0.08	$0.45	$0.33	$0.12	$0.10	$0.26	$1.28	$2.62

[1] Transmission length assumed to be 1 mile.
[2] Customers per gross acre of service = 2 units per acre. Annual flow per reclaimed water customer = 388 gpd/unit * 365 day/year = 141,620 gallons per year. This information was used to convert the unit micro distribution cost from $/acre to $/gpd.
[3] Non-construction cost = 0.45 x construction cost.
[4] Land and land acquisition costs include right-of-way and easement acquisition. These costs are project specific and can be calculated using Table C-5 in Appendix D. For this cost example land and acquisition costs for transmission and distribution systems were assumed to be $0.
[5] Interest rate for equivalent annual cost analysis = 7.0 %

If reclaimed water is used only to replace an existing potable water demand, the implementation of the reclaimed water system for landscape irrigation cannot encourage additional irrigation or the purpose of replacement will be defeated. Since the analysis assumes that only water used by in-ground irrigation systems is replaceable, new in-ground systems cannot be encouraged if the objective is to be met. Accordingly, in order for this replacement to be effective, one or both of the following two policies may be required when a reclaimed water supply is provided.

1. Only properties with existing in-ground irrigation systems that are connected to public potable water supplies will be allowed to connect to the reclaimed water supply.

2. The charge for using reclaimed water must equal the charge for the potable supply it replaces in order to discourage increased use of the new resource and to allow replacement by other properties.

The above are important considerations given that properties with in-ground irrigation systems may use as much as three to four times as much water as those without in-ground systems.

RECOMMENDATIONS

It is recommended that the results of this study be used by SJRWMD in the overall Investigation of Alternative Water Supply Strategies. The cost for replacing publicly supplied water used for landscape irrigation with self-supply irrigation wells can be used directly for offsetting up to 50 percent of the estimated replaceable irrigation quantities.

For replacing publicly supplied water use with reclaimed water, consideration must be given to the proximity of the reclaimed water source to the water service area being evaluated and current levels of reclaimed water treatment in order to estimate a cost for a particular reclaimed water alternative. In evaluating the overall technical feasibility of using reclaimed water to replace publicly supplied water for landscape irrigation, consideration should be given to the measures needed to ensure that the reuse system truly replaces a potable water use and does not encourage over-use, which would decrease the availability of the reclaimed water supply.

It was beyond the scope of this study to conduct a detailed evaluation of reclaimed water availability within the PWRCA. Data utilized were based on a 1995 Wastewater and Reuse Inventory prepared by SJRWMD. It is thought that these data most likely overestimate the availability in 1995 for facilities with existing reuse programs. Because of seasonal variability in reclaimed water demand in public access and agricultural reuse programs, facilities with these types of reuse systems may have little to no excess capacity during certain times of the year. In addition, many utilities have plans to expand their reuse programs with infrastructure already committed to expansion - - what is reported as available reclaimed water in 1995 may already be committed to other users. On the other hand, other facilities may have no future reuse plans and may be expecting an increase in reclaimed water availability as their wastewater system grows. If it appears that replacement of potable water with reclaimed water for landscape irrigation is a viable alternative water supply strategy in the decision model analysis, it is recommended that additional evaluation and estimation of future reclaimed water availability be conducted.

Because this study was conducted on a broad, planning-level basis, the results are appropriate for use in the Investigation of Alternative Water Supply Strategies. The results can be used for preliminary feasibility assessments for individual utilities, but it is recommended that more site specific information be used, where available.

REFERENCES

Brown & Caldwell and Whitcomb, J.B. 1993. *Water Price Elasticity Study*. Southwest Florida Water Management District, Brooksville, FL.

Jackson, Jo Ann. 1995. Seasonality of reuse demands and the need for alternate disposal. *Proceedings of the Florida Water Resources Conference*. Jacksonville, FL.

Johnson, David. 1996. Telephone Communications, Seminole County Property Appraisers Office. Sanford, FL.

Law Engineering. 1996. *Water supply needs and sources assessment: Alternative water supply strategies investigation: Water supply and wastewater systems component cost information*. Special Publication SJ97 SP3., Palatka, FL. St. Johns River Water Management District.

Post, Buckley, Schuh & Jernigan, Inc. 1993. *Reclaimed Water Master Plan*. City of Pinellas Park, FL.

Post, Buckley, Schuh & Jernigan, Inc. 1992. *Wastewater Reuse Feasibility Study*. Miami-Dade Water and Sewer Authority Department. Miami, FL.

SJRWMD. 1995. Wastewater Treatment and Reuse Inventory. Palatka, FL.

Soil Conservation Service, USDA. Rev. 1970. *Irrigation Water Requirements*. Technical Release No. 21.

Soil Conservation Service, USDA. 1986. *Urban Hydrology for Small Watersheds*. Technical Release No. 55.. Second Ed. (210-VI-TR-55).

Talton, Edward H., Morrell, Robert A., and Jackson, Jo Ann. 1996. *Phase I: Replacement of Potable Quality Water for Landscape Irrigation*. Post, Buckley, Schuh & Jernigan, Inc. for St. Johns River Water Management District, Palatka, FL.

Vergara, Barbara (ed.). 1994. *Water supply needs and sources assessment: 1994: St. Johns River Water Management District.* Technical Publication SJ94-7. Palatka, FL. St. Johns River Water Management District.

Well Contractor References

C.H. Well Drilling. December 26, 1996. Telephone Communications, Eustis, FL.

Dick Joyce Well Drilling. December 26, 1996. Telephone Communications, Orange County, FL.

All Florida Irrigation Supply. December 26, 1996. Telephone Communications, Daytona Beach, FL.

Cullens Well Drilling. December 26, 1996. Telephone Communications, Titusville, FL.

Summers Well Drilling. December 26, 1996. Telephone Communications, Titusville, FL.

Frank Boydson Well Drilling. December 26, 1996. Telephone Communications, Brevard County, FL.

Dodge Well Drilling. December 26, 1996. Telephone Communications, Orange County, FL.

Bill Young Well Drilling. December 26, 1996. Telephone Communications, Seminole County, FL.

APPENDICES

Appendix A
Well Contractor Questionnaire

Well Contractor Questionnaire Date:________________

Introduction Interviewer:____________

Name__________________________________

Company_______________________________

Phone #_______________________________

1. Where do you install most of your irrigation wells?____________________________

2. What size are most irrigation wells?______________________________________

3. Are they residential or commercial irrigation wells? Estimate percentage & pump rate

   Residential well percentage:______________Pump rate:________________

   Commercial well percentage:______________Pump rate:________________

4. Can you estimate the percentage of residential homes with irrigation wells in _____ County?____

5. Are they deep or shallow irrigation wells? How deep? Estimate percentage:

   Deep well depth ____________ percentage_______________

   Shallow well depth __________ percentage_______________

6. What is total construction cost? Including drilling, electric, controls, pump, tank, if necessary.

   Typical shallow well ____ inch size, Cost:____________________________

   ____

   Typical deep well ____ inch size, Cost:______________________________

   ____

Appendix B
Cost Estimation Procedures Letters

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

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

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February 29, 1996

Ms. Jo Ann Jackson, P.E.
Post, Buckley, Schuh & Jernigan, Inc.
1560 Orange Avenue, Suite 700
Winter Park, Florida 32789

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

Dear ~~Ms. Jackson~~: Jo Ann

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 electrical 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,

Don

Donald Brandes, Ph.D.
Water Conservation Program Manager

DB:bv

cc: Ron Wycoff, P.E.
Ed Copeland, 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

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

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April 5, 1996

Ms. Jo Ann Jackson, P.E.
Post, Buckley, Schuh, and Jernigan, Inc.
1560 Orange Avenue, Suite 700
Winter Park, Florida 32789

Re: SJRWMD Contract No. 95W166B, Alternative Water Supply Strategies Investigation, economic analysis criteria

Dear ~~Ms. Jackson~~: Jo Ann

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,

Don Brandes, Ph.D.
Water Conservation Program Manager

DB:bav

cc: Hal Wilkening, P.E.
Barbara A. Vergara, P.G.
Patrick Burger
Alan Weaver

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

Ms. Jo Ann Jackson, P.E.
Post, Buckley, Schuh, and Jernigan, Inc.
1560 Orange Avenue, Suite 700
Winter Park, FL 32789

Re: SJRWMD Contract No. 95W166B, Alternative Water Supply Strategies Investigation, economic analysis criteria

Dear Ms Jackson:

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

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

Appendix C
Water Use Data Analysis

Table C.1 Landscape Irrigation Estimate [Annual Average minus Minimum Month Flow] for the 25 Largest Utilities in the WRCA

#	Utility Name	Data Source	Data Years	Annual Average - Minimum Month & Ratio to Annual Average Water Use														Total Annual Average 1995 Use	Estimated Irrigation Highest % x1995 Flow
				1990		1991		1992		1993		1994		1995		Data Range			
				mgd	Ratio	mgd	Ratio	mgd	Ratio	mgd	Ratio	mgd	Ratio	mgd	Ratio	Avg. Ratio	Highest Ratio	mgd	mgd
1	OUC	SJRWMD	6	13.98	17.7%	3.69	5.2%	7.42	10.0%	9.43	12.5%	7.68	10.1%	12.92	16.2%	11.9%	17.7%	79.61	14.09
2	Orange County	SJRWMD	6	4.59	16.4%	1.71	6.6%	4.05	15.6%	5.46	19.6%	3.83	13.3%	5.95	18.9%	15.1%	19.6%	31.49	6.17
3	City of Cocoa	SJRWMD	6	2.66	11.3%	1.59	7.1%	2.59	10.4%	5.07	20.2%	3.54	15.1%	3.18	13.3%	12.9%	20.2%	23.96	4.85
4	City of Daytona Beach	SJRWMD	6	1.38	11.4%	0.84	7.0%	1.09	8.9%	1.59	12.4%	1.25	10.1%	0.98	7.9%	9.6%	12.4%	12.42	1.54
5	City of Winter Park	SJRWMD	6	1.59	11.7%	1.51	12.4%	1.35	11.2%	1.67	14.4%	1.46	13.0%	1.26	11.1%	12.3%	14.4%	11.35	1.64
7	So. States Util./Deltona Plant	SJRWMD	6	1.93	21.6%	1.37	16.4%	1.78	20.6%	2.83	30.4%	1.99	24.1%	2.45	27.1%	23.4%	30.4%	9.03	2.75
9	City of Altamonte Springs	Utility	6	0.66	8.2%	0.38	5.4%	0.53	8.0%	0.49	7.6%	0.95	14.3%	0.46	7.4%	8.5%	14.3%	6.26	0.90
11	City of Titusville	SJRWMD	6	0.55	9.7%	0.18	3.5%	0.42	8.0%	0.79	14.6%	0.62	13.2%	1.14	23.3%	12.1%	23.3%	4.90	1.14
12	City of Sanford	SJRWMD	6	0.46	8.2%	0.32	5.9%	0.63	11.9%	0.72	13.4%	0.58	11.0%	0.81	14.1%	10.7%	14.1%	5.74	0.81
13	City of Port Orange	SJRWMD	6	0.78	16.2%	0.69	14.8%	0.42	8.6%	0.89	17.1%	0.80	16.0%	0.61	11.6%	14.0%	17.1%	5.27	0.90
15	City of Ormond Beach	SJRWMD	6	0.90	18.9%	0.69	14.8%	0.42	8.6%	0.89	17.1%	0.39	8.1%	0.36	7.3%	12.5%	18.9%	4.90	0.93
17	City of New Smyrna Beach	SJRWMD	6	0.54	13.0%	0.36	9.6%	0.88	21.9%	0.73	17.7%	0.50	12.6%	0.56	13.1%	14.6%	21.9%	4.29	0.94
19	City of Leesburg	SJRWMD	6	0.54	15.5%	0.45	14.8%	0.37	12.6%	1.01	29.0%	0.94	20.4%	1.21	24.8%	19.5%	29.0%	4.87	1.41
25	City of Oviedo	SJRWMD	6	0.40	20.2%	0.39	19.4%	0.31	15.3%	0.59	24.3%	0.43	17.0%	0.60	21.2%	19.6%	24.3%	2.83	0.69
6	Seminole County	PBS&J	4	N/A	N/A	N/A	N/A	1.43	15.7%	2.45	25.0%	1.60	16.6%	1.99	19.1%	19.1%	25.0%	10.39	2.60
8	Sanlando Utilities	FDEP	3	N/A	N/A	N/A	N/A	N/A	N/A	2.24	29.9%	1.38	20.9%	2.11	27.7%	26.2%	29.9%	7.61	2.27
10	City of Casselberry[1]	Utility	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14.4%	5.12	0.74
14	City of Apopka	FDEP	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.96	18.8%	1.35	22.7%	20.7%	22.7%	5.96	1.35
16	City of DeLand	Utility	3	N/A	N/A	N/A	N/A	N/A	N/A	1.03	20.1%	0.64	13.2%	0.77	15.2%	16.2%	20.1%	5.08	1.02
18	City of Winter Springs	Utility	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.19	12.6%	N/A	12.6%	1.48	0.19
20	Villages of Lake Sumter, Inc.	Utility	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.87	24.3%	N/A	24.3%	3.57	0.87
21	City of Ocoee	Utility	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.04	28.2%	N/A	28.2%	3.68	1.04
22	City of Maitland	Utility	3	N/A	N/A	N/A	N/A	N/A	N/A	0.49	17.4%	0.47	17.3%	0.65	22.9%	19.2%	22.9%	2.83	0.65
23	City of Mt. Dora[2]	Utility	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.1%	2.26	0.50
24	Town of Eustis	Utility	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.53	22.1%	N/A	22.1%	2.40	0.53

25 Total Utilities

For 14 utilities with 6-year monthly data:

	1990	1991	1992	1993	1994	1995	6-Year Avg.	@Highest %
Avg. Annual - Min. Mont	30.97	14.17	22.26	32.17	24.96	32.48		38.75
Average Annual (mgd)	203.52	188.21	194.03	199.85	197.51	206.91		
Ratio to Annual Average	15.2%	7.5%	11.5%	16.1%	12.6%	15.7%	13.2%	18.7%

For 11 utilities with 1 to 4-year monthly data:

	1995	@Highest %
Avg. Annual - Min. Month	9.49	11.75
Average Annual (mgd)	50.38	
Ratio to Annual Average	18.8%	23.3% (Highest)

For all 25 utilities with 1 to 6-year monthly data:

	1995	@Highest %
Avg. Annual - Min. Month	41.97	50.51
Average Annual (mgd)	257.29	
Ratio to Annual Average	16.3%	19.6% (Highest)

[1] Percent irrigation was estimated based on Winter Park
[2] Percent irrigation was estimated based on Eustis

Appendix D
Given Reclaimed Water System Cost Information

Planning level cost data for wastewater treatment plant improvements needed to meet FDEP requirements of FDEP for public access reuse and to provide operational storage and pumping requirements were based on SJRWMD Contract No. 95W166C, Alternative Water Supply Strategies Investigation, Law Engineering 1996. The data taken from the Law Engineering Report is summarized below:

Table D.1 Summary of Storage Facility Cost Estimates Provided by SJRWMD

Storage Tanks (No Aerator)							
Storage Volume Mgal	Construction Cost	Non-Construction Cost	Capital Non-Land Cost	Land and Acquisition Cost	Capital Cost	O & M Cost per year	Equivalent Annualized Cost
1.00	$267,917	$120,563	$388,480	Not Given	$388,480	Not Given	$30,002
2.00	$412,180	$185,481	$597,661	Not Given	$597,661	Not Given	$46,157
3.00	$515,225	$231,851	$747,076	Not Given	$747,076	Not Given	$57,697
4.00	$628,574	$282,858	$911,432	Not Given	$911,432	Not Given	$70,390
5.00	$741,924	$333,866	$1,075,790	Not Given	$1,075,790	Not Given	$83,083

	Storage Tanks (Urban)			Storage Tanks (Suburban)			Storage Tanks (Rural)		
Storage Volume Mgal	Land and Acquisition Cost[1]	Total Capital Cost	Equivalent Annualized Cost	Land and Acquisition Cost[1]	Total Capital Cost	Equivalent Annualized Cost	Land and Acquisition Cost[1]	Total Capital Cost	Equivalent Annualized Cost
1.00	$114,784	$503,264	$38,037	$22,957	$411,437	$31,609	$5,739	$394,219	$30,404
2.00	$151,802	$749,463	$56,783	$30,360	$628,021	$48,282	$7,590	$605,251	$46,688
3.00	$179,350	$926,426	$70,251	$35,870	$782,946	$60,207	$8,968	$756,044	$58,324
4.00	$201,518	$1,112,950	$84,495	$40,304	$951,736	$73,210	$10,076	$921,508	$71,094
5.00	$224,977	$1,300,767	$98,831	$44,995	$1,120,785	$86,232	$11,249	$1,087,039	$83,870

Notes:
Tank Cost Recovery Factor = 0.0772292
Land Cost Recovery Factor = 0.07
Source: Table 14, Law Engineering (December 1996).
[1]Estimated by PBS&J

Table D.2 Summary of Pump Station Cost Estimates Provided by SJRWMD

	Pump Station			
Component Capacity mgd[1]	Constr-uction Cost	Non-Construction Cost	Capital Non-Land Cost[2]	O & M Costs[3] per year
1	$300,000	$135,000	$435,000	$21,334
5	$600,000	$270,000	$870,000	$97,407
10	$1,000,000	$450,000	$1,450,000	$192,965
20	$1,500,000	$675,000	$2,175,000	$381,586

	Pump Station (Urban)			Pump Station (Suburban)			Pump Station (Rural)		
Component Capacity mgd[1]	Land and Acquisition Cost	Total Capital Cost[2]	Equivalent Annualized Cost	Land and Acquisition Cost	Total Capital Cost[2]	Equivalent Annualized Cost	Land and Acquisition Cost	Total Capital Cost[2]	Equivalent Annualized Cost
1	$375,000	$810,000	$88,644	$75,000	$510,000	$67,644	$18,750	$453,750	$63,706
5	$375,000	$1,245,000	$205,776	$75,000	$945,000	$184,776	$18,750	$888,750	$180,838
10	$375,000	$1,825,000	$356,081	$75,000	$1,525,000	$335,081	$18,750	$1,468,750	$331,143
20	$375,000	$2,550,000	$613,134	$75,000	$2,250,000	$592,134	$18,750	$2,193,750	$588,197

Notes:
Pump Station Cost Recovery Factor 0.09439
Land Cost Recovery Factor = 0.07

[1]The component capacity does not include factors for peak conditions.
[2]The capital costs include construction (all equipment, material and installation) and non-construction (administrative, engineering, general contingency and land) costs.
[3]The O&M costs include normal maintenance, energy, chemicals and labor.
Source: Table 15, Law Engineering (December 1996).

Table D.3 Summary of Reclaimed Water Filtration Cost Estimates Provided by SJRWMD

Filtration (Gravity Dual-Media)				
Component Capacity mgd[1]	Construction Cost	Non-Construction Cost	Capital Non-Land Cost[2]	O & M Cost[3] Annual
1	$822,789	$370,255	$1,193,044	$5,666
5	$2,206,913	$993,111	$3,200,024	$20,080
10	$3,644,514	$1,640,031	$5,284,545	$37,318
20	$5,217,838	$2,348,027	$7,565,865	$68,707

Component Capacity mgd[1]	Filtration (Urban) Land and Acquisition Cost	Filtration (Urban) Total Capital Cost[2]	Filtration (Urban) Equivalent Annualized Cost	Filtration (Suburban) Land and Acquisition Cost	Filtration (Suburban) Total Capital Cost[2]	Filtration (Suburban) Equivalent Annualized Cost	Filtration (Rural) Land and Acquisition Cost	Filtration (Rural) Total Capital Cost[2]	Filtration (Rural) Equivalent Annualized Cost
1	$12,500	$1,205,544	$119,457	$2,500	$1,195,544	$118,513	$625	$1,193,669	$118,336
5	$25,000	$3,225,024	$324,490	$5,000	$3,205,024	$322,603	$1,250	$3,201,274	$322,249
10	$40,000	$5,324,545	$539,901	$8,000	$5,292,545	$536,881	$2,000	$5,286,545	$536,315
20	$78,750	$7,644,615	$790,282	$15,750	$7,581,615	$784,335	$3,938	$7,569,803	$783,220

Notes:
Cost Recovery Factor = 0.09439

[1]The component capacity does not include factors for peak conditions
[2]The capital costs include construction (all equipment, material and installation) and non-construction (administrative, engineering, general contingency and land) costs.
[3]The O&M costs include all energy, labor and other maintenance.
Source: Table 21. Technical Memorandum 2.b.2, Law Engineering (December 1996)

Table D.4 Summary of Reclaimed Water High Level Disinfection Cost Estimates Provided by SJRWMD

High Level Disinfection							
Component Capacity mgd[1]	Construction Cost	Non-Construction Cost	Capital Non-Land Cost[2]	Land and Acquisition Cost	Total Capital Cost	O & M Cost[3] per year	Equivalent Annualized Cost
1	$134,562	$60,553	$195,115	$0	$195,115	$17,520	$35,937
5	$245,895	$110,653	$356,548	$0	$356,548	$69,350	$103,004
10	$347,820	$156,519	$504,339	$0	$504,339	$127,750	$175,355
20	$517,141	$232,713	$749,854	$0	$749,854	$248,200	$318,979

Notes:
[1]The component capacity does not include factors for peak conditions
[2]The capital costs include construction (all equipment, material and installation) and non-construction (administrative, engineering, general contingency and land) costs.
[3]The O&M costs include all energy, labor and other maintenance.
Source: Table 22, Law Engineering (December 1996).

Table D.5 Reclaimed Water Pipe Cost Estimates

Pipe Diameter (Nominal) inch	Total[1] Cost	Land Requirmt ft^2/LF
4[2]	$20	15
6[2]	$26	15
8[2]	$32	15
12	$48	15
16	$67	15
20	$88	15
24	$109	15
30	$140	20
36	$171	20
42	$201	25
48	$258	25
54	$306	30
60	$354	30

Notes:
[1]The costs construction and non-construction costs for the pipeline, valves, and jack and bores.
A valve was assumed to occur once per mile of pipeline.
Jack and bores were assumed to occur once every 5 miles.
[2]Total costs for 4, 6 and 8-inch diameter pipes extrapolated for this project from the given data.
Source: Table 20, Law Engineering (December 1996).

Table D.6 Pipe Construction Land Cost Estimates

	Adjacent to Public ROW					
	Easement			ROW		
Land Type	Land $/ft^2	Acquisition $/ft^2	Total $/ft^2	Land $/ft^2	Acquisition $/ft^2	Total $/ft^2
Urban	$4.00	$1.00	$5.00	$6.00	$1.50	$7.50
Suburban	$1.75	$0.44	$2.19	$3.00	$0.75	$3.75
Rural	$0.75	$0.19	$0.94	$1.00	$0.25	$1.25
	New Areas					
	Easement			ROW		
Land Type	Land $/ft^2	Acquisition $/ft^2	Total $/ft^2	Land $/ft^2	Acquisition $/ft^2	Total $/ft^2
Urban	$3.00	$0.75	$3.75	$5.00	$1.25	$6.25
Suburban	$1.00	$0.25	$1.25	$2.00	$0.50	$2.50
Rural	$0.50	$0.13	$0.63	$0.75	$0.19	$0.94

Notes:
Source: Table 17, Law Engineering (December 1996).

Table D.7 Proposed Water Supply Facilities Service Life Criteria[1]

Component Type	Service Life Criteria years
Pipelines, collection and distribution systems	40
Buildings, tankage, site improvements, etc.	35
Wells	30
Process and auxilliary equipment (treatment equipment, pumps, mechanical equipment, etc.)	20

Notes:
[1]Based on June 5, 1996 communication from Barbara Vergara of SJRWMD in a table titled Water Supply Facilities Service Life Criteria Comparison.

Non-construction costs 0.45 x construction costs

Land Acquisition costs 0.25 x land costs

Cost of Money = 7.00%

Source: Law Engineering (December 1996).

Cost of Energy = $0.08 /kW-hour

Assumed for self supply energy cost calculation.

Appendix E
Example Reclaimed Water System Cost Calculation

Reclaimed Water System Unit Cost Development

Methodology

The following components are necessary to implement a reclaimed water system:

* Reclaimed water filtration
* High level disinfection
* Operational storage
* Pump Station
* Transmission
* Macro-distribution system
* Micro-distribution system

Component system capacities and the associated costs will be converted to average annual flow (AAF) terms based on the following component capacity assumptions:

Reclaimed Water Filtration capacity =	1.0 * AAF
High level disinfection capacity =	1.0 * AAF
Operational storage criteria =	24.0 hour total storage of AAF
Operational storage volume =	1.0 * AAF - day
Number of tanks =	1.0 tanks
Operational pumping and transmission peak flow requirements =	4.0 * AAF
Transmission system design velocity for peak flow =	4.0 fps
Micro distribution homes served per acre (existing in-ground systems in area to be served with micro distribution system) =	2.0 typical residential connections per acre

In order to determine intermediate component costs from the given tables, cost curves were developed. The following equation format was assumed:

$y = ax^b + c$

where:

y= Cost
a= Constant
x= Component capacity (Mgal or mgd)
b= Power factor representing economies of scale, usually 0.6 to 1.0 (1.0=straight line)
c= Constant

Table E.1 Cost Curve Constants for Reclaimed Water Cost Estimation

Component		Non-Land Capital	O&M	Land and Land Acquisition		
				Urban	Suburban	Rural
Storage per tank:	a =	388,480	0	27,010	5,402	1,351
	b =	0.63	1	1	1	1
	c =	0	0	93,456	18,691	4,673
Cost Recovery Factor =		0.07723	1	0.07000		
Pump Station(>1mgd):	a =	260,000	18,961	0	0	0
	b =	0.681	1	1	1	1
	c =	175,000	2,674	375,000	75,000	18,750
Pump Station(>1mgd):	a =	435,000	18,961	0	0	0
	b =	0.681	1	1	1	1
	c =	0	2,674	375,000	75,000	18,750
Cost Recovery Factor =		0.09439	1	0.07000		
Reclaimed Water Filtration:	a =	1,205,500	3,304	3,496	699	175
	b =	0.62	1	1	1	1
	c =	0	3,205	7,596	1,519	380
Cost Recovery Factor =		0.09439	1	0.07000		
High Level Disinfection(>1 mgd):	a =	65,000	12,081	0	0	0
	b =	0.75	1	1	1	1
	c =	135,000	6,975	0	0	0
High Level Disinfection(>1 mgd):	a =	195,115	12,081	0	0	0
	b =	0.75	1	1	1	1
	c =	0	6,975	0	0	0
Cost Recovery Factor =		0.09439	1	0.07000		
Transmission and Distribution						
Cost Recovery Factor =		0.07501	1	0.07000		

Using the cost curves, component capacity peaking assumptions, and cost recovery factors listed in Table D.1, develop cost estimates for reclaimed water storage, pumping, filtration, and high level disinfection on a common AAF basis.

Table E.2 Storage Cost Estimates

Average Annual Flow(AAF) mgd	Storage (No Land)			Storage (Suburban)			
	Storage Volume Mgal	Capital Non-Land Cost	O & M Costs per year	Land and Acquisition Cost	Total Capital Cost	Equivalent Annualized Cost	Equivalent Unit Cost $/1000 gal
1	1.00	$388,480	$0	$24,093	$412,573	$31,689	$0.09
5	5.00	$1,070,828	$0	$45,701	$1,116,529	$85,899	$0.05
10	10.00	$1,657,176	$0	$72,711	$1,729,888	$133,074	$0.04
20	20.00	$2,564,588	$0	$126,732	$2,691,320	$206,934	$0.03

Table E.3 Pump Station Cost Estimates

Average Annual Flow(AAF) mgd	Pumping (No Land)			Pumping (Suburban)			
	Component Capacity mgd	Capital Non-Land Cost	O & M Costs per year	Land and Acquisition Cost	Total Capital Cost	Equivalent Annualized Cost	Equivalent Unit Cost $/1000 gal
1	4	$843,307	$78,518	$75,000	$918,307	$163,368	$0.45
5	20	$2,174,746	$381,893	$75,000	$2,249,746	$592,418	$0.32
10	40	$3,381,094	$761,112	$75,000	$3,456,094	$1,085,504	$0.30
20	80	$5,315,172	$1,519,550	$75,000	$5,390,172	$2,026,499	$0.28

Table E.4 Reclaimed Water Filtration System Cost Estimates

Average Annual Flow(AAF) mgd	Filtration (No Land) Component Capacity mgd	Capital Non-Land Cost	O & M Costs per year	Filtration (Suburban) Land and Acquisition Cost	Total Capital Cost	Equivalent Annualized Cost	Equivalent Unit Cost $/1000 gal.
1	1	$1,205,500	$6,509	$2,218	$1,207,718	$120,452	$0.33
5	5	$3,269,856	$19,726	$5,015	$3,274,871	$328,719	$0.18
10	10	$5,025,360	$36,247	$8,512	$5,033,872	$511,187	$0.14
20	20	$7,723,352	$69,289	$15,504	$7,738,856	$799,381	$0.11

Table E.5 Reclaimed Water High Level Disinfection Cost Estimates

Average Annual Flow(AAF) mgd	High Level Disinfection (No Land) Component Capacity mgd	Capital Non-Land Cost	O & M Costs per year	High Level Disinfection (Suburban) Land and Acquisition Cost	Total Capital Cost	Equivalent Annualized Cost	Equivalent Unit Cost $/1000 gal.
1	1	$200,000	$25,936	$0	$200,000	$44,814	$0.12
5	5	$352,341	$101,779	$0	$352,341	$135,037	$0.07
10	10	$500,522	$196,584	$0	$500,522	$243,828	$0.07
20	20	$749,732	$386,194	$0	$749,732	$456,961	$0.06

Micro Distribution costs were based on the following analysis:

Table E.6 Micro Distribution System Unit Cost Development

Pipe Diameter inch	Pipe Length feet	Capital Unit Cost $/LF	Capital Cost
4	15,600	$20	$312,000
6	3,200	$26	$83,200
8	800	$32	$25,600
Total Capital Cost			$420,800
From Pinellas Park analysis, gross micro-distribution area, acres			117.1
Unit Cost per acre			$3,594
Reclaimed Water Meter & Box, per connection			$200
Water Service Backflow Prevention per connection			$100
Use ==>		$3,600 /acre	
Plus		$300 /connection	

Macro Distribution costs were based on the following analysis:

Proposed Pinellas Park reclaimed water system macro distribution system analysis

Growing Season Demand gpd	Non-Grow Season Demand gpd	Average Demand gpd
10,548,922	5,227,569	7,528,245

PEAK FLOW = 2.5   * GROWING SEASON IRRIGATION REQUIREMENTS

Table E.7 Macro Distribution System Unit Cost Development

Pipe Diameter inch	Pipe Length feet	Capital Unit Cost $/LF	Capital Cost
4	900	$20	$18,000
6	3,550	$26	$92,300
8	7,600	$32	$243,200
12	26,750	$48	$1,284,000
16	39,000	$67	$2,613,000
20	2,750	$88	$242,000
24	35,050	$109	$3,820,450
30	6,600	$140	$924,000
36	0	$171	$0
42	0	$201	$0
48	0	$258	$0
54	0	$306	$0
60	0	$502	$0
		Cost	$9,236,950
		Cost/gpd	$1.23
	Use ==>	$1.25 /gpd	

Macro-Distribution Cost Check

Table E.8 Macro Distribution System Cost Comparison

Project	Construction Cost $/gpd	Capital Cost $/gpd
Proposed-this Project	$0.86	$1.25
MDWASAD (1992)	$0.92	$1.34
	$0.70	$1.01
	$0.58	$0.85
Brevard County-SCR Reuse Master Plan (1993)	$1.22	$1.77
	$0.94	$1.37
Brevard County-Merritt Island Reuse Feasibility Study (1992)	$0.80	$1.17

Notes:
Construction cost estimates from the source were used and multiplyed by 1.45 to compare capital costs.

Micro-Distribution Cost Check

Table E.9 Micro Distribution System Cost Comparison

Project	Construction Cost $/acre	Capital Cost $/acre
Proposed-this Project	$2,483	$3,600
MDWASAD (1992)	$2,350	$3,408
Pinellas Park	$2,361	$3,423
Orlando Acres Water Distribution Retrofit (1994)	$2,000	$2,900
Brevard County-SCR Reuse Master Plan (1993)	$2,736	$3,967

Notes:
Construction cost estimates from the source were used and multiplyed by 1.45 to compare capital costs.

Reclaimed Water Transmission costs could be simplified as follows:

Table E.10 Reclaimed Water Total Transmission Main Cost Estimates[1]

Nominal	Transmission							
Average Annual Flow(AAF) mgd	Pipe Diameter (Nominal) inch	Peak Flow @ 4 fps mgd	AAF @ Peak Flow of 4 * AAF mgd	Total Unit Capital Cost $/LF	Add Easement & ROW Costs	Total Unit Capital Cost $/mile	Equivalent Annualized Cost $/yr/mile	Equivalent Unit Cost, $/ 1000 gal/mi
	12	2.0	0.5	$48	___	$253,440		
	16	3.6	0.9	$67	___	$353,760		
1	20	5.6	1.4	$88	___	$464,640	$34,853	$0.10
	24	8.1	2.0	$109	___	$575,520		
	30	12.7	3.2	$140	___	$739,200		
	36	18.3	4.6	$171	___	$902,880		
5	42	24.9	6.2	$201	___	$1,061,280	$79,607	$0.04
	48	32.5	8.1	$258	___	$1,362,240		
10	54	41.1	10.3	$306	___	$1,615,680	$121,192	$0.03
	60	50.8	12.7	$354	___	$1,869,120		
	66	61.4	15.4	$402	___	$2,122,560		
	72	73.1	18.3	$456	___	$2,407,680		
20	78	85.8	21.4	$502		$2,650,560	$198,819	$0.03

Notes:
[1]Costs include the pipeline, valves, and jack & bores.
Valve spacing was assumed to be one mile.
Jack and bores were assumed to occur every 5 miles.
Unit costs based on Alternative Water Supply Strategies Investigation
(SJRWMD Contract No. 95W166C, Law Engineering, 1996)
Assumed peak flow design velocity 4.0 fps

Calculate the reclaimed water distribution costs as follows:

Table E.11 Reclaimed Water Macro Distribution System Cost Estimates

Average	Macro Distribution System				
Annual Flow(AAF) mgd	Unit Capital Cost $/AAF-gpd	Total Capital Cost	O & M Cost[1] per year	Equivalent Annualized Cost	Equivalent Unit Cost $/1000 gal.
	$1.25				
1		$1,250,000	--	$93,763	$0.26
5		$6,250,000	--	$468,813	$0.26
10		$12,500,000	--	$937,625	$0.26
20		$25,000,000	--	$1,875,250	$0.26

Notes:
[1]O&M costs were included in the micro-distribution system O&M costs.

Table E.12 Reclaimed Water Micro Distribution System Cost Estimates

Micro Distribution System			
Unit Pipe Capital Cost $/acre	Meter & BFP Capital Cost $/unit	# of Units Served per Gross Acre	Unit AAF gpd/unit
$3,600	$300	2	388

Average Annual Flow(AAF) mgd	Micro Distribution System							
	Total # of Units Served	Total Gross acre Served	Pipe Capital Cost	Meter & BFP Capital Cost	Total Capital Cost[1]	O & M Cost[2] per year	Equivalent Annualized Cost	Equivalent Unit Cost $/1000 gal.
1	2,577	1,289	$4,639,175	$773,196	$5,412,371	$62,050	$468,032	$1.28
5	12,887	6,443	$23,195,876	$3,865,979	$27,061,856	$310,250	$2,340,160	$1.28
10	25,773	12,887	$46,391,753	$7,731,959	$54,123,711	$620,500	$4,680,320	$1.28
20	51,546	25,773	$92,783,505	$15,463,918	$108,247,423	$1,241,000	$9,360,639	$1.28

Notes:

[1]Capital costs for installation in existing neighborhoods with meter, box and water backflow prevention.

[2]O&M costs were assumed to be $0.17 per thousand gallon based on the MDWASAD Reuse Feasibility Study (1993).

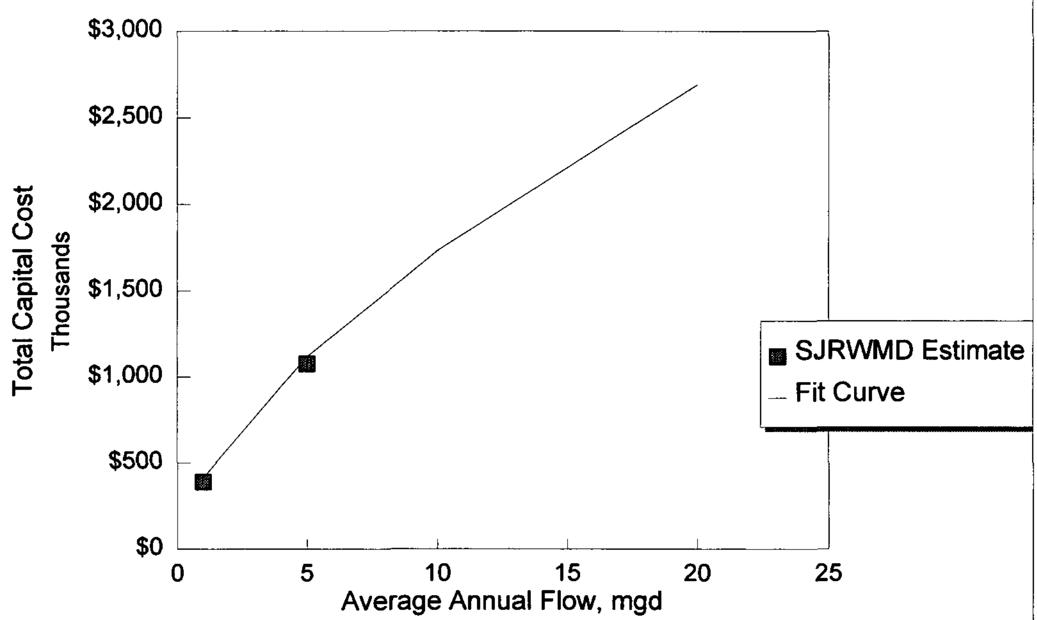

Figure E.1 Storage tank capital cost estimate
(1 day AAF storage volume, 1 tank)

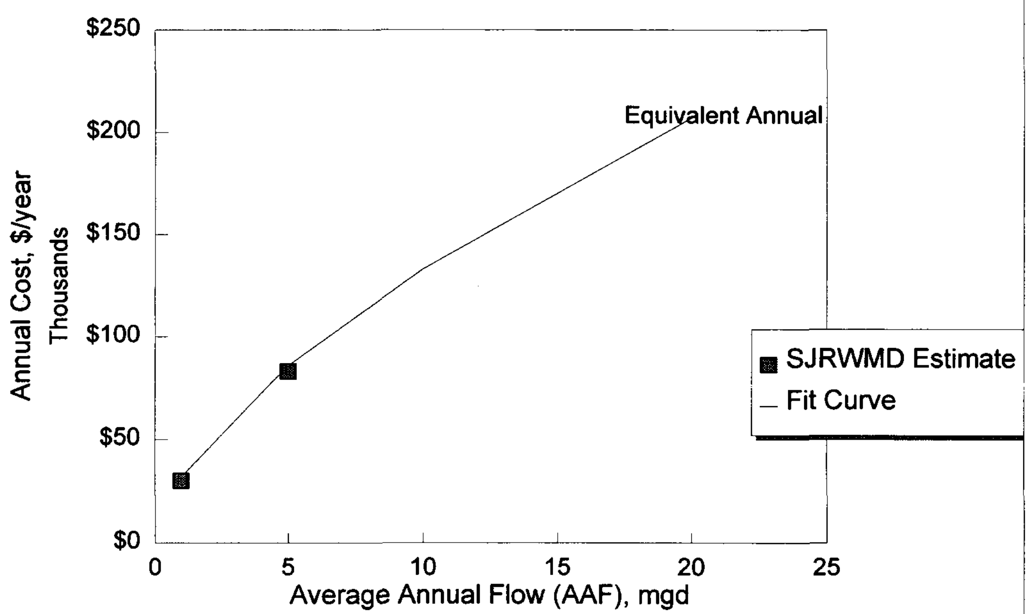

Figure E.2 Storage tank annual cost estimat
(1 day AAF volume, 1 tank, O&M cost given as $0/yr)

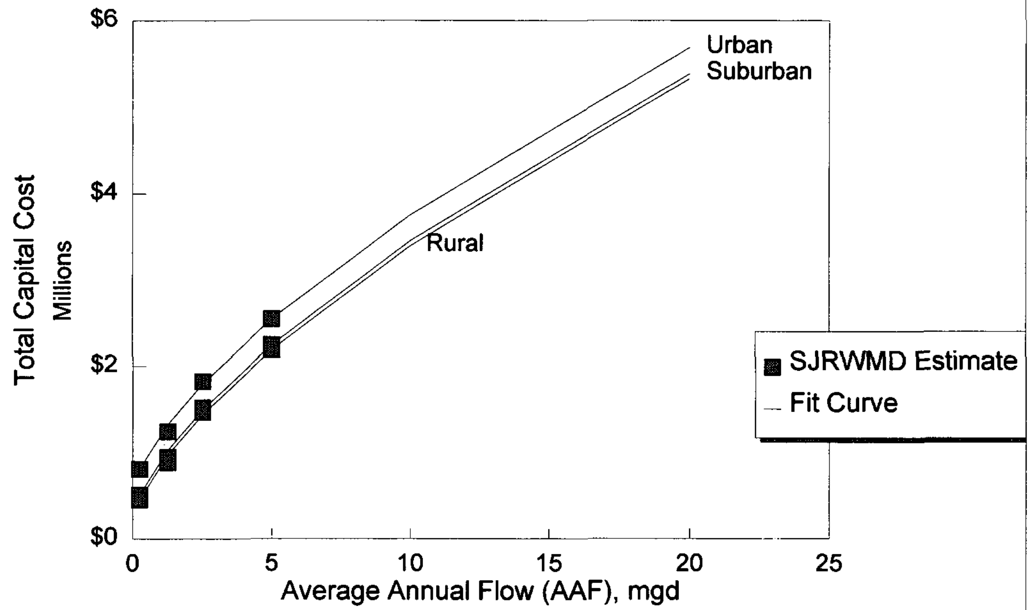

Figure E.3 Pump station capital cost estimat
(Pump station capacity = 4.0 x AAF)

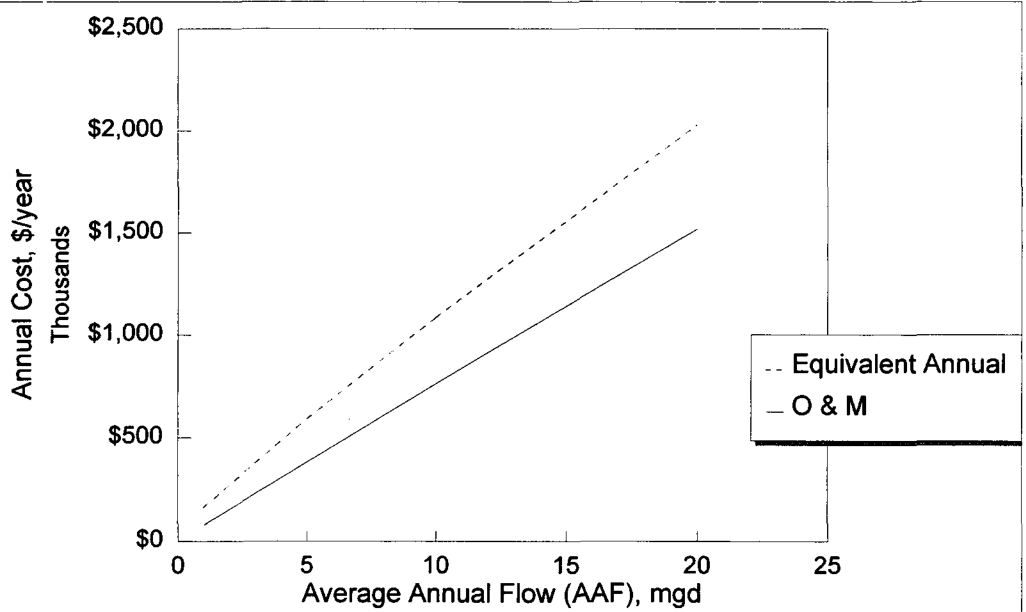

Figure E.4 Pump station annual cost estimat
(Pump station capacity = 4.0 x AAF)

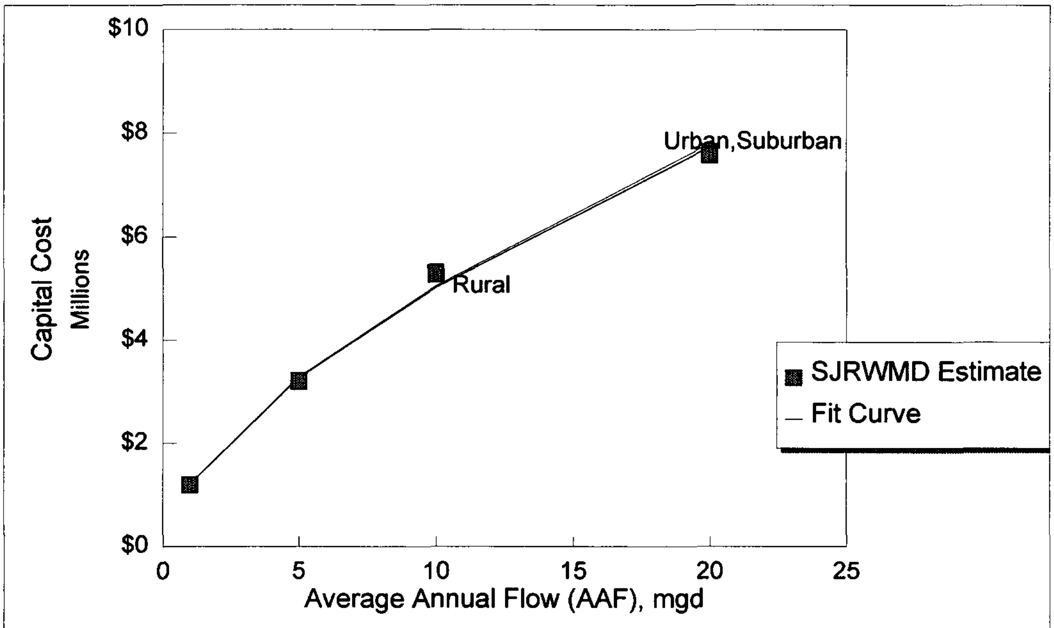

Fig. E.5 Reclaimed water filtration capital cost estimates
(Filtration capacity = 1.0 x AAF)

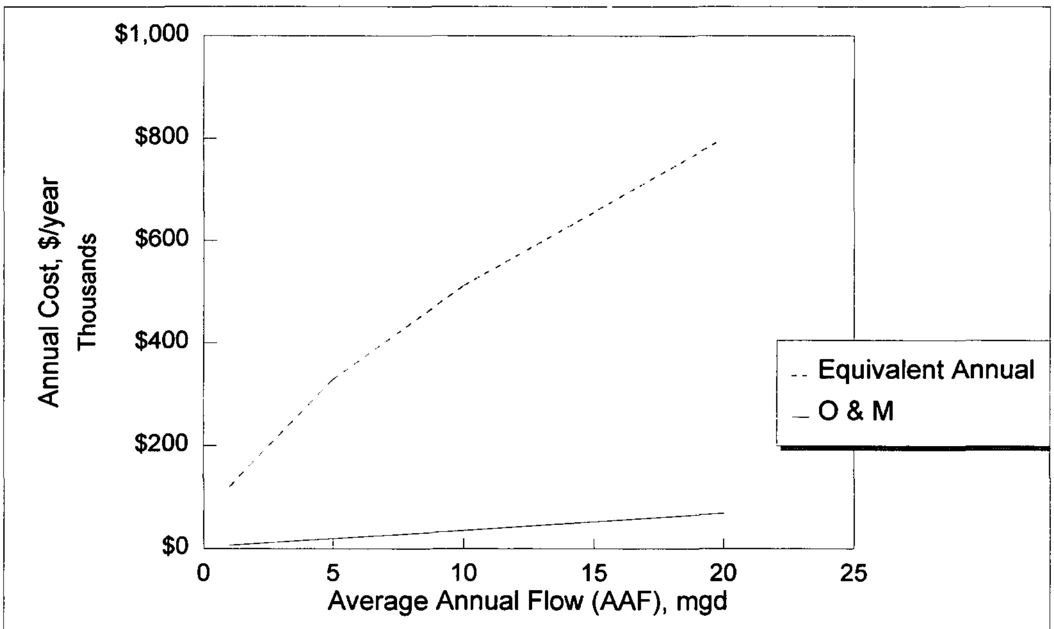

Fig. E.6 Reclaimed water filtration annual cost estimates
(Filtration capacity = 1.0 x AAF)

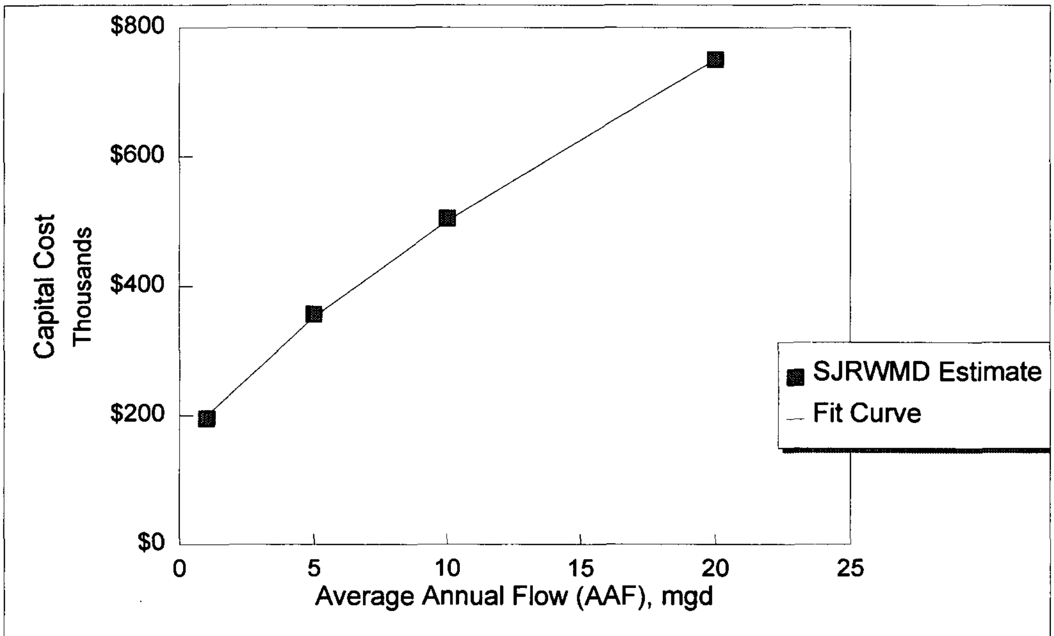

Fig. E.7 High level disinfection capital cost estimates
(Disinfection capacity = 1.0 x AAF)

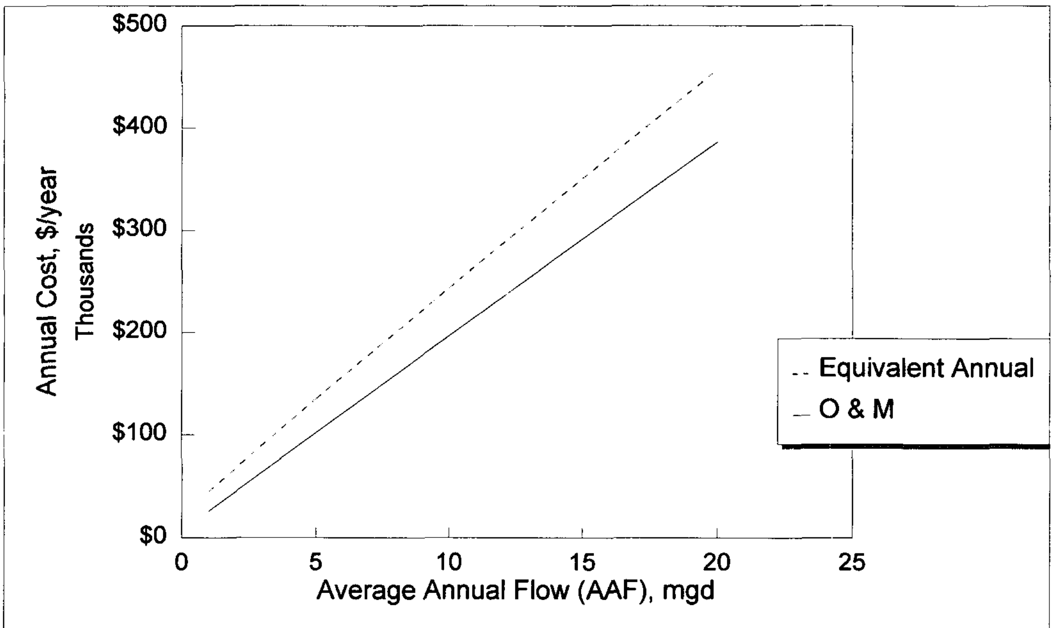

Fig. E.8 High level disinfection annual cost estimates
(Disinfection capacity = 1.0 x AAF)

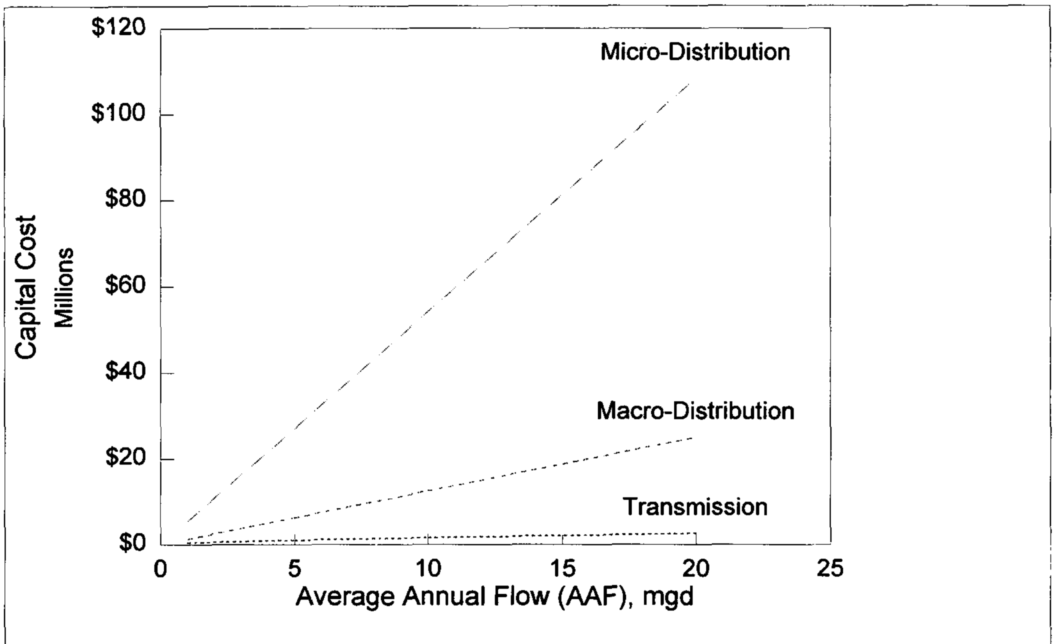

Fig. E.9 Reclaimed water transmission & distribution capital cost estimates

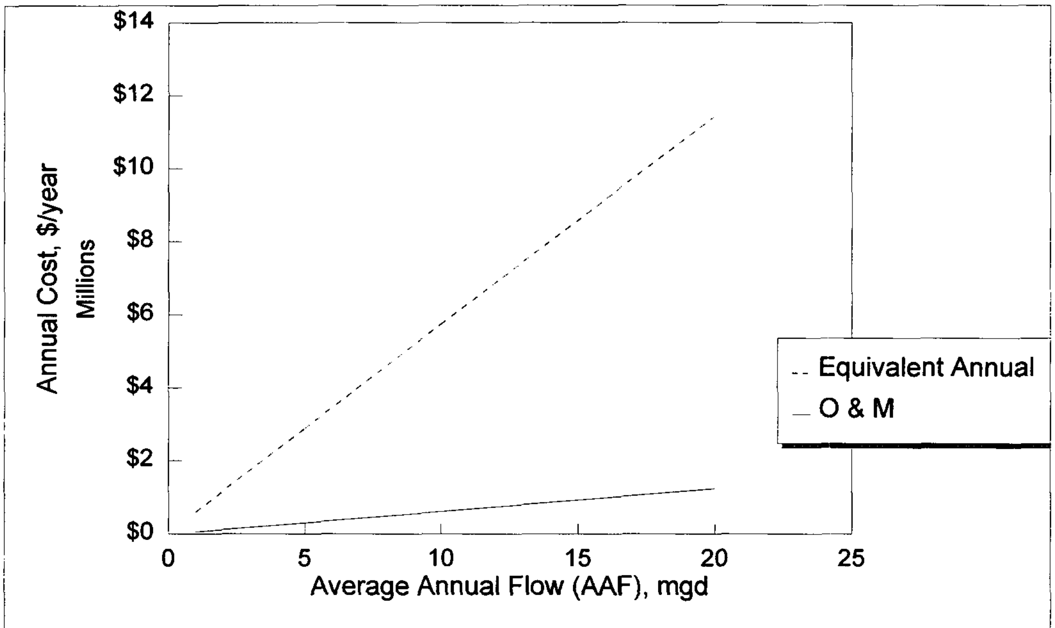

Fig. E.10 Reclaimed water transmission & distribution annual cost estimates