REUSE FEASIBILITY STUDY
MARCO ISLAND WASTEWATER TREATMENT PLANT

Prepared For

Southern States Utilities, Inc.

February 1993

HARTMAN & ASSOCIATES, INC.

engineers, hydrogeologists, surveyors & management consultants

REUSE FEASIBILITY STUDY
MARCO ISLAND
WASTEWATER TREATMENT PLANT

Prepared For

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Prepared By

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February, 1993

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February 15, 1992 HAI #92-231.00

Mr. Rafael A. Terrero, P.E.
Environmental Services Manager
Southern States Utilities, Inc.
1000 Color Place
Apopka, Florida 32703

Subject: Marco Island Wastewater Treatment Plant
Reuse Feasibility Study

Dear Mr. Terrero:

Hartman & Associates, Inc. (HAI) is pleased to submit twelve (12) copies of the Reuse Feasibility Study for the Marco Island wastewater treatment plant (WWTP). The Reuse Feasibility Study was prepared in accordance with Chapter 17-610, of the Florida Administrative Code (F.A.C.), and Section 403.064 of the Florida Statutes (F.S.). Please distribute this document to all necessary parties.

If you have any questions regarding this report, please do not hesitate to call me.

Very truly yours,

Hartman & Associates, Inc.

Jon D. Fox
Project Engineer

JDF/ll/C-13/terrero2.jdf
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SOUTHERN STATES UTILITIES, INC.
REUSE FEASIBILITY STUDY
MARCO ISLAND WWTP

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SECTION 1

INTRODUCTION

1.1 GENERAL

The purpose of this report is to assess the feasibility of reuse, as defined in Chapter 17-610, of the Florida Administrative Code, (F.A.C.), of the wastewater effluent from the Marco Island Wastewater Treatment Plant (WWTP). This report also addresses the requirements of Chapter 17-40 for reuse of reclaimed water in designated critical water supply areas to encourage and promote the beneficial reuse of reclaimed water, as produced by a public or privately owned and operated wastewater treatment facility. The use of reclaimed water for beneficial reuse will subsequently result in water management and conservation of potable drinking water. This report is prepared in accordance with Section 403.064, of the Florida Statutes (FS) and Chapter 17-610, F.A.C.

1.2 BACKGROUND

The Deltona Corporation developed in the area of Marco Island prior to July 1989. Concomitant with development, the corporation established an extensive water and wastewater utility system. In July of 1989, Southern States Utilities, Inc. (SSU) purchased from Deltona Corporation the water and wastewater facilities for the Marco Island service area. Since acquiring the utility system, numerous capital expansion projects, necessary to adequately serve the existing and growing customer base, have been undertaken by SSU.

The Marco Island water and wastewater systems are located in southwestern Collier County, Florida as shown on Figure 1-1. The Florida Public Service Commission (FPSC) certificated water and wastewater service areas were transferred to SSU via FPSC Order and are illustrated in Figure 1-2. However, the actual wastewater service area encompasses a larger area than the FPSC certificated service area since wholesale wastewater service is provided to Collier County Utilities and North Marco Utilities, as shown in Figure 1-3. The remainder of the island is served by individual on-site septic tank systems.

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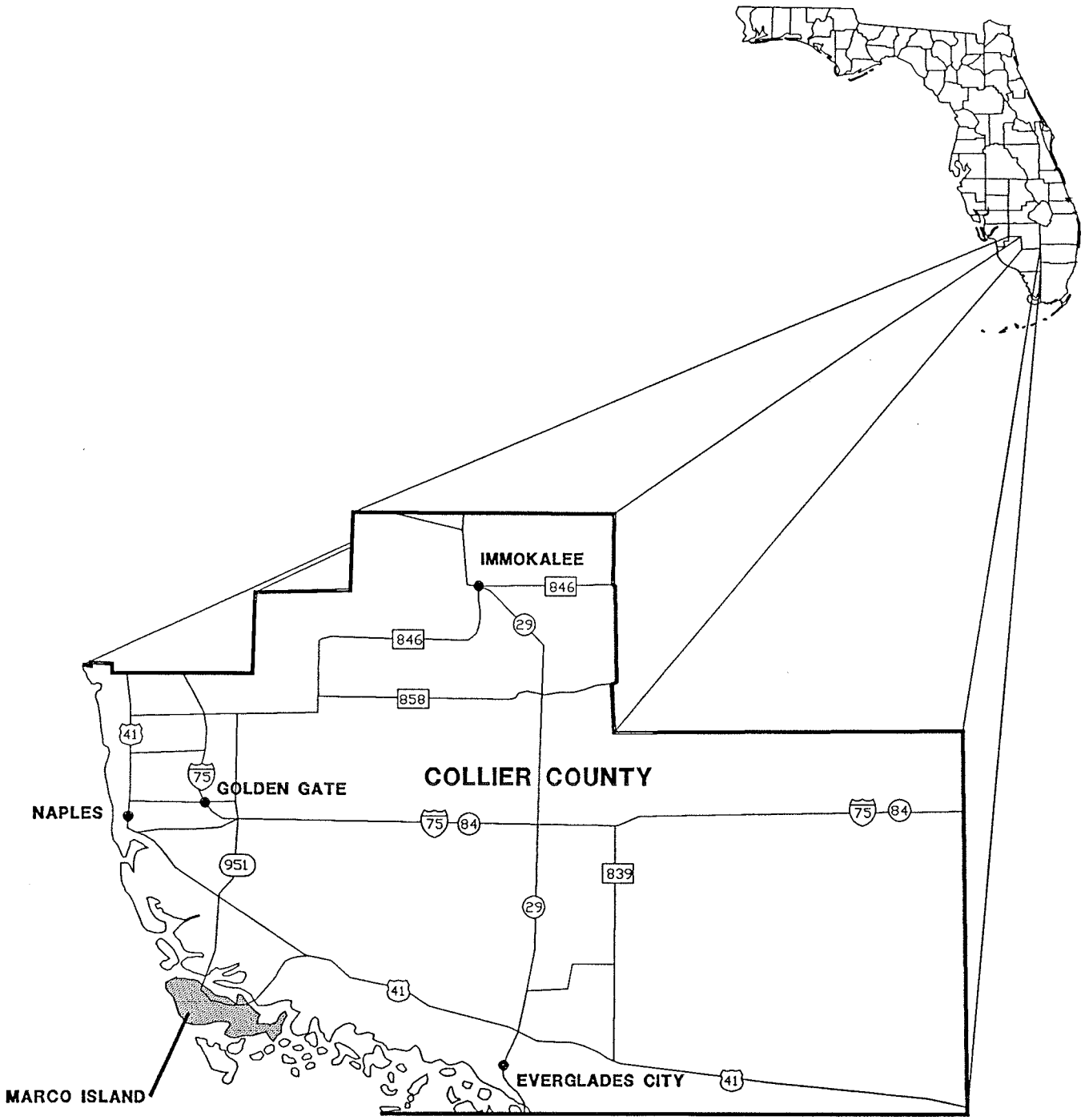

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LOCATION MAP

FIGURE 1-1

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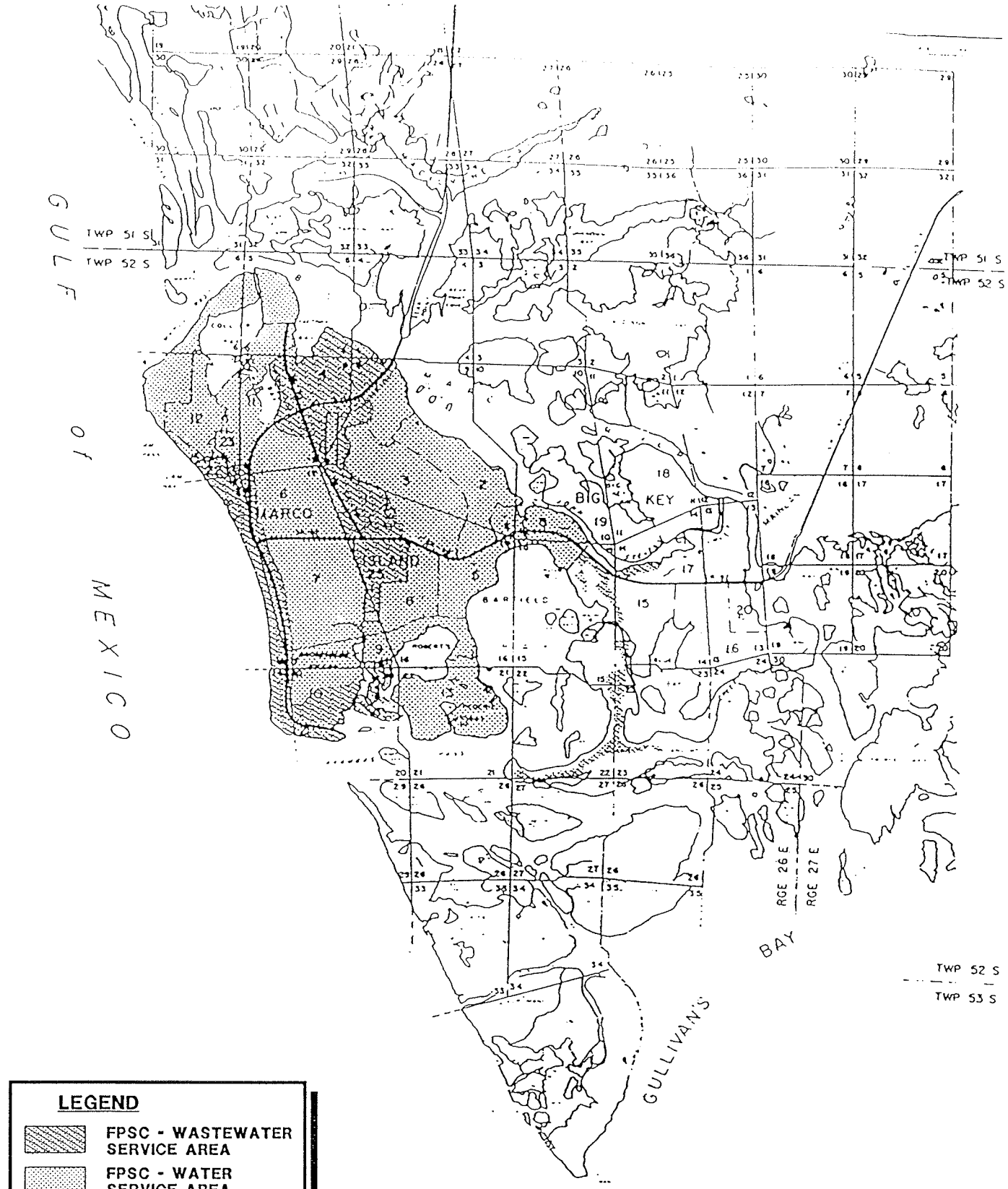

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SOUTHERN STATES UTILITIES, INC.
EXISTING FPSC SERVICE AREA

FIGURE 1-2

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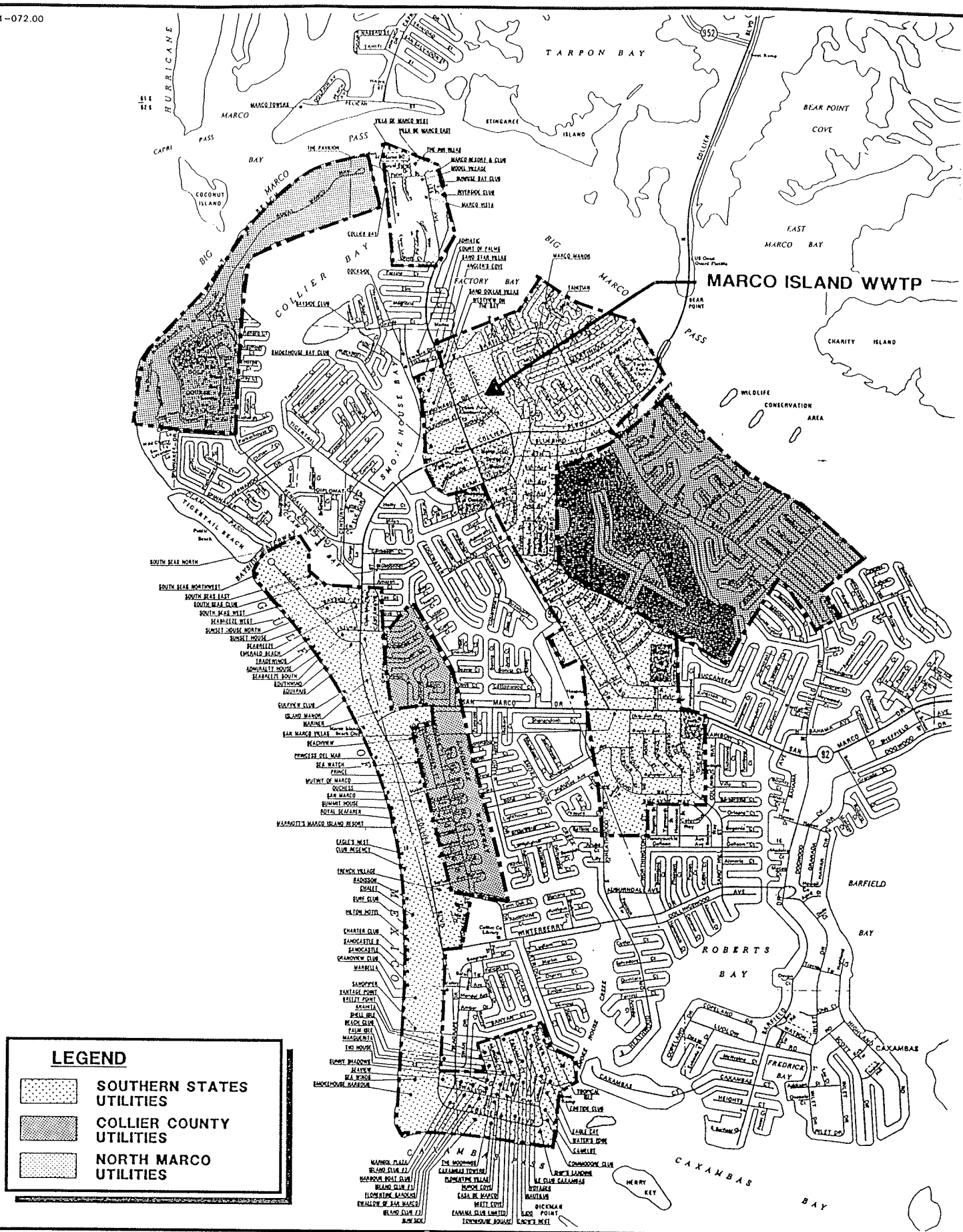

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SOUTHERN STATES UTILITIES, INC.
ACTUAL WASTEWATER SERVICE AREA

FIGURE 1-3

1.3 SCOPE OF SERVICES

The scope of this report is to evaluate the existing reuse program for the Marco Island wastewater treatment plant, and determine if the existing reuse facilities currently provide and will continue to provide a reasonable amount of reuse of reclaimed water throughout the 20 year planning period. Summarized herein are the tasks for the evaluation:

- Service Area Description. Evaluate the geographic extent and land use characteristics (i.e., development type, etc.) of the certificated water and wastewater service areas for the Marco Island WWTP.

- Flow Projections. Review local population growth rates, development projections, service commitments, and other projections to develop a projected population growth over a 20-year period. Prepare flow projections for this 20-year period utilizing a designated per capita flow rate.

- Facility Description. Visit site and describe unit processes and operational criteria with respect to the permitted capacities for treatment, residuals and effluent disposal/reuse systems.

- Reuse Evaluation. Evaluate the existing reclaimed water reuse facilities and determine if the facilities currently provide and will continue to provide a reasonable amount of reuse of reclaimed water through a 20-year planning period.

- Final Report. Prepare a final reuse feasibility study to be submitted to FDER in accordance with Section 403.064, F.S., and Chapter 17-610, F.A.C.

SECTION 2

SECTION 2

EXISTING CONDITIONS

2.1 GENERAL

This section will provide a description of the existing water and wastewater facilities serving the residents of Marco Island. In addition, historical wastewater flow and water demand trends will be summarized.

2.2 SERVICE AREA DESCRIPTION

The Marco Island water and wastewater systems are located on Marco Island in southwestern Collier County, Florida. According to the Collier County Growth Management Plan, "Future Land Use Element," Marco Island is the most extensive development south of Naples, constructed in the Middle of Rookery Bay Reserve and Cape Romano-Ten Thousand Islands Aquatic Preserve. The greatest percent of developed and vacant land on Marco Island was created from dredge and fill activity and the development is categorized by Collier County as "mixed use urban residential."

For planning purposes, Collier County is divided into twelve planning communities and Marco Island along with Isle of Capri, Goodland and Marco Shores are contained within the Marco planning community. The majority (73.6 percent) of the Marco planning community is made up of environmentally sensitive lands. These 18,751 acres of wetlands are part of the Rookery Bay Reserve and Cape Romano Aquatic Preserve which surround the island. The developed lands which amount to approximately 4,730 acres or 18.5 percent of the planning community, are the developed lands of Marco Island, Isles of Capri, Goodland and Marco Shores. The small amount of environmentally tolerant lands are situated in the northwest portion of the community within the upland areas.

2.3 WASTEWATER MANAGEMENT

The Marco Island wastewater system consists of a number of components which make up the overall facilities and includes:

- Wastewater collection/transmission facilities

- Wastewater treatment facilities
- Reclaimed water disposal facilities

Summarized in this subsection is a brief description of the above facilities.

2.3.1 Wastewater Collection and Transmission System

The wastewater collection and transmission facilities consist of a number of components which are necessary to convey and transport the raw wastewater from the individual connections within the wastewater service area to the wastewater treatment plant (WWTP) for treatment. The components necessary to transfer the raw wastewater from the individual connections to the WWTP include the following:

- Gravity pipelines
- Manholes
- Lift stations
- Force mains

The Marco Island wastewater collection and transmission system consists of approximately 10 miles of gravity sewer ranging in diameter from 8 to 15 inches, 11 miles of force mains ranging in diameter from 3 to 16 inches and twenty-two lift stations strategically located throughout the wastewater service area. Raw wastewater enters the WWTP site via four (4) force mains sized at 6, 8, 12 and 16 inches. These existing force mains are hydraulically equivalent to an approximate 20 inch force main and are sufficient to convey 7.0 million gallons per day (MGD), on a peak hourly basis, of raw wastewater to the WWTP for treatment.

2.3.2. Wastewater Treatment

The Marco Island WWTP has a design capacity of 3.5 MGD utilizing two (2) contact stabilization treatment trains operating in parallel. The treatment processes include screening, flow equalization, contact stabilization and secondary clarification. The reclaimed water facilities consist of filtration and disinfection with reuse by rapid rate ground water recharge, slow rate land application, and alternate backup means by deep

well injection. Waste sludge from the activated sludge process is thickened, aerobically digested, and ultimately hauled off-site for land application. The treatment facilities are Class I reliable in accordance with the United States Environmental Protection Agency guidelines. Figure 2-1 illustrates the existing facilities at the Marco Island WWTP.

As mentioned previously, the Marco Island WWTP has a design capacity of 3.5 MGD utilizing two (2) treatment trains rated at 2.5 MGD and 1.0 MGD. The 2.5 MGD treatment train has been in operation for approximately 25 years and consists of two (2) contact basins and three (3) stabilization basins. Whereas, the 1.0 MGD treatment train is a circular ring type treatment plant containing a contact basin, stabilization basin and aerobic digester in the outer ring with the clarifier contained within the inner ring. This plant has only been in operation for approximately 2 years. Both plants appear to be in good condition as can be expected based on age and produce quality effluent. The following paragraphs contain a brief description for the existing WWTP facilities and process stream.

Raw wastewater from the wastewater collection system enters the pretreatment structure, where the raw influent is screened for removal of selective objects (i.e., rags, plastics, etc.) which could otherwise damage equipment. The pretreatment structure is a dual channel structure recently constructed with one (1) channel containing a 6.0 MGD (peak flow) mechanically cleaned bar screen and the other channel containing a manual bar screen for emergency stand-by or maintenance purposes.

From the pretreatment structure, the raw wastewater flows by gravity into either one of two (2) surge tanks. The surge tanks operate as flow equalization basins. The surge tanks are circular with a volume of approximately 250,000 gallons and 500,000 gallons for tanks one and two, respectively. To maintain proper mixing and aerobic conditions, each surge tank is equipped with course bubble diffused air systems. The total flow equalization volume provides approximately 21 percent of storage for the design average daily flow of 3.5 MGD.

From the equalization basins, raw wastewater is pumped to the 2.5 MGD treatment facility and equally split between the two (2) contact basins where it is aerated and mixed with bacteria. In this basin, the microorganisms come in contact with both

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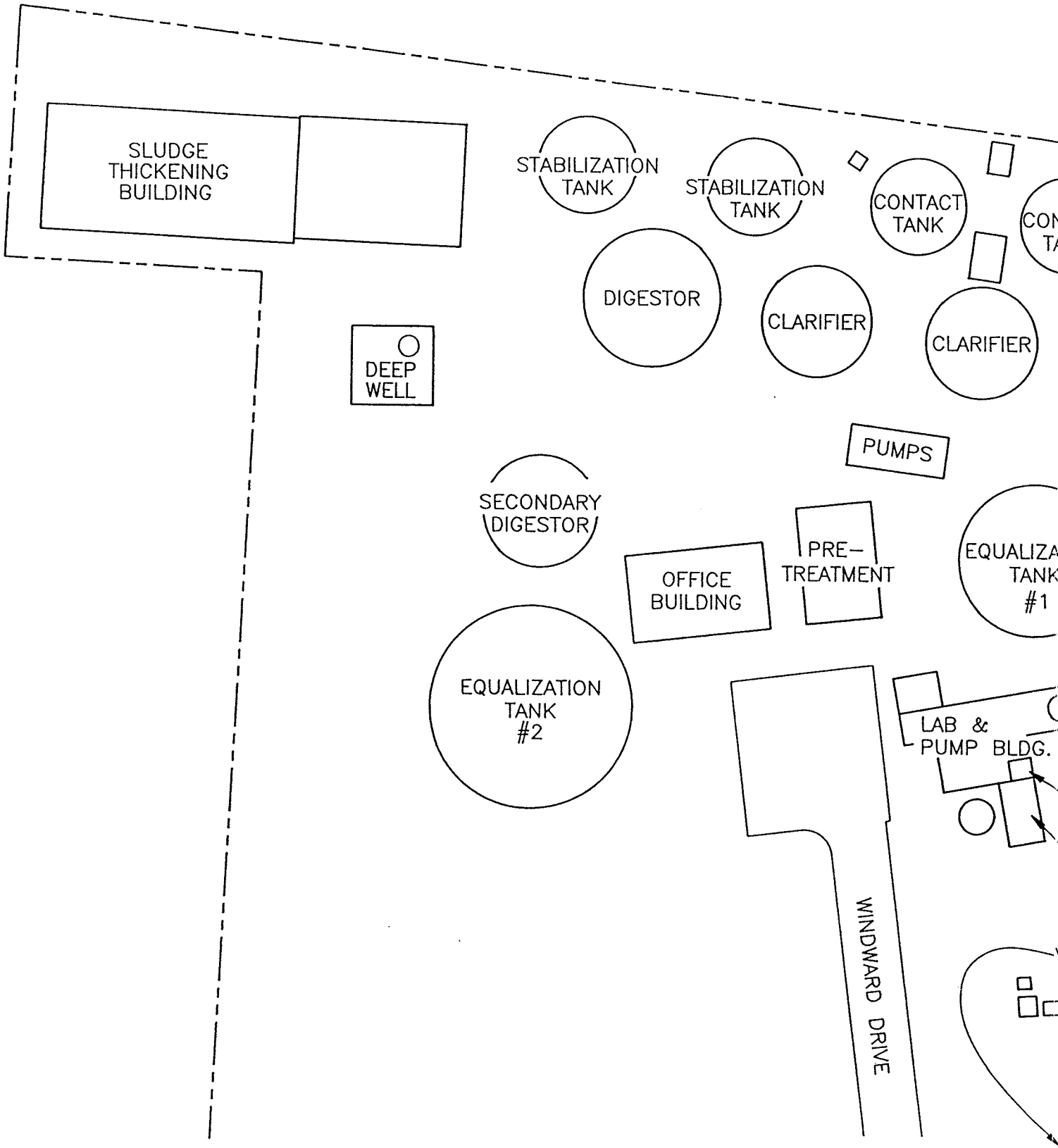

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MARCO

soluble and insoluble organic material. The insoluble material passes through the bacteria's cell walls and the solids material sticks to the outside of the cells. Each contact basin is a circular concrete structure with a volume of approximately 100,970 gallons. Mixed liquor suspended solids (MLSS) in the contact basin is aerated and mixed utilizing a surface mechanical aeration system and a coarse-bubble diffused aeration system. The diffused aeration system was installed to supplement the air requirements during peak mass loading periods.

From the contact basins, the MLSS flows by gravity to a clarifier splitter box, which proportions the flow to one (1) 50 foot and two (2) 40 foot diameter clarifiers. Clarification separates the activated sludge bio-mass from the treated wastewater. The settled sludge is collected from the bottom of the clarifier by a continuously rotating mechanical sludge collector.

Settled sludge from the clarifiers is pumped to one of three stabilization basins, or thickened and wasted to one of two (2) aerobic digesters. Two (2) of the stabilization basins each have a volume of approximately 100,970 gallons, while the third basin has a volume of approximately 296,730 gallons. The stabilization basins are also aerated by surface mechanical and diffused aeration systems. The digesters are sized at approximately 206,000 gallons and 131,500 gallons, respectively, and are operated in series.

In addition to the 2.5 MGD WWTP, raw wastewater is pumped from the equalization basins to the 1.0 MGD WWTP. The 1.0 MGD WWTP is a dual ring type treatment plant which contains a contact basin, stabilization basin and digester in the outer ring and a secondary clarifier in the inner ring. Raw wastewater from the equalization basin is pumped directly into the contact basin where it is aerated and mixed with bacteria. The contact basin is a sectioned-off portion of the treatment plants outer ring and has a volume of approximately 125,300 gallons. The MLSS in the contact basin is aerated and mixed utilizing centrifugal blowers and a coarse-bubble diffused aeration system.

From the contact basin, MLSS flows by gravity into the secondary clarifier. The clarifier is circular with a volume of approximately 169,200 gallons. Settled sludge from the clarifier is collected from the bottom of the basin by a continuously rotating mechanical sludge collector and pumped into the stabilization basin, wasted to the

aerobic digester. The stabilization basin has volume of approximately 250,250 gallons and is aerated utilizing a diffused aeration system.

The clarified effluent from both plants is combined and flows by gravity to one of two (2) traveling bridge filtration units. Each unit has a rated capacity of 2.5 MGD, with approximately 864 square feet of surface area and an average design overflow rate of 2.11 gallons per minute per square feet (gpm/sf). The effluent filters are utilized to remove excess suspended solids to meet the effluent total suspend solids (TSS) requirement of 5 mg/l.

From the traveling bridge filters, the filtered effluent is hydraulically split between two (2) chlorine contact basins where chlorine is added for disinfection. The chlorine contact basins are designed to provide 15 minutes of contact time at peak flow conditions. Chlorinated reclaimed water is discharged from the chlorine contact chamber into the on-site reclaimed water effluent pump station where it is pumped for ultimate utilization.

2.3.3 Reclaimed Water Reuse

The Marco Island WWTP has a reclaimed water reuse system consisting of rapid-rate ground water recharge and public-access slow-rate land application. Deep well injection facilities are available as backup in the event the reuse facilities cannot be used.

Public access slow rate land application of reclaimed water is presently being performed by irrigation on two (2) golf courses, a public school and manually by Collier County on median strips using tanker trucks. Reuse of reclaimed water via rapid rate ground water recharge water is considered the primary means of effluent reuse accomplished utilizing three (3) percolation ponds. The other land application facilities have not historically been included as a primary means of reclaimed water reuse for the reason that these facilities are only operated on an "as requested" basis, in relation to weather conditions. However, these facilities are given a priority of use such that reclaimed water is delivered to these facilities to meet their demands prior to utilization for recharge by the percolation ponds. The percolation ponds are triangular in shape and have a permitted capacity of 3.5 MGD. These ponds were recently

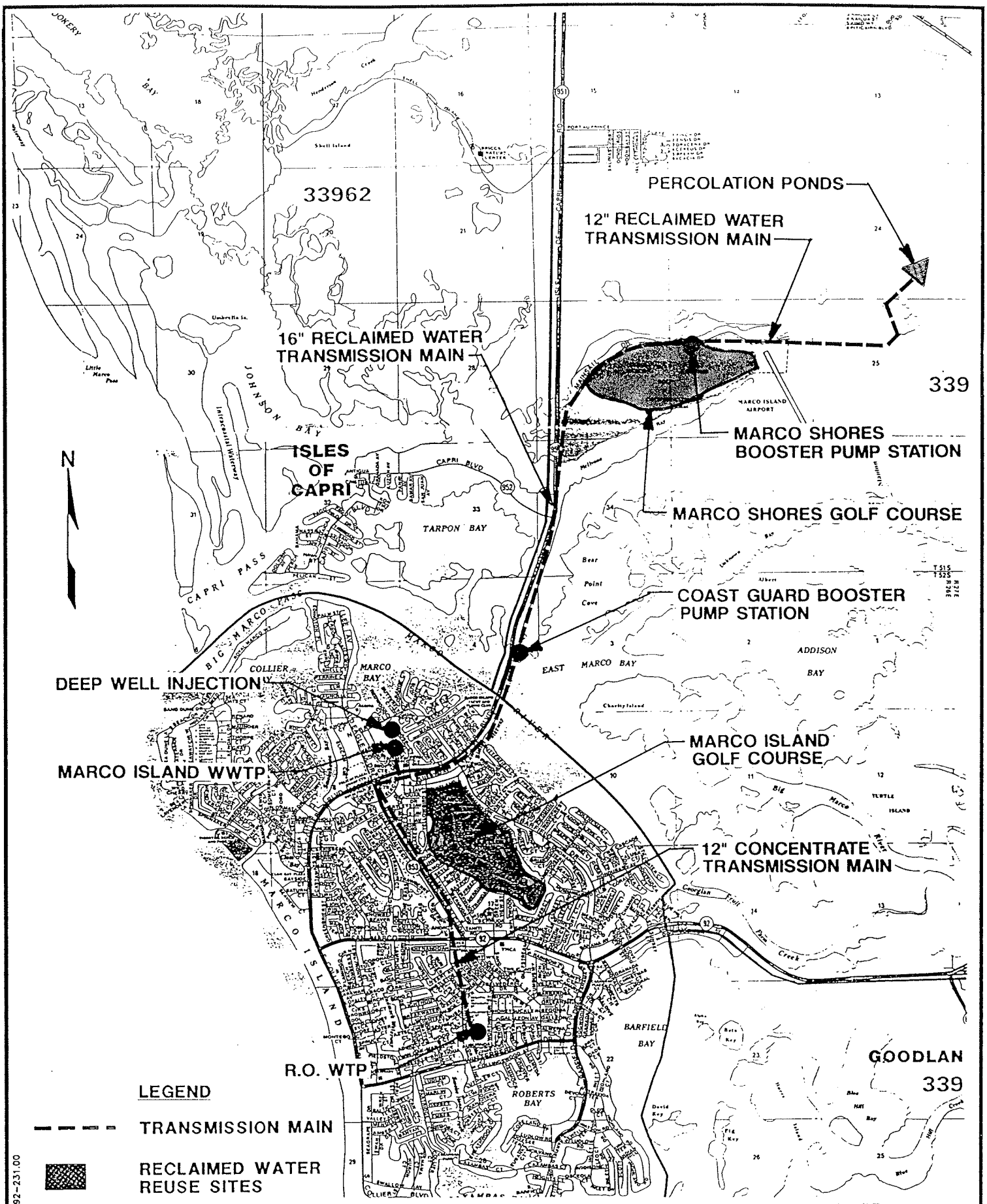
reconstructed as a result of the WWTP expansion to increase the capacity of the system from 2.5 MGD to 3.5 MGD.

In addition to the reclaimed water reuse facilities, the Marco Island WWTP also has access for reclaimed water disposal by deep well injection. This system was primarily designed for disposal of the reject (brine) produced by the Marco Island reverse osmosis WTP. The deep well has a maximum permitted capacity of 5.76 MGD. In the event weather conditions, breakage of the reclaimed water force main, or mechanical or electrical failures associated with the booster pumping stations, preclude the use of the reuse or electrical facilities, the deep injection well has available capacity to provide emergency backup. The existing reclaimed water reuse facilities are shown in Figure 2-2.

2.3.4 Historical Wastewater Flow

This subsection presents historical trends in wastewater flow, as well as flow variability. Historical flow data for the Marco Island WWTP were obtained for the years 1987 through 1992 from the FDER monthly operating reports (MOR). These data are summarized in Table 2-1. The historical data include the annual average daily flow (ADF), the maximum month average daily flow (MMF), and the maximum daily flow (MDF). These data were utilized to estimate wastewater flow factors for the ratio of MMF/ADF and MDF/ADF.

Wastewater flow to the treatment facility varies seasonally in response to the influx of population during the winter and spring months. Figure 2-3 illustrates the monthly average and maximum daily flows for the years 1987 through 1992. The historical wastewater flow data show an increasing trend in average daily wastewater flow over the last six years of record. Maximum month average daily flows occurred repeatedly in March or February of each year at the height of the tourist season. The ratio of the maximum month to annual average daily flow ranged from 1.17 to 1.42, and averaged 1.30. The maximum day to annual average daily flow ranged from 1.49 to 2.02 with an average of 1.68. The maximum day ratio appears to be decreasing as the annual average daily flow increases, as would be expected, with the exception for 1992 due to the excessive amount of rain the southwest coast of Florida received in June.



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EXISTING WASTEWATER RECLAIMED WATER DISPOSAL/REUSE FACILITIES

FIGURE 2-2

TABLE 2-1

SOUTHERN STATES UTILITIES, INC.
MARCO ISLAND WASTEWATER TREATMENT PLANT
REUSE FEASIBILITY STUDY

HISTORICAL WASTEWATER FLOW DATA

Year	Annual Average Daily Flow, MGD (ADF)	Maximum Month Average Daily Flow, MGD (MMF)[1]	Ratio (MMF/ADF)	Maximum Day Flow, MGD (MDF)[1]	Ratio (MDF/ADF)
1987	1.459	2.076(3)	1.42	2.735(5)	1.87
1988	1.545	2.034(3)	1.32	2.297(2)	1.49
1989	1.931	2.518(3)	1.30	3.021(3)	1.56
1990	2.294	2.689(2)	1.17	3.555(5)	1.54
1991	2.039	2.567(3)	1.26	3.208(9)	1.57
1992	1.985	2.650(2)	1.33	4.012(6)	2.02

Note:

1. The month in which the maximum daily and maximum month average daily flow occurred are shown in parentheses.

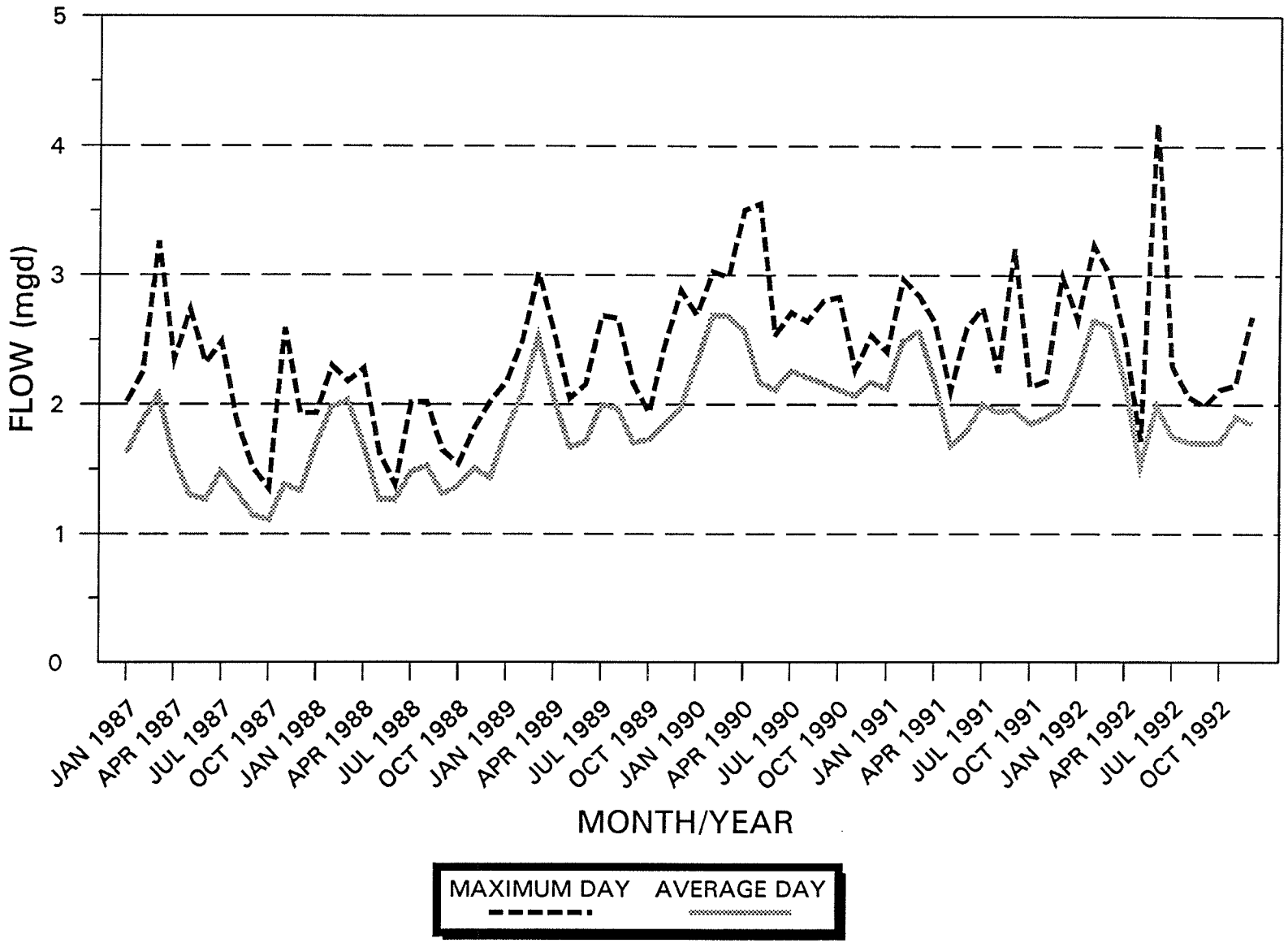

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FIGURE 2-3

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MARCO ISLAND WWTP
HISTORICAL MONTHLY WASTEWATER FLOWS

2.4 WATER SUPPLY

The Marco Island water system consists of a number of components which make up the overall facilities and includes:

- Raw water supply and transmission facilities.
- Water treatment facilities.
- Finished water storage and distribution facilities.

Summarized in this subsection is a brief description of the above facilities.

2.4.1 Raw Water Supply and Transmission

SSU utilizes two separate and distinct raw water supplies for its water treatment facilities located on Marco Island. The first and original raw water supply source consists of two (2) borrow pits and two (2) infiltration galleries located on the northern side of U.S. 41 and County Road (CR) 951, which is approximately 8½ miles north of the lime softening water treatment facility. The borrow pits were the original source of supply until 1980, when the first infiltration gallery was constructed to supplement the lake during drought conditions, and the last gallery being constructed in 1988. These two surface water supply sources serve the 5.0 MGD lime softening water treatment plant. According to the South Florida Water Management District (SFWMD), water use permit (WUP) No. 11-00080-W issued on January 17, 1991, this supply source has a permitted annual average daily withdrawal capacity of 6.8 MGD.

The second raw water supply source was recently constructed to supply raw water to the 4.0 MGD reverse osmosis water treatment plant. This supply source consists of ten (10) deep wells strategically located throughout the island all pumping groundwater from the lower Hawthorne aquifer. According to the SFWMD water use permit, this supply source has a permitted annual average daily withdrawal capacity of 5.4 MGD.

As mentioned previously, these two sources are completely distinct of one another and are limited by the WUP to a combined maximum daily withdrawal of 10.78 MGD, as opposed to the total of the two (2) sources which is 12.2 MGD. It should be noted that

the raw water quantities are significantly higher than the finished water quantities produced by the treatment facilities. Uses at the lime softening plant for lime slurry blow down and filter backwashing require approximately 10% and reject water at the reverse osmosis plant accounts for approximately 25% of the raw water pumped to the treatment facilities.

2.4.2 Water Treatment

The Marco Island water treatment facilities consists of two (2) separate and distinct water treatment plants (WTP). The first plant being a 5.0 MGD General Filter lime softening water treatment plant consisting of a 3,500 gpm lime softening unit, four (4) sand filters, lime silo and slaker. In addition to the lime softening treatment facilities, disinfection is accomplished by gaseous chlorination and trihalomethane (THM) control by quenching the THM formation using ammonia gas. The second WTP is a 4.0 MGD reverse osmosis WTP provided with micron filtration, reverse osmosis water treatment, and chlorine disinfection. Therefore, the total permitted water treatment capacity on the island is equal to 9.0 MGD.

2.4.3 Historical Water Demand

This subsection presents historical trends in water demand. As with the wastewater system, historical data for the Marco Island WTP's were obtained from the time period 1973 through 1992 from the FDER monthly operating reports. This data is summarized in Table 2-2. Figure 2-4 illustrates the annual average and maximum day water demand for the years 1973 through 1992. The historical data include the annual average daily demand and the annual maximum day demand. As expected, the trend of these two demands is in an upward direction with a few minor variations, probably attributable to climatic conditions.

Table 2-2 also presents the ratio of the annual maximum day demand to annual average daily demand. This ratio is significant in that it allows one to calculate the projected annual maximum day demand using the historical trends. Figure 2-5 shows this ratio in a graphical form. As can be seen, there has been a general downward trend in this ratio since 1973. This is typical, because the larger the water system, the less variation there is between the annual average daily demand and the maximum day demand.

TABLE 2-2

SOUTHERN STATES UTILITIES, INC.
MARCO ISLAND WASTEWATER TREATMENT PLANT
REUSE FEASIBILITY STUDY

HISTORICAL WATER DEMAND DATA
(1973-1992)

Year	Maximum Day Demand (mgd)	Annual Average Day Demand (mgd)	Max. Day/ Avg. Day
1973	3.25(10)	1.69	1.92
1974	3.38(2)	1.89	1.79
1975	3.51(3)	1.88	1.87
1976	3.32(8)	1.81	1.83
1977	3.17(11)	1.45	2.18
1978	4.20(5)	2.31	1.85
1979	4.54(5)	2.85	1.59
1980	5.31(6)	3.45	1.54
1981	6.14(11)	3.93	1.56
1982	6.48(3)	3.92	1.65
1983	5.70(6)	3.46	1.65
1984	6.34(11)	3.88	1.63
1985	6.66(1)	4.28	1.56
1986	6.62(3)	4.29	1.54
1987	6.83(5)	4.65	1.47
1988	7.49(10)	5.51	1.36
1989	7.93(11)	5.67	1.40
1990	7.48(8)	5.51	1.36
1991	7.70(3)	5.36	1.43
1992	8.53(12)	6.06	1.41

Note:

1. The month in which the maximum daily demand occurred is shown in parenthesis.

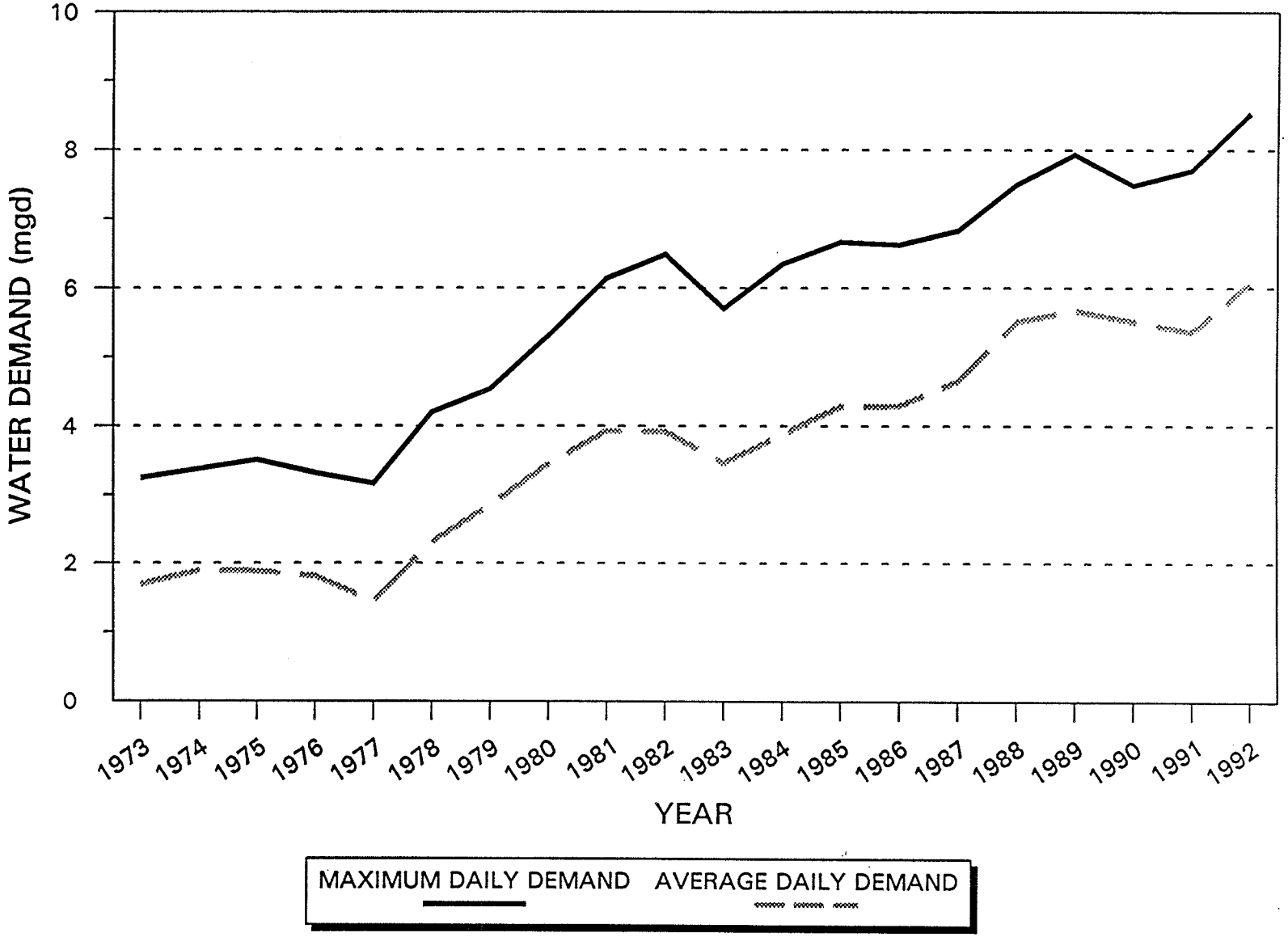

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FIGURE 2-4

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MARCO ISLAND WWTP
HISTORICAL WATER DEMANDS

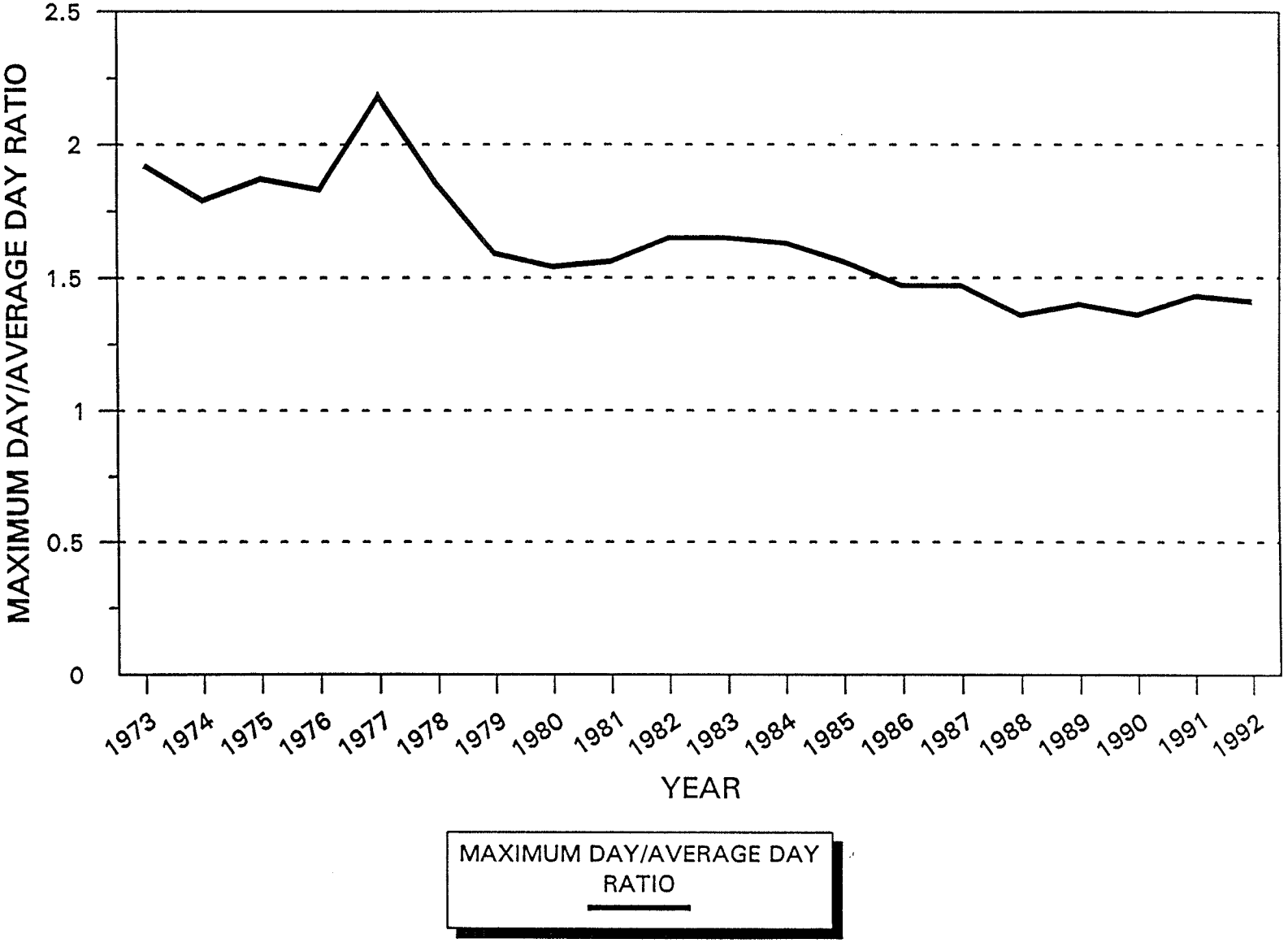

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FIGURE 2-5

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MARCO ISLAND WWTP
HISTORICAL WATER DEMAND
MAXIMUM DAY / AVERAGE DAY

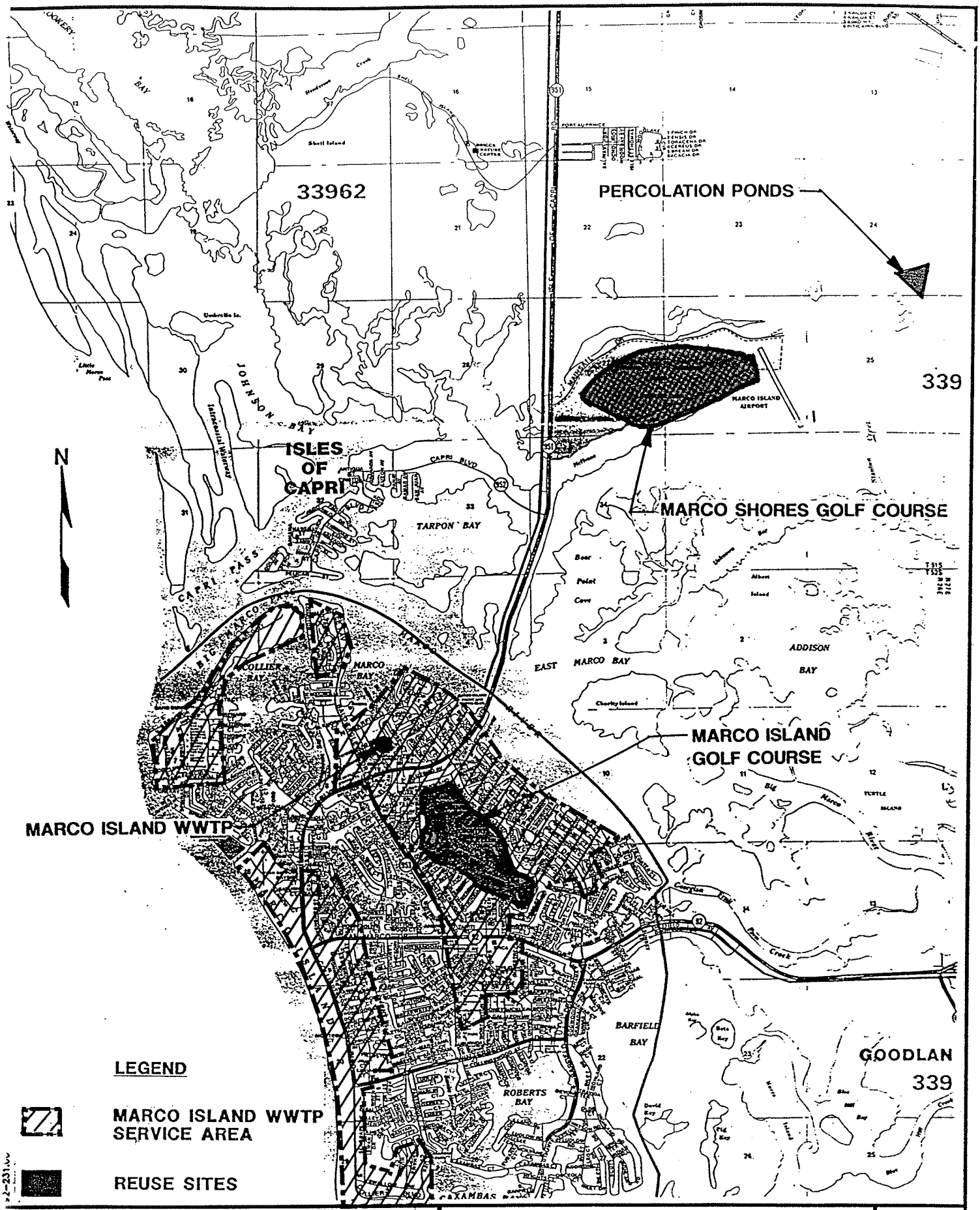
2.5 REUSE FACILITIES

The Marco Island wastewater treatment facilities are currently served by two different types of reclaimed water reuse facilities: i) rapid rate ground water recharge through percolation ponds; and ii) public access slow-rate land application through golf course irrigation. The percolation ponds and the golf course irrigation facilities have historically provided the primary means of reclaimed water reuse capacity for the wastewater system. Locations of the various reclaimed water reuse sites in relation to the wastewater service area, and WWTP are illustrated in Figure 2-6.

The existing percolation pond facilities are located off an extension of Marriott Club Drive northeast of Marco Shores on a 43 acre site. The system was recently reconstructed to provide a total of three cells with a total rated and permitted capacity of 3.5 MGD. The reconstruction of the percolation ponds included: i) relocation of the ponds to the area east onto a triangular shaped parcel; ii) the expansion of the total pond bottom area; iii) an increase in the permitted capacity from 2.5 to 3.5 MGD; iv) the construction of perimeter trenches around the pond bottoms to penetrate through the clayey sand layer to the top of limestone; and v) the placement of fill to raise the pond bottom above existing grade to facilitate drying of the bottoms for normal cell rotation and maintenance in accordance with Chapter 17-610.510, F.A.C.

Reclaimed water is pumped to the percolation ponds from the WWTP via a transmission system which includes a transmission force main consisting of 12 and 16 inch segments and two booster pumping stations. The reclaimed water pump station at the WWTP includes three (3) pumps with rated capacities of 2.3 MGD each for a total and firm capacity of 4.6 MGD. The two (2) booster pump stations are duplex pump stations each having a firm rated capacity of 2.5 MGD. The booster pump stations limit the capacity of the reclaimed water transmission system to 2.5 MGD. The utility will be required to improve these facilities in the future to increase the firm capacity to 3.5 MGD, as the wastewater flows increase to the design capacity of the WWTP.

Reclaimed water reuse via slow rate land application is presently being performed on two golf courses, the Marco Island and Marco Shores Golf courses, located on the north end of Marco Island and in the Marco Shores Development. Both golf courses were originally provided with a source of raw water supply. However, due to the lack of plentiful source of raw water



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EXISTING WASTEWATER SERVICE AREA AND RECLAIMED WATER SITES

FIGURE 2-6

supply, the Water Management District requested that they be supplied with reclaimed water, since their consumptive use permitting requirements require that the lowest quality water be used to serve a demand. SSU subsequently agreed to supply reclaimed water to these facilities. Reclaimed water is delivered to the Marco Island Golf Course facilities via a 8 inch force main connected to the reclaimed water force main to the percolation ponds site. Reclaimed water supplied to the Marco Island golf course is stored at the golf course for irrigation using their own pumping facilities. Reclaimed water supplied to the Marco Shores golf course is stored in a 0.5 MG prestressed concrete reservoir prior to use on the golf course. Reclaimed water is pumped from the Marco Island WWTP plant site by the on-site reclaimed water pump station and force main system previously described.

Historical reclaimed water disposal data for the Marco Island reclaimed water reuse system was provided by SSU operations for the years 1990 through 1992. This data is summarized in Table 2-3. The disposal system is operated such that the respective golf courses are allotted as much reclaimed water as needed, then the remaining reclaimed water is pumped to the percolation ponds. Historically, both the Marco Island and Marco Shores golf courses have disposed of 0.337 MGD on an annual average daily flow basis.

TABLE 2-3

SOUTHERN STATES UTILITIES, INC.
MARCO ISLAND WASTEWATER TREATMENT PLANT
REUSE FEASIBILITY STUDY

AVERAGE DAILY RECLAIMED DISPOSAL QUANTITIES[1]

Month	Injection Well (MGD)	Marco Island Golf Course (MGD)	Marco Shores Golf Course (MGD)	Medians (MGD)	Evap/ Percolation Ponds (MGD)
January, 1990	(2)	0.051	0.211	0.000	2.059
February, 1990	(2)	0.173	0.317	0.000	2.199
March, 1990	(2)	0.379	0.376	0.000	1.928
April, 1990	(2)	0.306	0.449	0.000	1.818
May, 1990	(2)	0.168	0.364	0.000	1.639
June, 1990	(2)	0.004	0.673	0.000	1.434
July, 1990	(2)	0.000	0.003	0.000	2.254
August, 1990	(2)	0.142	0.063	0.000	2.005
September, 1990	(2)	0.023	0.017	0.000	2.123
October, 1990	(2)	0.015	0.106	0.000	1.992
November, 1990	(2)	0.099	0.334	0.000	1.634
December, 1990	(2)	0.185	0.297	0.000	1.690
1990 Average	(2)	0.129	0.268	0.000	1.898
January, 1991	(2)	0.150	0.147	0.056	1.770
February, 1991	(2)	0.133	0.224	0.000	2.130
March, 1991	(2)	0.218	0.260	0.000	2.089
April, 1991	(2)	0.304	0.263	0.000	1.610
May, 1991	(2)	0.223	0.254	0.056	1.150
June, 1991	(2)	0.031	0.121	0.000	1.643
July, 1991	(2)	0.085	0.054	0.000	1.861
August, 1991	(2)	0.058	0.055	0.000	1.827
September, 1991	(2)	0.020	0.013	0.000	1.927
October, 1991	(2)	0.021	0.067	0.056	1.706
November, 1991	(2)	0.245	0.142	0.058	1.455
December, 1991	(2)	0.296	0.191	0.056	1.437
1991 Average	(2)	0.149	0.149	0.023	1.717

TABLE 2-3 (Continued)

SOUTHERN STATES UTILITIES, INC.
MARCO ISLAND WASTEWATER TREATMENT PLANT
REUSE FEASIBILITY STUDY

AVERAGE DAILY RECLAIMED DISPOSAL QUANTITIES[1]

Month	Injection Well (MGD)	Marco Island Golf Course (MGD)	Marco Shores Golf Course (MGD)	Medians (MGD)	Evap/ Percolation Ponds (MGD)
January, 1992	(2)	0.277	0.181	0.056	1.736
February, 1992	(2)	0.316	0.184	0.020	2.130
March, 1992	(2)	0.192	0.190	0.014	2.204
April, 1992	(2)	0.174	0.200	0.017	1.779
May, 1992	(2)	0.247	0.194	0.023	1.066
June, 1992	1.323	0.053	0.200	0.010	0.404
July, 1992	1.258	0.028	0.194	0.012	0.262
August, 1992	1.560(3)	0.033	0.019	0.000	0.098
September, 1992	1.594(3)	0.075	0.028	0.000	0.000
October, 1992	0.715	0.071	0.156	0.056	0.711
November, 1992	1.397	0.101	0.233	0.029	0.148
December, 1992	0.289	0.298	0.194	0.028	1.041
1992 Average	1.162	0.155	0.164	0.022	0.965

Notes

1. Rates are an average value based on the monthly total and the number of days in the month.
2. Deep well injection placed in operation June 1992.
3. Percolation ponds taken off-line for reconstruction.

SECTION 3

SECTION 3

PROJECTED CONDITIONS

3.1 GENERAL

The following section describes projections for population, wastewater flow and water supply demand for the Marco Island wastewater and water service areas through the year 2012.

3.2 PROJECTED GROWTH AND POPULATION

Historical and projected development data and population information was obtained from two sources for use in the preparation of this Reuse Feasibility Study. The first source of information was prepared by Deltona Utilities Consultants, Inc. (DUCI) for the wastewater system as referenced in the Hartman & Associates, Inc. report entitled "Marco Island 10-Year Water and Wastewater Master Plan". The second source of information was prepared by Collier County as presented in the "Collier County Growth Management Plan, Future Land Use Element - Support Document: Land Use Data and Analysis", January, 1989, (CLUP) and updated in August 1992 as contained in the report entitled "Demographic and Economic Profile of Collier County," (DEP).

The DUCI data was prepared for the existing wastewater service area based upon the use of estimated residential unit counts for single family and multi-family units within the existing wastewater service area. Future unit growth was projected by DUCI for the years 1993 through 2012, based upon a linear regression of the historical unit growth data for the years 1984 through 1992 as summarized in Table 3-1. The regression analysis predicts a single family growth rate of 129 dwelling units per year and a multi-family growth rate of 251 units per year. Corresponding population projections for the wastewater service area, based upon an occupancy rate of 2.7 persons per single family residence and 2.2 persons per multi-family dwelling unit are summarized in Table 3-2. The DUCI projections indicate a 65% increase in the total number of dwelling units by the end of the twenty year planning period in 2012. Growth is anticipated as a result of wastewater service area expansion, development buildout, and increased population density of the existing service area. The projections indicate a corresponding increase in wastewater service area population from 27,701 in 1993 to 45,105 by 2012.

TABLE 3-1

SOUTHERN STATES UTILITIES, INC.
MARCO ISLAND WASTEWATER TREATMENT PLANT
REUSE FEASIBILITY STUDY

WASTEWATER SERVICE AREA HISTORICAL POPULATION
(1984-1992)

Year	Single-Family Units		Multi-Family Units		Total Units	Total Population	Percent Growth
	No.	Pop.	No.	Pop.			
1984	1,072	2,894	7,526	16,557	8,598	19,452	--
1985	1,083	2,924	8,065	17,743	3,148	20,667	6.25
1986	1,109	2,994	8,389	18,456	9,498	21,450	3.79
1987	1,232	3,326	8,518	18,740	9,750	22,066	2.87
1988	1,613	4,335	8,682	19,100	10,295	23,456	6.30
1989	1,633	4,409	8,889	19,556	10,522	23,965	2.17
1990	1,742	4,704	9,224	20,294	10,966	24,997	4.30
1991	1,871	5,052	9,476	20,846	11,347	25,899	3.60
1992	2,000	5,401	9,727	21,399	11,727	26,800	3.50

TABLE 3-2

SOUTHERN STATES UTILITIES, INC.
MARCO ISLAND WASTEWATER TREATMENT PLANT
REUSE FEASIBILITY STUDY

WASTEWATER SERVICE AREA POPULATION PROJECTIONS[1]
(1993-2012)

Year	Single-Family Units		Multi-Family Units		Total Units	Total Population
	No.	Pop.	No.	Pop.		
1993	2,129	5,749	9,978	21,952	12,107	27,701
1994	2,258	6,098	10,229	23,505	12,487	28,603
1995	2,388	6,446	10,481	23,058	12,869	29,504
1996	2,517	6,795	10,732	23,611	13,249	30,405
1997	2,646	7,143	10,983	24,163	13,629	31,307
1998	2,775	7,492	11,235	24,716	14,010	32,208
1999	2,904	7,841	11,486	25,269	14,390	33,110
2000	2,033	8,489	11,737	25,822	14,770	34,011
2001	3,162	8,538	11,988	26,375	15,150	34,912
2002	3,291	8,886	12,240	26,927	15,531	35,813
2003	3,420	9,235	12,491	27,480	15,911	36,715
2004	3,549	9,583	12,742	28,033	16,291	37,616
2005	3,678	9,932	13,994	28,586	16,672	38,518
2006	3,808	10,280	13,245	29,139	17,053	39,419
2007	3,937	10,629	13,496	23,691	17,433	40,320
2008	4,066	10,977	13,747	30,244	17,813	41,220
2009	4,195	11,326	13,999	30,797	18,194	42,123
2010	4,324	11,675	14,250	31,350	18,574	43,025
2011	4,458	12,035	14,501	30,987	18,959	44,136
2012	4,588	12,384	14,753	31,481	19,340	45,105

Note:

1. Data prepared by Deltona Utilities' Consultants.

The CLUP and DEP reports prepared by Collier County contain growth and permanent population estimates for the Marco Island planning area which includes Marco Island, Isles of Capri, Goodland, and areas immediately to the north and south of Marco Island and west of C.R. 951. Therefore, for projection purposes it will be assumed that the Marco Island system is equivalent to the Marco Island planning area. Marco Island has become increasingly popular as a vacation spot or a winter home for many individuals. Therefore, in order to accurately project population for the Marco Island planning community the seasonal population influx must be considered. In 1990 the seasonal population was 139 percent of the permanent population and for projection purposes is assumed to decrease to 62 percent through the end of the planning period year 2012, as the permanent population increases. These projections indicate a corresponding increase in total population from 26,235 in 1990 to 57,098 by 2012, as summarized in Table 3-3.

In addition, separate projections for the Marco Shores wastewater service area must be included since the facility shares effluent disposal facilities (i.e., percolation ponds) with the Marco Island WWTP. Marco Shores wastewater service area is not included within the County's Marco Island Planning community since it is on the east side of C.R. 951 and is contained within the Royal Fakapalm planning community. The projections as summarized in Table 3-4 were based upon housing unit projections contained in the DEP report for geocell 111529Z of the Royal Fakaplam planning community, which encompasses the Marco Shores wastewater service area. The DEP report also indicates that the Marco Shores development consists only of multi-family housing units. For this reason and the fact that these projections will be utilized for wastewater flow projections, the total population in Marco Shores service area will be projected utilizing 2.2 persons per household, as previously utilized for Marco Island wastewater service area.

The DUCI unit growth and population projections were prepared specifically for the wastewater system, whose present service area encompasses a significantly smaller area of the island than the water system. These projections (see Table 3-2) along with projections for Marco Shores (see Table 3-4) will be utilized in Section 3.3 for preparation of the wastewater flow projections. The Collier County unit growth and population projections are representative of conditions within the present and future potable water service areas. These projections (see Table 3-3) will be utilized in Section 3.4 for preparation of the water demand projections.

TABLE 3-3

SOUTHERN STATES UTILITIES, INC.
MARCO ISLAND WASTEWATER TREATMENT PLANT
REUSE FEASIBILITY STUDY
MARCO ISLAND POPULATION PROJECTIONS
(1990-2012)

Year	Permanent Population[1]	Seasonal Population[2]	Total Population
1990	10,977	15,258	26,235
1995	15,615	19,011	34,626
2000	20,653	21,582	42,235
2005	26,275	22,925	49,200
2010[7]	32,453	22,717	55,170
2012[7]	35,181	21,917	57,098

Notes:

1. Permanent population obtained from Collier County Demographic and Economic Profile, August 1992. Assumption that Marco Island System equals the Marco planning area.

2. Seasonal population determined utilizing 1980 census technique 139% factor of permanent population assumed to reduce to 70% in year 2010 and continue to decrease to 62% in year 2012.

TABLE 3-4

SOUTHERN STATES UTILITIES, INC.
MARCO ISLAND WASTEWATER TREATMENT PLANT
REUSE FEASIBILITY STUDY
MARCO SHORES HOUSING UNIT AND POPULATION PROJECTIONS
(1989-2012)

Year	Multi-Family Units[1]	Total Population[2]
1990	289	636
1995	492	1082
2000	724	1593
2005	983	2163
2010	1,241	2730
2012	1,344	2957

Notes:

1. Based on data obtained from the Collier County Planning Department "Housing Unit Count" 1990. Geocell 115298

2. Total population based on an occupancy rate for multi-family units of 2.2 persons per dwelling unit as projected for the Marco Island multi-family wastewater services.

3.3 WASTEWATER FLOW PROJECTIONS

The historical wastewater flow data, DUCI wastewater service area and Marco Shores DEP population projections as discussed in the previous sections were used to estimate the wastewater flow projections for the Marco Island and Marco Shores WWTP's, respectively. The DUCI population figures are based upon projected dwelling units and represent an average occupancy of 2.3 persons per dwelling unit. This closely corresponds to the 100% occupancy rate of 2.24 persons per dwelling unit contained in the Collier County CLUP and DEP documents, therefore taking into account seasonal population fluctuation. Utilizing these population figures and historical maximum monthly average daily flow a usage rate of 100 gallons per capita day (gpcd) was determined. Utilizing 100 gpcd and projected population for Marco Island and Marco Shores, wastewater flow projections through year 2012 were determined as shown in Table 3-5.

3.4 WATER DEMAND PROJECTIONS

The projected growth and population information discussed in Section 3.2, based upon the Demographic and Economic Profile of Collier County was used as the basis of the projected water demands. The population projections shown previously in Table 3-3, were the figures used for finished water demand projections.

The actual average daily water demand for 1990 was determined to be 221 gallons per capita day (gpcd) based on the total population figure of 26,235 which accounts for seasonal population influx. Utilizing this usage along with incorporating a gradual water conservation program, it is assumed that water demand on a per capita demand basis will decrease from 200 gpcd in 1995 to 166 gpcd in the year 2012. During the twenty year planning period, it is projected that the annual average finished water demand in the Marco Island service area will rise from 5.81 mgd in 1990 to approximately 9.48 MGD in 2012 as summarized in Table 3-6.

TABLE 3-5

REUSE FEASIBILITY STUDY
MARCO ISLAND WASTEWATER TREATMENT PLANT
WASTEWATER FLOW PROJECTIONS[1]
(1993-2012)

Year	Projected Population		Total Population	Project Flow (MGD)[1]
	Marco Shores	Marco Island		
1993	903	27,701	28,604	2.86
1994	993	28,603	29,596	2.96
1995	1,082	29,504	30,586	3.06
1996	1,184	30,405	31,589	3.16
1997	1,286	31,307	32,593	3.26
1998	1,387	32,208	33,595	3.36
1999	1,490	33,110	34,600	3.46
2000	1,593	34,011	35,604	3.56
2001	1,707	34,912	36,619	3.66
2002	1,821	35,813	37,634	3.76
2003	1,935	36,715	38,650	3.86
2004	2,049	37,616	39,665	3.97
2005	2,163	38,518	40,681	4.07
2006	2,276	39,419	41,695	4.17
2007	2,389	40,320	42,709	4.27
2008	2,503	41,220	43,723	4.37
2009	2,616	42,123	44,739	4.47
2010	2,730	43,025	45,935	4.59
2011	2,843	44,136	46,979	4.70
2012	2,957	45,105	48,062	4.80

Note:

1. Projected flow based on 100 gallons per capita per day (maximum month values).

TABLE 3-6

SOUTHERN STATES UTILITIES, INC.
MARCO ISLAND WASTEWATER TREATMENT PLANT
REUSE FEASIBILITY STUDY
MARCO ISLAND WATER DEMAND PROJECTIONS
(1991-2012)

Year	Total Population	Water Demand (MGD)	
		Average Daily Demand	Maximum Daily Demand
1990	26,235	5.81	7.48
1995	34,626	6.92(1)	9.70(2)
2000	42,235	8.02	11.03
2005	49,200	8.86	11.96
2010	55,170	9.38	12.43
2012	57,098	9.48	12.47

Notes:

1. Average daily flow determined utilizing 200 gpcd and assuming a decreasing trend to 166 gpcd through the year 2012.

2. Maximum to average daily ratio of 1.40 in 1995 decreasing to 1.315 in 2012.

SECTION 4

SECTION 4

ALTERNATIVE ANALYSIS

4.1 GENERAL

The Marco Island wastewater system as previously discussed currently provides reuse of reclaimed water utilizing two (2) distinct land application methods, in accordance with Chapter 17-610, F.A.C. entitled "Reuse of Reclaimed Water and Land Application." The first method of reuse being rapid-rate land application through the use of percolation ponds, and the second method of reuse being slow-rate land application through spray irrigation on two (2) golf courses, on a elementary school site and roadway median strips. These two methods of reuse have historically and will continue to provide the primary means of reclaimed water disposal capacity for the Marco Island wastewater system. This section will discuss the ability of the existing reuse facilities presently and through the 20 year planning period to provide "a reasonable amount of reuse of reclaimed water" as required in Chapter 17-40.401(5), F.A.C., hence, the "no action" alternative will be pursued through the permit period.

4.2 NO ACTION ALTERNATIVE

Rapid rate land application utilizing percolation ponds may be classified as reuse of reclaimed water. Reuse of reclaimed water by percolation ponds in accordance with Chapters 17-610.200,(41)(a)4 and 17-610.200,(41)(b), F.A.C., is defined as follows:

> "(a)4. Ground water recharge (such as slow-rate, rapid-rate, and absorption field land application systems), but not include disposal methods described in Rule 17-610.200(41)(b), F.A.C."
>
> "(b) Overland flow land application systems, rapid-rate land application systems providing continuous loading to a single percolation cell, other land application systems involving less than secondary treatment prior to application, septic tanks, and ground water disposal systems using Class I wells injecting effluent or wastewater into Class G-IV waters shall be excluded from the definition of reuse."

The percolation ponds have recently been relocated and reconstructed to increase the permitted capacity from 2.5 to 3.5 MGD. The reconstructed ponds have three (3) cells which is a more

desirable minimum number of cells to meet the regulations while providing a greater firm capacity while one cell is being rested and restored. This method of reclaimed water reuse hence meets the requirements for reuse through rapid rate land application as contained in Chapter 17-610.200(41)(a)4 and (b), F.A.C., since multiple cells have been provided for alternate loading and resting cycles.

Slow rate land application reuse by spray irrigation is also classified as reuse of reclaimed water. Reuse of reclaimed water by spray irrigation in accordance with Chapter 17-610.200,(41)(a)1. is defined as follows:

> "Landscape irrigation (such as irrigation of golf courses, cemeteries, highway medians, parks, playgrounds, school yards, retail nurseries, and residential properties)."

Currently, the Marco Island WWTP provides reclaimed water for spray irrigation that has received high-level disinfection as required for non-restricted public access reuse. As presented in Section 2, the Marco Island and Marco Shores golf courses from 1990 through 1992 utilized on an annual average basis approximately 0.337 MGD of reclaimed water. Reuse in this manner is highly dependent on climatic conditions. Therefore, in order to estimate the potential average disposal capacity of the two golf courses, preliminary water balance calculations were performed for this area.

Precipitation data for the vicinity were obtained from NOAA Climatological Reports representing the most recent 18 years of record in which total annual precipitation was reported. These data were statistically ranked and graphed on probability paper to determine the one in ten year wettest and driest annual return frequency precipitation rates, which were found to be 66.82 inches and 40.0 inches, respectively. The resultant average annual return precipitation rate was estimated to be 52.0 inches.

Evaporation rates for the area were estimated using the McCloud method based upon historical average monthly mean temperatures as recorded at the Naples recording station. The McCloud method was utilized for this site, since the vegetation cover is primarily turf grass and this method was developed specifically for turf grasses in Florida. Any additional evapotranspiration resulting from the existing vegetation was not considered in the calculations.

Stormwater runoff from the site was estimated to be approximately 25% of precipitation on an average annual basis. This assumption seems reasonable considering the higher antecedent moisture condition created by the higher than average precipitation rate. Ground water outflow from the site was set at zero to provide a conservative estimate of site capacities and in the absence of detailed groundwater flow modeling information. The results of the water balance calculations as provided in Appendix A indicate that on an annual average basis, both golf courses combined have a reuse capacity of approximately 0.450 MGD which equates to approximately 0.54 inches per week per course.

One would expect based on the permitted capacity of the percolation ponds and the average capacity through spray irrigation, the existing reuse facilities to have an overall capacity of 3.95 MGD. However, the overall capacity of the reuse facilities is in fact limited to 3.5 MGD for the following reasons:

- The golf courses are not 100% reliable since reclaimed water is only utilized on an "as requested" and "voluntary" basis.

- The deep injection well for emergency backup is limited to a capacity of approximately 3.5 MGD.

- The capacity of reclaimed water transmission facilities is limited by the capacity of the booster pumping stations.

The reuse facilities can only anticipate a potential reuse capacity of 3.95 MGD during times when weather permits and the golf course owners request reclaimed water for irrigation.

According to the wastewater flow projections as presented in Section 3 of this report, the existing reuse facilities presently have installed and/or permitted capacity to provide 100 percent reuse of reclaimed water and are projected to continue to do so through the projected year 2000. Beyond the year 2000 through the end of the 20 year planning period, the existing reuse system will continue to provide and maintain reuse of reclaimed water above 73 percent of the projected wastewater flow. To achieve full utilization of the existing permitted facilities will require upgrading the firm capacity of the booster pumping stations to at least 3.5 MGD, which is estimated to cost approximately $120,000.

Moreover, the operation of the existing land application systems will provide for capacity to reuse 100% of the projected reclaimed water flow from the Marco Island WWTP throughout the five year term of the WWTP operating permit, and through the expiration of the existing water use permit on January 17, 1996.

Finally, the Utility is applying for a general reuse permit to include all of the areas of Marco Island and Marco Shores. Upon receipt of this permit, the Utility will be able to make future cost effective expansions of its reuse system to increase its capacity, and the area served with reclaimed water.

4.3 SUMMARY AND CONCLUSIONS

Southern States Utilities has recently completed construction and placed into operation rapid rate land application facilities with a permitted reclaimed water capacity of 3.5 MGD. Southern States Utilities has also expanded their wastewater treatment facilities from 2.5 to 3.5 MGD and upgraded the facilities to provide Class I reliability, tertiary effluent filtration, and high level disinfection. The upgrade of the treatment facilities was necessitated in order to produce a reclaimed water suitable for public access reuse. In this manner, reclaimed water for irrigation of the Marco Island and Marco Shores golf courses could continue to be made available for utilization to prevent the use of potable water or higher quality groundwater sources for this purpose. The Utility is committed to the use of reclaimed water and makes it available for median irrigation and other purposes where it is of suitable quality. The capacity of the existing reuse system is considered to be approximately 3.5 MGD mean average annual basis, which includes the permitted capacity of the rapid rate land application system of 3.5 MGD.

Wastewater flows to the Marco Island WWTP are presently 1.985 MGD on an annual average basis and are not expected to exceed the capacity of the reuse systems until 2000, with the exception of the reuse booster pump stations. Therefore, upgrading the existing reuse booster pump stations will be the only additional capital investment anticipated to be required to provide 100% reuse of reclaimed water throughout the term of the FDER operating permit or the SFWMD water use permit. The Utility has recognized that reuse of reclaimed water as defined in Chapter 17-40 and 17-610 are both feasible and desirable as evidenced by their actions to date which include expansion of the reuse facilities, and upgrading of the treatment facilities. The existing reuse facilities constructed and operated as described herein are

expected to provide 100% reuse of reclaimed water through the next 7 years and up above 73% through the end of the planning period. The existing facilities are therefore considered to meet all the requirements for reuse of reclaimed water in accordance with Chapter 17-40.401(5) which requires that "a reasonable amount of reuse of reclaimed water from domestic wastewater treatment facilities shall be required within designated critical water supply problem areas unless such reuse is not economically, environmentally, or technically feasible," and therefore, no additional actions are required on the part of the Utility to comply at this time.

WATER BALANCE CALCULATIONS

Water Balance
Marco Island Spray Irrigation Effluent Disposal
Wettest Year in 10

Month	Mean Temp.	PPT (inches)	ET (inches)	ET−PPT (inches)	PW (inches)	SWR (inches)	LW (inches)	LW (in/wk)
January	64.7	2.42	2.79	0.37	0	0.36	0.73	0.16
February	65.2	2.53	2.89	0.36	0	0.38	0.74	0.19
March	69.5	2.88	3.87	0.99	0	0.47	1.46	0.33
April	73.1	2.12	4.93	2.81	0	0.28	3.09	0.72
May	76.7	5.77	6.29	0.52	0	1.19	1.72	0.39
June	81.8	9.92	8.89	−1.03	0	2.23	1.20	0.28
July	82.3	10.23	9.19	−1.04	0	2.31	1.27	0.29
August	82.9	10.8	9.57	−1.23	0	2.45	1.22	0.28
September	82.2	11.7	9.13	−2.57	0	2.68	0.11	0.02
October	74.9	5.02	5.57	0.55	0	1.01	1.56	0.35
November	70.3	1.57	4.08	2.51	0	0.14	2.65	0.62
December	66	1.83	3.05	1.22	0	0.21	1.43	0.33
Total		66.79	70.27	3.48	0.00	13.70	17.18	

(9) Land Application Area
- Marco Island G.C. 125.00
- Marco Shores G.C. 90.00

(10) Surface Runoff, %PPT 25.00%

(11) Avg. Loading Rate (in/wk): 0.33

(12) Avg. Irrigated Quanity (MGD): 0.275

Notes:
1. (6) = {(2)−1.0} * (10)
2. Evapotranspiration data determined by McCloud Method.
3. Percipitation from the Naples station for average annual precipitation.

Water Balance
Marco Island Spray Irrigation Effluent Disposal
Dryest Year in 10

Month	Normal Temp.	PPT (inches)	ET (inches)	ET−PPT (inches)	PW (inches)	SWR (inches)	LW (inches)	LW (in/wk)
January	64.7	1.45	2.79	1.34	0	0.11	1.46	0.33
February	65.2	1.52	2.89	1.37	0	0.13	1.50	0.38
March	69.5	1.72	3.87	2.15	0	0.18	2.33	0.53
April	73.1	1.27	4.93	3.66	0	0.07	3.73	0.87
May	76.7	3.45	6.29	2.84	0	0.61	3.46	0.78
June	81.8	5.94	8.89	2.95	0	1.24	4.18	0.98
July	82.3	6.13	9.19	3.06	0	1.28	4.35	0.98
August	82.9	6.47	9.57	3.10	0	1.37	4.47	1.01
September	82.2	7.01	9.13	2.12	0	1.50	3.62	0.85
October	74.9	3.01	5.57	2.56	0	0.50	3.06	0.69
November	70.3	0.94	4.08	3.14	0	0.00	3.14	0.73
December	66	1.09	3.05	1.96	0	0.02	1.98	0.46
Total		40.00	70.27	30.27	0.00	7.02	37.29	

(9) Land Application Area
- Marco Island G.C. 125.00
- Marco Shores G.C. 90.00

(10) Surface Runoff, %PPT 25.00%

(11) Avg. Loading Rate (in/wk): 0.72

(12) Avg. Irrigated Quanity (MGD): 0.596

Notes:
1. (6) = {(2)−1.0} * (10)
2. Evapotranspiration data determined by McCloud Method.
3. Percipitation from the Naples station for average annual precipitation.

Water Balance
Marco Island Spray Irrigation Effluent Disposal
Average Year

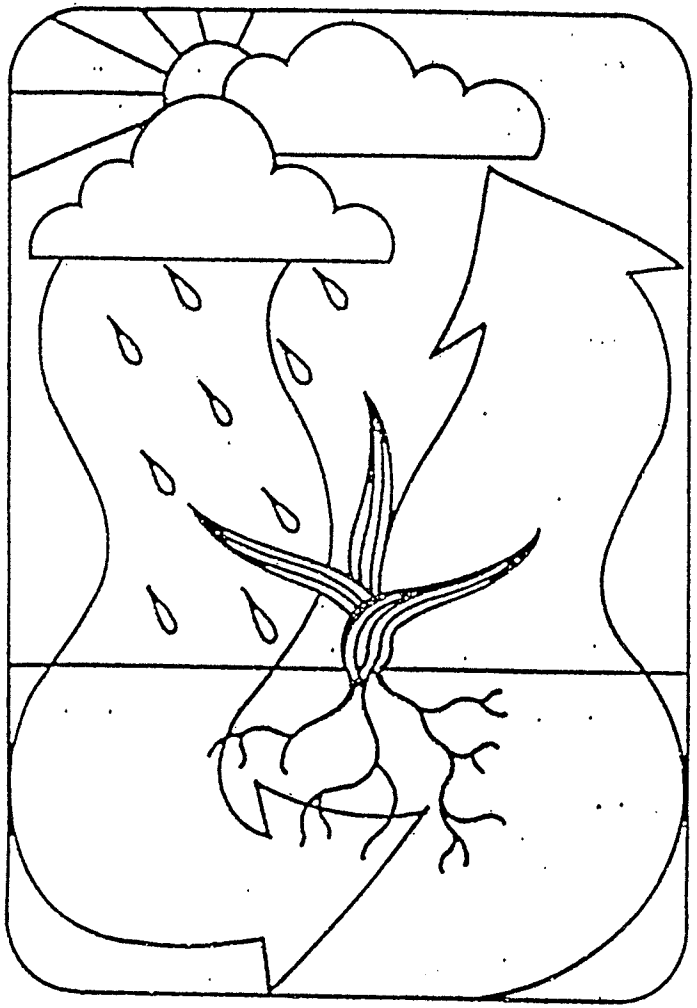
Month	Normal Temp. (1)	PPT (inches) (2)	ET (inches) (3)	ET−PPT (inches) (4) = (3)−(2)	PW (inches) (5)	SWR (inches) (6)	LW (inches) (7) = (4)+(5)+(6)	LW (in/wk) (8)
January	64.7	1.88	2.79	0.91	0	0.22	1.13	0.26
February	65.2	1.97	2.89	0.92	0	0.24	1.16	0.29
March	69.5	2.24	3.87	1.63	0	0.31	1.94	0.44
April	73.1	1.65	4.93	3.28	0	0.16	3.45	0.80
May	76.7	4.49	6.29	1.80	0	0.87	2.68	0.60
June	81.8	7.73	8.89	1.16	0	1.68	2.84	0.66
July	82.3	7.96	9.19	1.23	0	1.74	2.97	0.67
August	82.9	8.41	9.57	1.16	0	1.85	3.02	0.68
September	82.2	9.11	9.13	0.02	0	2.03	2.05	0.48
October	74.9	3.91	5.57	1.66	0	0.73	2.39	0.54
November	70.3	1.22	4.08	2.86	0	0.06	2.92	0.68
December	66	1.43	3.05	1.62	0	0.11	1.73	0.39
Annual		52.00	70.27	18.27	0.00	10.00	28.27	

(9) Land Application Area
- Marco Island G.C. 125.00
- Marco Shores G.C. 90.00

(10) Surface Runoff, %PPT 25.00%
(11) Avg. Loading Rate (in/wk): 0.54
(12) Avg. Irrigated Quanity (MGD): 0.452

Notes:
1. (6) = {(2)−1.0} * (10)
2. Evapotranspiration data determined by McCloud Method.
3. Percipitation from the Naples station for average annual precipitation.

WATER REQUIREMENTS OF FLORIDA TURFGRASSES



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equations for ...g ETP in several locations within a wide geographical region, one ... selec... ...meth... ...at ca... ...used ... data ...ted each location.

McCloud (13) developed an equation for predicting potential evapotranspiration, which reflected turfgrass water use under Florida conditions. As McCloud noted, most formulas tend to underestimate water use when the mean temperature is over 70° F.

ESTIMATION OF ET.

$$\text{McCloud's Formula: } ETP = KW^{(T-32)}$$

where, $K = \frac{0.01}{0.31}$, $W = 1.07$, and T = mean temperature in ° F

In Florida more than half of the months have average temperatures above 70°F, and in some locations the monthly mean temperature is above 80°F four months of the year (9). Utilizing Thornthwaite, Penman, or Blaney-Criddle methods under these conditions can lead to significant underestimation of potential evapotranspiration.

Figure 1 shows a comparison of the McCloud, Penman, and Thornthwaite methods of calculating potential evapotranspiration for Miami, Florida. All methods show similar ETP rates in the winter and early spring where monthly temperatures are less than 70°F. As monthly temperatures in late spring and summer increase above 70°F, Penman and Thornthwaite ETP rates level off, while McCloud ETP rates continue to reflect the increasing temperatures. Practical experience has shown that irrigation requirements can approach McCloud's predicted rates if rainfall does not occur at regular intervals and amounts during the summer. If rains occur on a frequent basis in amounts less than one inch then irrigation amounts will follow trends similar to Table 1 because high humidity and cloud cover reduce ET. Keeping in mind the definition of potential evapotranspiration and to more accurately reflect Florida's environmental conditions, McCloud's Formula appears to be a better predictor of turfgrass water use. When weather monitoring facilities across the state begin collecting environmental parameters, such as net radiation, relative humidity, cloud cover, or others, then other ETP predicting methods may prove more suitable.

Turfgrass Irrigation Systems

Turfgrass in Florida is commonly irrigated with overhead sprinkler systems. These systems are permanently buried in the soil and consist of sprinkler heads, pipes, fittings, valves, and controllers. Numerous differences exist among sprinkler systems due to differences in manufactured parts, system design, and installation. Sophistication and automation of a sprinkler

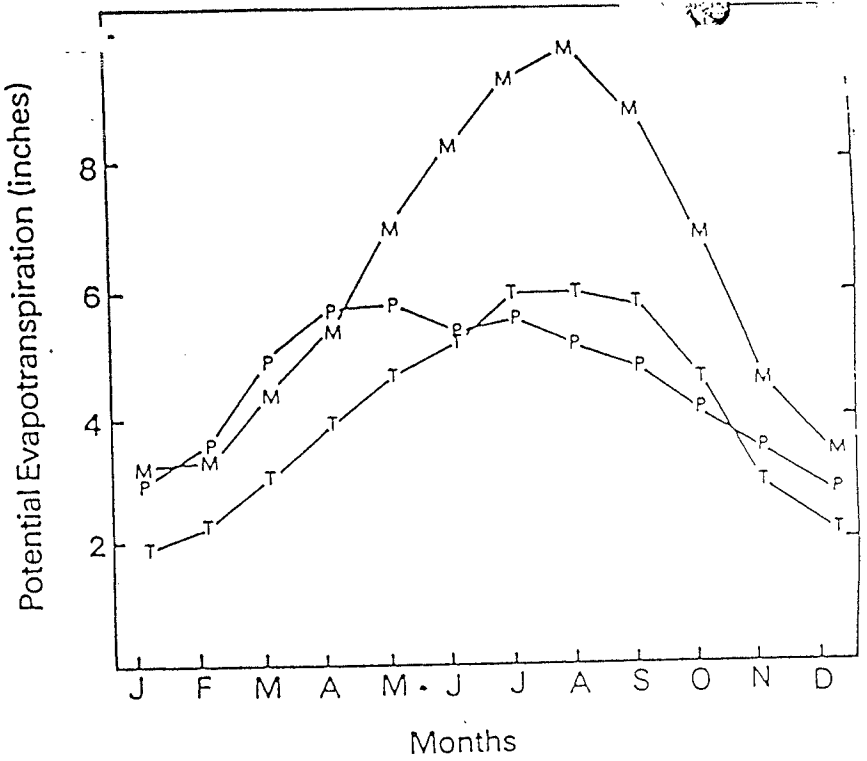

Figure 1. A comparison of McCloud (M), Penman (P), and Thornthwaite (T) methods of calculating potential evapotranspiration for Miami, Florida.

system are closely related to the price of installation. Specific details on sprinkler system design, construction, and operation are given by Watkins (30) and Sarsfield (22).

Regardless of the sprinkler system, a person needs to know a few basic details about the performance of the system in order to efficiently apply water. First, one should know the irrigation rate of the system, in inches (centimeters) of water applied per hour. This can be easily determined by calibrating the sprinkler system (1). Next, one needs to know when to water, how much water to apply, and the method of applying water. Specific irrigation instructions can be found in *Watering Your Florida Lawn* (2).

Efficient water use and conservation of irrigation water are the responsibility of the system operator and require knowledge of turfgrass water requirements and sprinkler system capabilities. Proper turfgrass management practices are also essential in making the most effective use of rainfall and applied irrigation. Information on Florida turfgrass culture is available at all county extension offices.