DRAFT

WATER RECLAMATION STUDY FOR SYSTEM NO. 9

Prepared for

Palm Beach County Water Utilities Department

CH2M HILL

Draft - April, 1986

MAY 13 1986

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WATER RECLAMATION PLAN
FOR SYSTEM NO. 9

Prepared for

THE PALM BEACH COUNTY WATER UTILITIES DEPARTMENT

Prepared by

CH2M HILL
March 1986

FC18009.F0

PREFACE

This report provides the Palm Beach County Water Utilities Department (PBCWUD) with guidelines for developing and implementing a water reclamation program for System No. 9. The report includes identification of potential users of reclaimed water, an outline of the regulatory requirements, a plan for operation, evaluation of storage and pumping, transmission requirements, formulation of a monitoring and control strategy, development of a cost estimate and user charge estimate, development of policy recommendations, and an assessment of the program's feasibility.

CONTENTS

TABLES

FIGURES

V/ / / Dave
Please note date of meeting

5/14/86

Engineers
Planners
Economists
Scientists

Leslie
Steve Riley sent us two copies of this report. He would like our review and comments at the below mentioned meeting on the 28th. Questions?
x640

May 13, 1986

FC18009.F0

South Florida Water Management District
3301 Gun Club Road
West Palm Beach, Florida 33406

Attention: Mr. Bruce Adams

Dear Bruce:

Enclosed please find two copies of of the DRAFT - WATER RECLAMATION STUDY for the Palm Beach County Water Utilities Department (PBCWUD) System No. 9. As we discussed, a meeting is scheduled for Wednesday, May 28, to discuss your agency's comments. Attendees at this meeting will include representatives from PBCWUD, CH2M HILL, and FDER. The meeting will be held at your conference room at 10:00 a.m.

If you have any questions, please call me at 737-6665.

Sincerely,

Stephen H. Riley

Stephen H. Riley, P.E.
Project Manager

bcrSHR1/53mf
Enclosure (2)
cc: R. Weismann/PBCWUD
C. L. McCall/PBCWUD

EXECUTIVE SUMMARY

Section 1
EXECUTIVE SUMMARY

BACKGROUND

The Palm Beach County Water Utilities Department (PBCWUD) System No. 9 provides wastewater management services to the southern unincorporated region of Palm Beach County west of Boca Raton. Wastewater treatment is provided by two facilities, Wastewater Treatment Plant No. 9 North (WWTP 9N) and Wastewater Treatment Plant No. 9 South (WWTP 9S). Unit processes at both plants include conventional activated sludge treatment, filtration and disinfection. Effluent disposal is accomplished by underground injection through a deep injection well located at WWTP 9N. Effluent from WWTP 9S is pumped to WWTP 9N for disposal through a 24-inch diameter main located within the State Road 7 right-of-way.

The underground injection system, completed in November, 1985, was constructed in response to an urgent requirement for both WWTP's to terminate effluent disposal to percolation ponds (WWTP 9S) and lakes (WWTP 9N). The selection of underground injection was made because an alternate means of effluent disposal was needed that could be implemented quickly.

Prior to implementation of the underground injection system, officials in Palm Beach County were aware of the potential benefits of using treated wastewater from System No. 9 for productive purposes, such as irrigation water supply. The process of upgrading the quality of wastewater effluent, so that it may be reused is known as water reclamation. Water reclamation plays an important role in water conservation by reducing the demand on groundwater.

SFWMD REUSE IMPLEMENTATION

The Consumptive Use Permits (CUP) for users of irrigation water in Palm Beach County expire in 1988. The CUP renewal process requires that all applicants evaluate the feasibility of utilizing treated wastewater for irrigation. SFWMD staff have indicated that the CUP's for some users may be cut back if wastewater is available and they do not implement a program to utilize it.

POTENTIAL DEMAND

A telephone survey was conducted to identify the major irrigation water users in the System No. 9 service area. The principal large users are golf courses although some residential developments, parks and plant nurseries also irrigate extensively. A total of 28 existing and potential large users of irrigation water were identified. Current irrigation demand is approximately 16.4 MGD. Irrigation demand is projected to increase to 20.3 MGD by 1990.

Currently, WWTP 9N and 9S produce a total of 4.6 MGD, although this is projected to increase to over 12 MGD by the year 2020. Thus, the "demand" for reclaimed water exceeds the "supply" within the System No. 9 service area.

REGULATIONS

The use of treated wastewater for irrigation of golf courses and other land with public access is regulated by the Florida Department of Environmental Regulation (FDER). Requirements for effluent quality include a limit of 5 mg/L Total Suspended Solids (TSS), high-level disinfection and no detectable fecal coliform bacteria. WWTP's 9N and 9S currently meet these standards of quality due to excellent operation and maintenance practices and the presence of filters to polish the effluent.

Regulations applicable to the land application site include the need for one or more groundwater monitoring wells, adequate buffer zones around the application area and public notification that treated wastewater is present. In most cases, only minor modifications to irrigation operations may be needed to comply with FDER regulations.

FACILITY IMPROVEMENTS

Delivery of reclaimed water to each user's site would be accomplished by pumping stations located at each WWTP and transmission pipelines. Sites along State Road 7 including Boca Woods Country Club, Mission Bay, Jack's Nursery and the Boca Greens Golf Course could be served by extending pipes from the 24-inch diameter effluent transmission main. Other users including the Hamptons Country Club, American Homes, Century Village and the Boca Raton Municipal Golf Course could be served from the 12-inch diameter effluent transfer main previously used to discharge WWTP 9N effluent to the lake system at the Hamptons Country Club.

Each user would have to provide a storage facility, such as a pond or tank, for receiving and holding reclaimed water. According to FDER, ponds used for storing reclaimed water must be isolated from other ponds or lakes which serve as stormwater retention ponds. This precaution is needed to prevent reclaimed water from discharging to surface drainage canals, a violation of State laws.

Monitoring and control of the delivery of reclaimed water could be accomplished by a radio-based remote telemetry system in conjunction with a remote station at each user's site consisting of a flow meter, electrically-actuated control valve and remote telemetry unit (RTU).

The central telemetry unit (CTU) is proposed to be located at WWTP 9N. From the CTU, the operators will be able to monitor delivery of effluent to the users and control the delivery by remotely opening and closing the control valve at each user's site.

USER COST ESTIMATE

A preliminary cost estimate of $0.12/1,000 gallons was developed for the PBCWUD to provide reclaimed water service during the five-year period 1987 through 1991. This estimate is based on the PBCWUD recovering the cost of: 1) operation and maintenance of the filtration, disinfection and effluent pumping systems, 2) debt service for a new pumping station and central telemetry station at WWTP 9N, and 3) administrative and general costs of the reclaimed water system. Other costs to be borne by the user include: 1) pipeline extensions, 2) a remote station consisting of a flowmeter, control valve and RTU, and 3) site modifications to comply with FDER regulations including storage pond or tank construction.

CONCLUSION

A water reclamation project within the PBCWUD System No. 9 service area appears to be feasible from all aspects except economics. Economics continues to favor irrigation supply obtained from on-site ponds or ground water. More stringent state regulations or prolonged drought conditions will likely be required to entice users to participate in a reclaimed water system. Thus a dedicated, continuing effort will be required to implement the project. A summary of the key factors affecting implementation is summarized below.

Factors Hindering Implementation

1. Resistance by users to the cost of new facilities and user charges for reclaimed water.

2. Overcoming public concern regarding the health aspects of wastewater reuse adjacent to residential areas.

Factors Favoring Implementation

1. Major pump station and pipelines which could provide reclaimed water to some users have already been constructed. Users would not have to absorb the costs of these facilities as they were required for operation of the existing effluent disposal system.

2. The cost for the PBCWUD to provide reclaimed water is estimated to be $0.12/1,000 gallons.

3. The treated effluent contains phosphorus and nitrogen, vital nutrients to turf grasses. The benefit of treated wastewater in terms of reduced fertilizer costs is estimated at $0.05/1,000 gallons.

4. The South Florida Water Management Disctrict (SFWMD) would exempt users from water use restrictions during periods of water shortages.

5. The SFWMD may reduce permitted irrigation water usage of golf courses that refuse to utilize reclaimed water when it is available.

6. Fresh water supply would be reserved for uses that require high quality water.

INTRODUCTION

Section 2
INTRODUCTION

BACKGROUND

The Palm Beach County Water Utilities Department (PBCWUD) System No. 9 provides wastewater management services to the southern unincorporated area of Palm Beach County. The system has two treatment facilities: the north plant or WWTP 9N, and the south plant, or WWTP 9S. Figure 2-1 shows the approximate location of the two treatment plants. WWTP 9N is located adjacent to State Road 7 between the American Homes and Moon Lake Subdivisions. WWTP 9S is located within the Sandalfoot Cove Golf Course. A future regional wastewater treatment plant is proposed on a site north of Clint Moore Road. Ultimately, this facility will treat all wastewater from the entire System No. 9 service area.

In 1984, the PBCWUD was cited by the Florida Department of Environmental Regulation (FDER) for violations of the operating permits for both WWTP 9N and 9S. It was discovered that the golf course lake, which received effluent from WWTP 9N, and the percolation ponds, which received effluent from WWTP 9S, where both continuously discharging water to adjacent surface drainage canals, in violation of their operating permits. A deep injection well was constructed at WWTP 9N in 1985 for disposal of the total effluent flow from System No. 9. When the injection well became operational, all discharge to the lakes and percolation ponds ended.

Flow from WWTP 9S is pumped to WWTP 9N through a new 24-inch diameter effluent transmission main shown on Figure 2-1. Effluent from the two plants is discharged into a wet well from which it is pumped to the deep injection well for underground disposal.

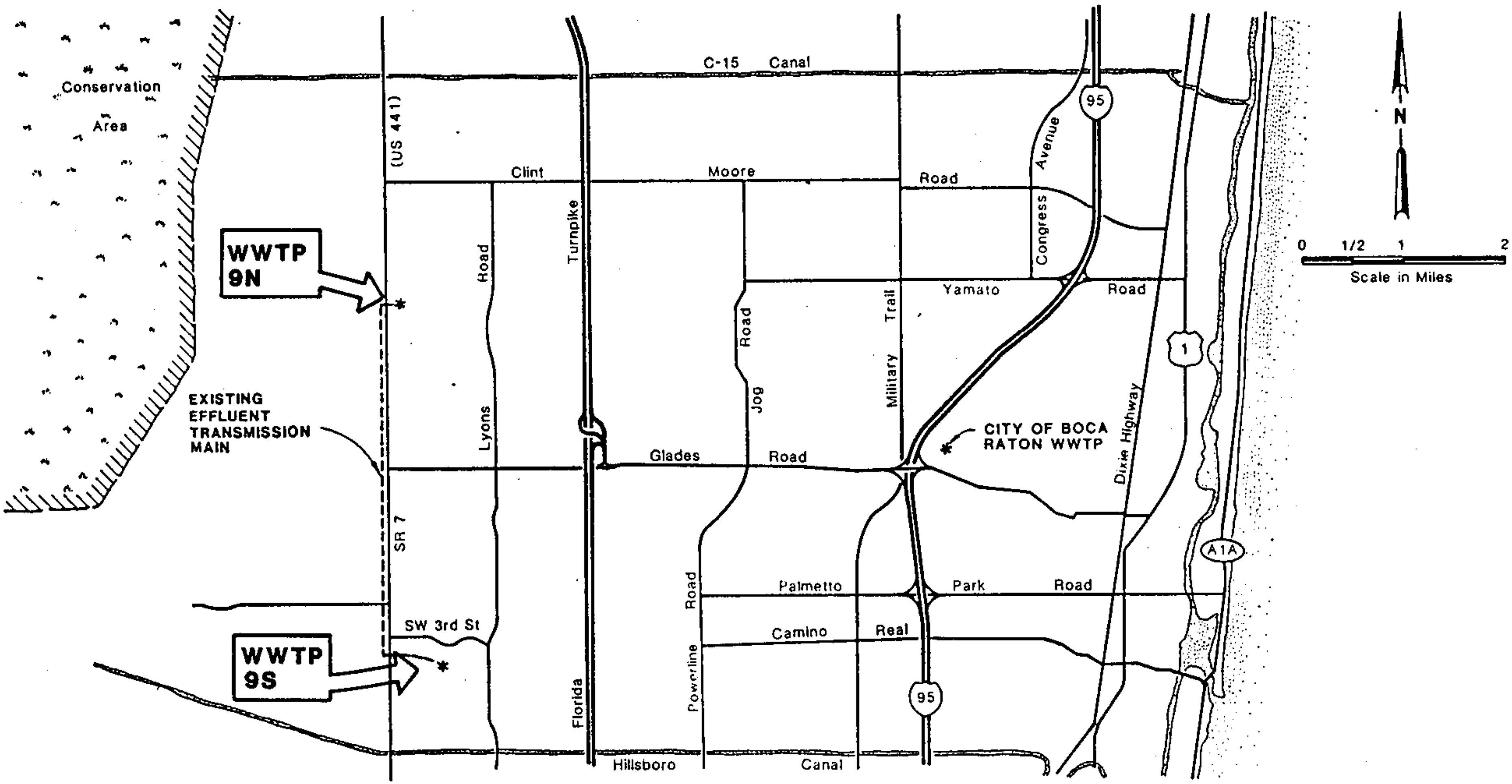

FIGURE 2-1

Location Map

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Prior to implementation of the underground injection system, officials in Palm Beach County were aware of the potential benefits of using treated wastewater for productive purposes such as irrigation water supply. Many officials in Palm Beach County and the South Florida Water Management District (SFWMD) believed that, in the future, wastewater reuse would be the primary method of effluent disposal and the injection well would serve only as a backup.

SFWMD REUSE IMPLEMENTATION PLAN

Consumptive Use Permits

No! All consumptive uses of water in the System No. 9 area are subject to regulation by the SFWMD. Any user whose use exceeds 100,000 gallons per day on an average basis must obtain a Consumptive Use Permit (CUP).
all users except those exempted by law or rule

Consumptive Use Permits are required in order to conserve and encourage the efficient use of Florida's water resources. In order to obtain a permit, an applicant must demonstrate that the proposed use of water is a "reasonable beneficial use", will not interfere with any presently existing legal uses of water, and is consistent with the public interest. Permit decisions are rendered by the SFWMD governing board after receipt of staff reports and public testimony during regularly scheduled board meetings. CUP's must be renewed by the permittee every three years. No!

Basin Yield Evaluation

Every 10 years, the SFWMD evaluates the water resources in sub-regional areas referred to as basins. Basin yield is the amount of water that can be withdrawn from the basin without causing water level declines unfavorable to the public interest. Most of Palm Beach County comprises a single basin.

The basin expiration date for Palm Beach County is October 15, 1988. All CUP's for irrigation water users expire on this date, regardless of whether they were issued less than three years prior to the basin expiration date. During the basin renewal process, the SFWMD may update and revise conditions on all CUP's. In some cases, withdrawal allowances may be reduced if demand exceeds the basin yield.

Reuse Incentive

All CUP applicants are required to conduct an evaluation of reclaimed water as a supplement or replacement to their present water supply source. SFWMD staff have indicated that the CUP's for some users may be cut back if reclaimed water is available to them as a source of irrigation water and they do not implement a program to utilize it. The SFWMD is considering this approach to initiate reuse because many users refuse to participate, claiming the economics are unfavorable.

OBJECTIVES

Reclaimed water is herein defined as wastewater that has been upgraded in quality for either direct reuse or indirect reuse. Direct reuse is the utilization of reclaimed water directly for a specific nonpotable use such as irrigation. The reclaimed water provides a lower quality, but acceptable substitute for fresh or potable water. Indirect reuse consists of discharging wastewater to a natural storage area such as an aquifer which provides potable or irrigation water supply. Examples include percolation ponds and rapid infiltration basins. From a resource-management perspective, direct reuse is favored by the SFWMD because it would achieve an immediate reduction in the existing demand for fresh water. This study addresses only direct reuse alternatives for reclaimed water.

The basic objective of direct reuse of wastewater is the conservation of fresh water. To meet the future demands for potable water it is essential that the quality and quantity of fresh water supplies be soundly managed. Chapter 17-40 of the Florida Administrative Code (FAC) which is part of the State Water Use Plan, includes a policy to "promote water conservation as an integral part of water management programs, rules, and plans and the use and reuse of water of the lowest acceptable quality for the purpose intended". The reuse of wastewater as a substitute for fresh water enables conservation of the higher quality, fresh water for the uses that require it.

DIRECT REUSE ALTERNATIVES

Examples of direct reuse alternatives include:

- o Irrigation - the use of treated wastewater for irrigation of turf grasses, agricultural lands, or horticultural lands.
- o Recycle - the use of wastewater, after extensive treatment, as a source for human consumption.
- o Industrial - utilizing treated wastewater as a source of water supply for industrial water needs.

Of the above reclamation methods, the one most suited for the PBCWUD System No. 9 service area is irrigation. Recycle is not feasible due to its prohibitive cost and social unacceptability. Industrial reuse is not feasible as there are no large industrial water users in the area.

Public perception of water reclamation, especially for irrigation purposes, has greatly improved in recent years. The success of irrigation systems such as the

St. Petersburg, Florida, project, where millions of gallons of treated wastewater are used by homeowners, golf courses and parks each day, has made the public aware that water reclamation by irrigation can be safe and practical.

RECLAIMED WATER SUPPLY AND DEMAND

Section 3
RECLAIMED WATER SUPPLY AND DEMAND

Within the System No. 9 service area there are numerous large users of irrigation water including golf courses, residential developments, recreational parks and plant nurseries. The quantity of reclaimed water available to supply the irrigation demands of these users is limited by the wastewater flows generated within the service area.

WASTEWATER FLOWS

CURRENT

Data from the monthly operating reports for WWTP 9S and 9N is presented in Table 3-1. For the one-year period ending in January, 1986, the average daily flow for WWTP's 9S and 9N was 1.74 mgd and 2.90 mgd, respectively. The total average day flow for System No. 9 is 4.64 mgd.

PROJECTED

Figure 3-1 presents a graph of the projected average day wastewater flows for the System No. 9 service area. The data for the graph was based on PBCWUD information and the Palm Beach County 201 Facilities Plan. The ultimate build-out average day flow for the System No. 9 service area is projected to 12.2 mgd.

IRRIGATION DEMANDS

Turf grasses in south Florida generally require irrigation with one to two inches of water per week. These rates are approximately equivalent to 4,000 to 8,000 gallons per acre per day. The SFWMD generally uses one inch per week as a guideline for estimating turf grass irrigation requirements.

Table 3-1
CURRENT ANNUAL AVERAGE DAY WASTEWATER FLOWS

MONTH	WWTP 9S (MGD)	WWTP 9N (MGD)
Feb. 1985	1.38	3.15
Mar.	1.59	3.06
Apr.	1.48	2.10
May	1.42	2.30
June	1.49	2.86
July	2.07	2.97
August	1.71	2.94
Sept.	1.85	3.09
Oct.	1.79	3.31
Nov.	1.79	2.98
Dec.	2.15	3.00
Jan. 1986	2.21	3.09
Annual Average	1.74 mgd	2.90 mgd

Combined Annual Avg. Day = 1.74 + 2.90 = 4.64 mgd

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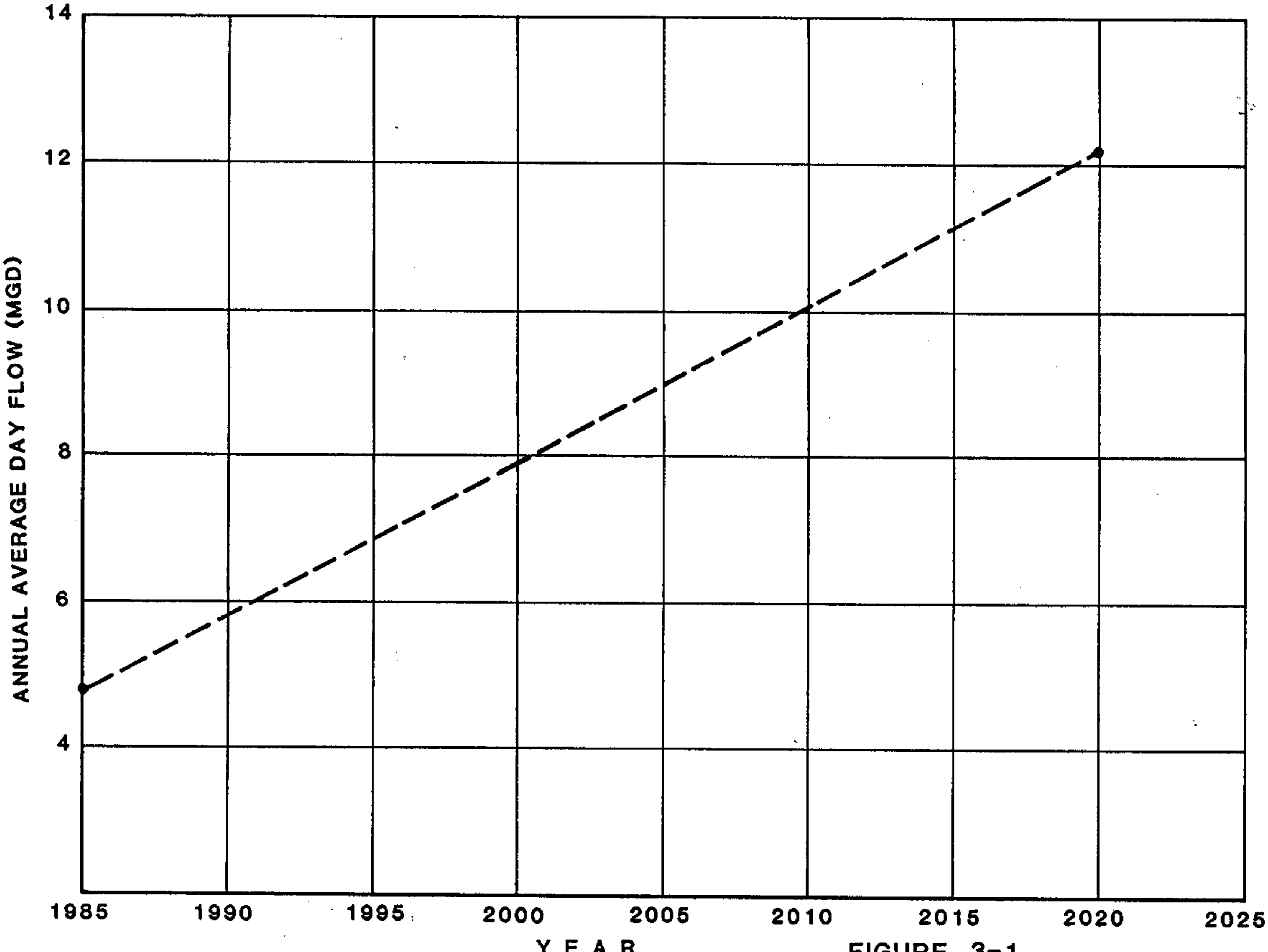

FIGURE 3-1
Projected Wastewater Flow

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Figure 3-2 presents a projection of the required acreage to land apply all effluent from System No.9. At current flows, approximately 1,200 acres would be needed. The projected requirement is based on an application rate of one inch per week. The amount of effluent available for land application is assumed to be the projected annual average day flow as shown on Figure 3-1.

SITES

The System No. 9 service area contains many land developments, golf courses, recreational parks and plant nurseries with large irrigation water needs. Identification of the potential land application sites was accomplished with information provided by the Palm Beach County Area Planning Board. A telephone survey was conducted to obtain further information on each site.

Figure 3-3 presents a map of the study area showing the potential land application sites. Potential sites which are adjacent to but not within, the System No. 9 service area are Boca West, University Park, and Broken Sound Golf Course. Table 3-2 presents a summary of information obtained from the survey and research of potential sites. Most of the sites are existing. Proposed sites are projected to be completed within the next two to five years.

Table 3-2 shows that a large-user irrigation demand in excess of 20 mgd is anticipated within the period 1985 to 1990. During this same period, the annual average day wastewater effluent flow is projected to increase from 4.6 to 5.8 mgd. Therefore, the potential demand for reclaimed water exceeds the available supply by a factor of almost four.

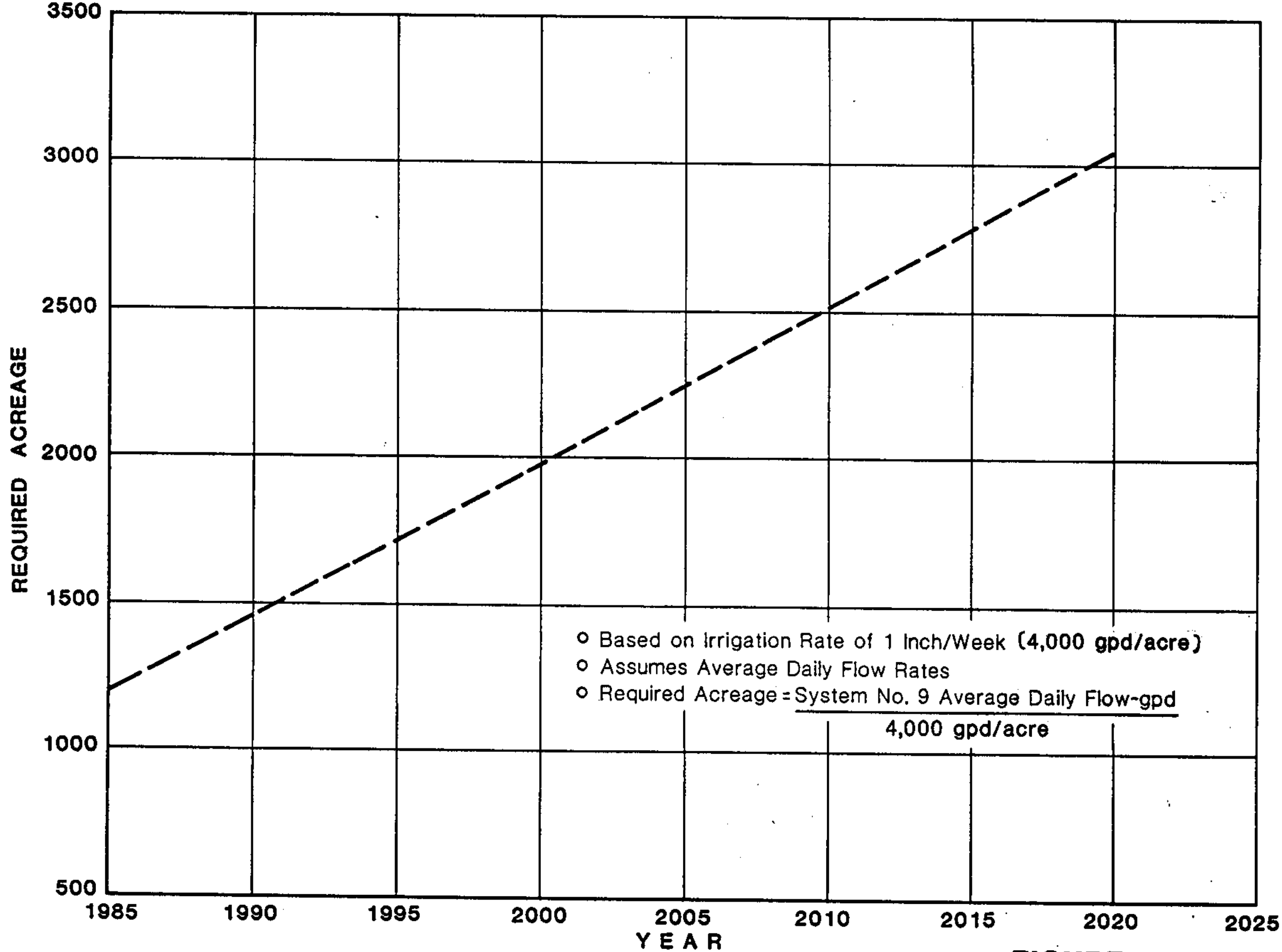

FIGURE 3-2

Acreage Required for Land Application

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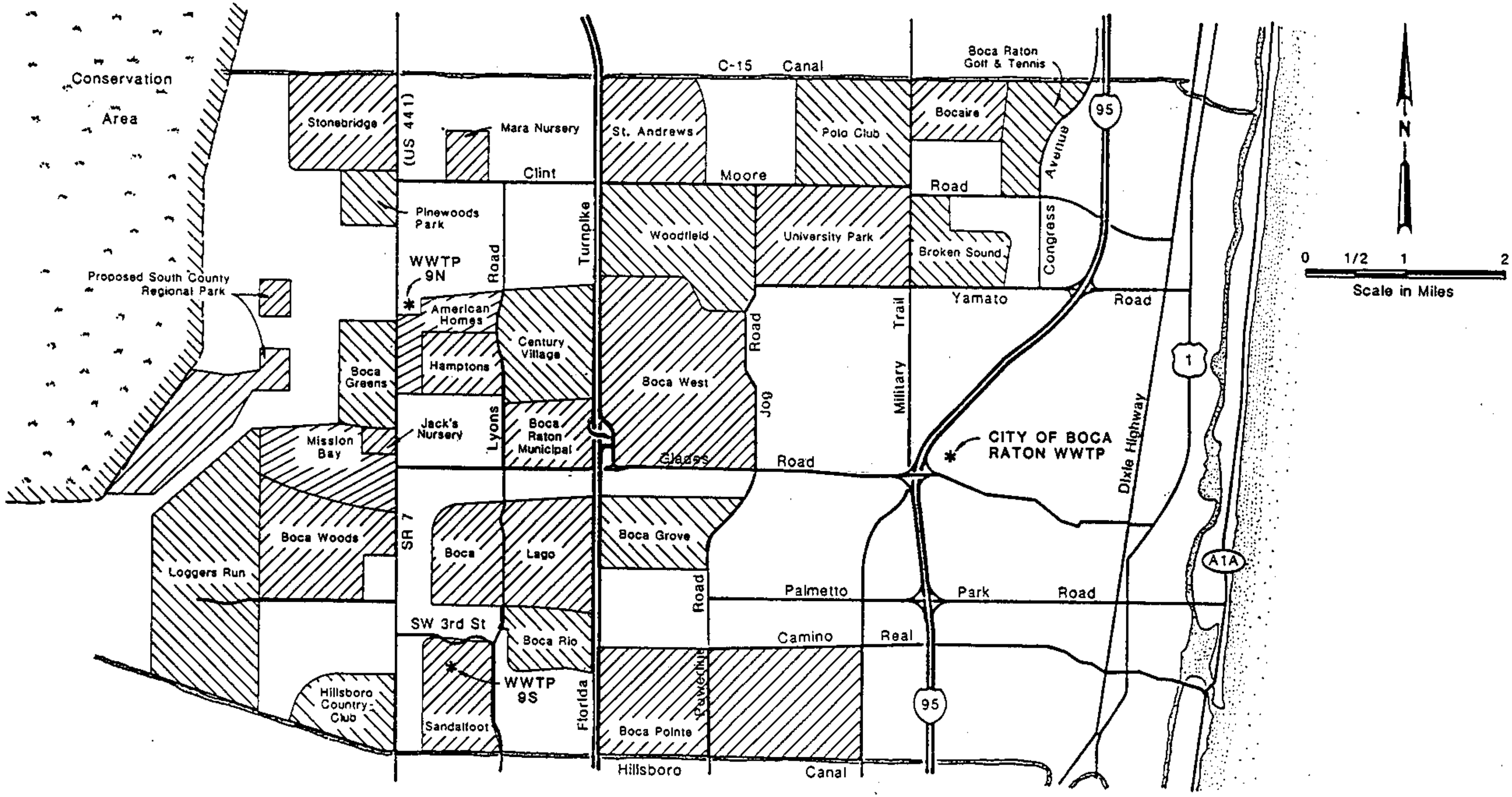

FIGURE 3-3

Potential Land Application Sites

TABLE 3-2

POTENTIAL LAND APPLICATION SITES

Site	Irrigated Acreage	Water Demands (in 1,000 gpd)
GOLF COURSES		
Boca Greens Country Club	180	720
Boca Grove Golf and Tennis Club	260	1,040
Bocaire	125[1]	500
Boca Lago Golf & Racket Club	225	900
Boca Pointe Golf and Racket Club	270	1,080
Boca Raton Golf and Tennis Club	125[1]	500
Boca Raton Municipal Golf Course	165	660
Boca Rio Golf Club	200	800
Boca West	630	2,520
Boca Woods Country Club	260	1,040
Broken Sound	125[1]	500
Hamptons Country Club	125	500
Hillsboro Country Club	125[1]	500
Polo Club	200	800
Sandalfoot Cove Country Club	---[2]	---
St. Andrews Country Club	220	880
Stonebridge	125[1]	500
University Park	125[1]	500
Woodfield Country Club	260[1]	1,040
Subtotal	3,745	14,980
RESIDENTIAL DEVELOPMENTS		
American Homes	160	300
Century Village	240	500
Loggers Run	---[3]	---[3]
Mission Bay	600	2,000
Subtotal	1,000	2,800
PARKS AND NURSERIES		
Clint Moore Nursery	70	280
Jack's Der Farm Nursery	15	60
Mara Nursery	60	240
Pinewoods County Park	12	50
South County Regional Park	475	1,900
Subtotal	632	2,530
GRAND TOTAL	5,377	20,310

[1] Information on actual acreage not available. Values shown represent estimate.

[2] Not included due to proximity to System No. 9 water supply well field.

[3] Owner unable to provide estimate.

ASSUMED PHASED SERVICE PLAN

A plan to provide reclaimed water to users must reflect that only a limited number of users can be served. This report will present an assumed plan for the five-year period 1987 through 1991. The rationale for prioritizing sites to be served in this time frame is primarily based upon economics, i.e., who can be served in the most cost-effective manner. Economics represent only one method of determining the priority of service to users. Other factors, such as water management and environmental protection concerns, may take precedence over economic considerations. This plan will not project a service schedule to sites beyond 1991. The evaluation and weighing of the above factors for each specific site to determine a service priority is not included in this study.

An assumed phased service plan for the years 1987 through 1991 is presented in Table 3-3. As discussed above, the selection of sites and phasing of service is based upon the amount of treated wastewater available and the lowest cost of new facilities. In general, the cost of new facilities is the lowest for those sites closest to the treatment plants and the effluent transmission main. Pipeline cost to the irrigation site is the key variable when comparing the cost of service between different sites.

In allocating the sites to be served by WWTP 9N and 9S, an attempt was made to match irrigation demand to plant average daily flow. An ideal balance was not possible. Where demand is less than plant capacity the excess effluent could either be delivered to the injection well for disposal or delivered to the users storage facility.

Table 3-3
ASSUMED PHASED SERVICE PLAN

Year	WWTP	Site To Be Served	Irrigation Demand (mgd)	Average Daily Wastewater Volume Available (mgd)
1987	9 South	Boca Woods	1.04	
		Boca Greens	0.72	
		Mission Bay	0.57[1]	
		Jack's Nursery	0.06	
		Subtotal	2.39	2.3
	9 North	Hamptons	0.50	
		Century Village	0.50	
		American Homes	0.30	
		Boca Municipal	0.70	
		Subtotal	2.00	2.9
		TOTAL	4.39	5.2
1988	9 South	Boca Woods	1.04	
		Mission Bay	0.95[1]	
		Jack's Nursery	0.06	
		Subtotal	2.05	2.3
	9 North	Hamptons	0.50	
		Century Village	0.50	
		American Homes	0.30	
		Boca Greens	0.72	
		Boca Municipal	0.70	
		Subtotal	2.72	3.1
		TOTAL	4.77	5.4
1989	9 South	Boca Woods	1.04	
		Mission Bay	1.30[1]	
		Jack's Nursery	0.06	
		Subtotal	2.40	2.4
	9 North	Hamptons	0.50	
		Century Village	0.50	
		American Homes	0.30	
		Boca Greens	0.72	
		Boca Municipal	0.70	
		Subtotal	2.72	3.2
		TOTAL	5.12	5.6

Table 3-3 (Continued)

Year	WWTP	Site To Be Served	Irrigation Demand (mgd)	Average Daily Wastewater Volume Available (mgd)
1990	9 South	Boca Woods	1.04	
		Mission Bay	1.26[1]	
		Subtotal	2.30	2.3
	9 South	Hamptons	0.50	
		Century Village	0.50	
		American Homes	0.30	
		Boca Greens	0.72	
		Jack's Nursery	0.06	
		Boca Municipal	0.70	
		Mission Bay	0.41[1]	
		Subtotal	3.17	3.5
		TOTAL	5.47	5.8
1991	9 South	Boca Woods	1.04	
		Mission Bay	1.26[1]	
		Subtotal	2.30	2.3
	9 North	Hamptons	0.50	
		Century Village	0.50	
		American Homes	0.30	
		Boca Greens	0.72	
		Jack's Nursery	0.06	
		Boca Municipal	0.70	
		Mission Bay	0.74[1]	
		Subtotal	3.52	3.7
		TOTAL	5.82	6.0

[1]Based on information at time of report, Mission Bay is projected to have a demand of 17 mg/mo. in 1987, increasing to 60 mg/mo. in 1990 and 1991. A linear increase has been assumed for the interim years.

REGULATORY REQUIREMENTS

Section 4
REGULATORY REQUIREMENTS

Wastewater land application projects must comply with the requirements of the State of Florida Administrative Codes (FAC) Chapter 17-6 and the FDER manual entitled "Land Applications of Domestic Wastewater Effluent in Florida". Irrigation of turf grasses falls under FDER criteria for "slow-rate" land application systems because the application rate is less than 2 inches per week. In cases where land application is the only source of wastewater disposal, provisions must be made to prevent surface runoff of the wastewater during periods when the soil is saturated.

Frequently, storage facilities are required at the treatment plant site to hold the wastewater until it can be land applied. However, central storage facilities will not be required at System No. 9 because the new deep injection well at WWTP 9N will provide the back-up means of disposal when the wastewater cannot be land applied.

PUBLIC NOTIFICATION

Access to open public areas must be restricted during the period when the reclaimed water is being applied. Public access areas may include private property that is not open to the public at large, but which is intended for frequent use by many persons.

At a golf course, application is typically by a sprinkler system during evening hours. The FDER has indicated that some means of public notification to adjacent homes or property owners will be required. Notification methods typically include public mailings and permanent signs at access points to the application site notifying the public that treated wastewater is being used for irrigation.

TREATMENT REQUIREMENTS

For all slow-rate systems involving irrigation of golf courses, parks, landscaped areas, and other areas intended to be accessible to the public, the FDER requires wastewater treatment more stringent than secondary treatment, as follows:

1. Not more than 20 mg/L Biochemical Oxygen Demand (BOD) as set forth in FAC Chapter 17-6, and

2. Effluent shall contain not more than 5 mg/L TSS and no detectable fecal coliform bacteria (high level disinfection criteria)

Effluent disinfection must produce an effluent where fecal coliform bacteria (per 100 ml sample) are below detectable limits. Where chlorine is utilized for disinfection, maintenance of 1.0 mg/L total chlorine residual after 15-minutes contact time at maximum daily flow, or 30-minutes contact time at average daily flow is required.

Both System No. 9 wastewater treatment plants currently produce a high quality effluent. As is shown on Tables 4-1 and 4-2, TSS concentrations and chlorine residual concentrations consistently comply with land application regulations. Fecal coliform bacteria are occasionally detected in very low amounts. However, the plant operators indicated that this may be the result of sample contamination during handling. BOD concentration, though not shown on Tables 4-1 and 4-2, is consistently below the 20 mg/L standard.

Table 4-1
WWTP 9N EFFLUENT QUALITY

Month	Average Total Suspended Solids (mg/L)	Average Chlorine Residual (mg/L)	Average Fecal Coliform Bacteria (MPN)
February, 1985	3	1.9	<1
March	3	2.2	1
April	3	2.1	<1
May	1	2.3	<1
June	2	2.0	0
July	3	2.4	<1
August	2	2.5	<1
September	3	2.4	<1
October	3	2.3	<1
November	2	2.3	0
December	3	3.0	<1
January, 1986	5	2.7	<1
Average	2.5	2.1	<1

Table 4-2
WWTP 9S EFFLUENT QUALITY

Month	Average Total Suspended Solids (mg/L)	Average Chlorine Residual (mg/L)	Average Fecal Coliform Bacteria (MPN)
February, 1985	2	2.4	<1
March	2	1.4	0
April	2	2.2	0
May	2	1.6	0
June	3	1.9	0
July	1	1.5	0
August	1	1.1	<1
September	1	1.6	<1
October	2	1.4	<1
November	3	1.2	0
December	1	1.5	<1
January, 1986	1	1.7	<1
Average	1.7	1.5	<1

SAMPLING AND TESTING REQUIREMENTS

Sampling and testing of the effluent is required to check compliance with FDER standards. As discussed earlier, the four key parameters for land application systems are BOD, TSS, total chlorine residual, and fecal coliform bacteria counts.

Currently, BOD, TSS, and fecal coliform are tested one time per week at each WWTP. Total chlorine residual is tested each day. The FDER has indicated that the frequency of testing must be increased to daily for all four parameters once land application of effluent is in operation. In addition, the FDER recommends that a continuous, automatic turbidity meter be placed at a point downstream of the filters at each plant. If turbidity readings exceeded a preset value, correlating to the 5-mg/L TSS limit, an alarm would be activated to notify the operators that effluent quality may be above allowable standards.

The FDER will require manual sampling points upstream and downstream of the filters, and downstream of the chlorine contact basins. Table 4-3 presents a list of the sampling requirements for the two WWTP's.

OFF-SITE EFFLUENT STORAGE

A typical golf course, park or other public access area is irrigated during the evening hours when their facilities are closed. It would not be economical for the PBCWUD to restrict delivery of reclaimed water to the evening hours for the following reasons: 1) wastewater effluent generated during the day would need to be stored onsite at the treatment plants until it could be pumped out at night, and

Table 4-3
EFFLUENT SAMPLING AND TESTING FOR LAND APPLICATION

Parameter Tested	Sample Method & Location	Sample Frequency	Remarks
TSS	Grab Sample - filter inlet box	Infrequent	Sample only when 5-mg/L TSS standard not met. Will give operator indication if unusually high TSS loads going on filters and possible problems in clarifiers.
TSS	Composite Sample - Chlorine Contact Basin	Daily	Must be 5 mg/L or less.
Turbidity	Automatic sampler and turbidmeter - draw sample from chlorine contact basin	Continuous	Lab tests will be required to correlate turbidity to TSS. Alarm will sound if unusually high turbidities measured.
Total Cl_2 residual, fecal coliform	Composite Sample - at downstream end of Chlorine Contact Basin	Daily	Cl_2 residual must be 1.0 mg/L or greater with no detectable fecal coliform bacteria.
BOD	Composite Sample - Chlorine Contact Basin	Daily	Bod must be less than 20 mg/L on annual average basis

2) effluent pumps and transmission mains would require a capacity at least 2 times the daily treatment rate since the total daily volume of wastewater would be pumped out in a period of 12 hours or less. WWTP 9N and 9S do not have storage facilities for treated effluent, nor are the pump stations and pipelines sized appropriately.

It would be more economical for the PBCWUD to discharge effluent on a continuous basis and require each user to provide a storage facility such as a pond or tank at their site. Thus, a user which received water during the day would put it in storage and have it available for use during the evening irrigation period.

GOLF COURSE LAKES

Most golf courses have lake systems which serve both aesthetic and functional purposes. Typically, the golf course is part of a residential development with a lake system that serves as a stormwater retention basin. Because many golf course irrigation systems draw water supply from these lakes they represent a potential storage facility for reclaimed water.

Utilization of the lakes for storage is appealing because cost savings could be realized as follows:

- construction of a new storage facility would not be needed.
- modification of existing irrigation pumping system might not be needed.
- the length of the delivery pipeline might be reduced.

The disadvantages of utilizing golf course lakes include dilution of nutrients present in the reclaimed water, causing a reduction in its value as a fertilizing agent, possible public resistance to using the ponds for this purpose, and loss of reclaimed water due to percolation.

Another constraint to storing reclaimed water in golf course lakes is the potential of overflow to adjacent drainage canals in violation of state and federal regulations. In most cases, the lakes are designed to discharge to the canals in wet weather conditions as part of the stormwater management system. During periods of dry weather, discharge to canals would normally be prevented by control structures.

Currently, the water quality in the surface drainage canals is below standard. For this reason, the FDER cannot permit any effluent discharge to these canals unless an extensive study and permit application process (National Pollution Discharge Elimination System permit) is performed which proves that the effluent will not further degrade the canal water quality.

Although there are many factors favoring the use of golf course lakes for storage of reclaimed water, the feasibility of their use will remain doubtful as long as the current regulations exist.

CONSTRUCTED PONDS

A pond could be constructed at a user's site to receive and hold the reclaimed water. Currently, the FDER does not require storage ponds to be lined providing they are outside the cone of influence of potable water supply wellfields. If the pond is not lined, the user risks loosing reclaimed water by percolation. Each user would have to evaluate his potential pond site for groundwater table elevation, available acreage and other site conditions affecting the feasibility of pond construction.

The banks of constructed ponds must be bermed to an adequate height to prevent overflow to canals or other surface waters. The FDER has indicated verbally that no less than 1 foot of freeboard would be required for such ponds. This requirement would be specific to System No. 9 because the deep injection well is available as back-up in the event pond levels would reach their maximum.

For control of mosquito breeding habitat and aquatic weed growth, the FDER recommends bank side slopes within a range of 3:1 to 1:1 (horizontal to vertical). The minimum recommended pond depth is 18 inches.

Tanks

Steel or concrete tanks are a feasible means for storage of reclaimed water. However, the cost of constructing these facilities is relatively high.

GROUNDWATER MONITORING

According to the FDER, at a minimum, one groundwater monitoring well is required in the vicinity of each storage pond. If there is a groundwater gradient in the area, the well must be placed down-gradient from the pond.

Additional groundwater monitoring wells may be required around storage ponds and/or within an irrigation area. However, the FDER has indicated that land application sites located a safe distance from drinking water supply well fields will probably not require additional monitoring wells.

BUFFER ZONES

Buffer zones are required between land application areas and surface waters, drinking water supply wells and developed areas. A minimum 500-foot buffer zone is recommended between the periphery of land application sites and shallow water supply wells and Class I potable supply waters. This buffer zone may be reduced to 200 feet for systems designed for restricted public access and 100 feet for systems designed for unrestricted access where Class I potable water supplies are not present. Buffer zones for application sites adjacent to surface waters are reviewed by the FDER on a case-by-case basis to assure that the water quality standards of those waters are not violated.

Buffer zones between the land application site and developed areas are also reviewed by the FDER on a case-by-case basis. Factors affecting buffer zone requirements include method of application, prevailing wind direction, and the presence of shrubs, trees, or windbreaks around the site. Most golf courses in the System No. 9 service area would probably require little or no modification to comply with the buffer zone requirements. A key consideration will be if aerosol drift from sprinkling operations carries over to developed areas. Spray irrigation and aerosol drift are not allowed to reach within 100 feet of outdoor public eating, drinking, or bathing facilities.

OTHER REQUIREMENTS

Other requirements for properly designed irrigation systems carrying reclaimed water include the following:

- the irrigation system should be designed to prevent clogging by algae

- all exposed pipes, application/distribution facilities and appurtenances should be labeled "non-potable"

- spray equipment should be installed or modified to minimize aerosol carry-over to buffer zones

- hose bibbs, spigots or other hand-operated connection cannot be present

PERMIT REQUIREMENTS

In Palm Beach County, permits for land application must be obtained from the FDER. The FDER's permit application review process includes review by the SFWMD and the Palm Beach County Health Department (PBCHD).

The SFWMD reviews the project to determine its impact on adjacent surface waters. The SFWMD requires that ponds used for storage of reclaimed water have no direct hydraulic connections to other surface waters. The PBCHD has adopted the FDER regulations for land application systems and does not have any supplemental requirements.

The user does not need a construction or operating permit for the land application site or irrigation system. Based on discussions with FDER representatvies, the users's storage facility must be included in the PBCWUD's operating permits for WWTP 9N and 9S. The purpose of this requirement is to make the reclaimed water system operator responsible for the monitoring and control of the water levels within the user's storage facility. The FDER's primary concern is the prevention of overflows due to the system operator not monitoring or controlling the delivery of the reclaimed water. The FDER will also require the

PBCWUD to be responsible for obtaining and reporting groundwater quality information from the user's groundwater monitoring wells.

Other than the above requirements, the FDER will not require the PBCWUD to be responsible for operation or maintenance of the storage facility, irrigation system or the application site.

SUMMARY

Table 4-4 presents a summary of the regulations discussed herein. This information is abridged from the Florida Administrative Code Chapter 17-6 and the FDER guidelines on land application. Some information was provided by local FDER representatives. Individual users should thoroughly review these documents and consult FDER officials for information specific to their system.

Table 4-4
SUMMARY OF KEY REGULATIONS
PERTAINING TO SLOW-RATE LAND APPLICATION SYSTEMS

Factor	Regulation or Guideline
Hydraulic Application Rate	Less than 2 inches/week (8,000 gpd/acre).
Treatment Requirements	BOD cannot exceed 20 mg/L on annual average basis.
	Not more than 5 mg/L TSS.
	No detectable fecal coliforms (high level disinfection - total CL_2 residual $\geq$1.0 mg/L).
Sampling Requirements	(See Table 4-3)
Off-site Storage Facilities	May be unlined, earthen ponds providing seepage or percolation does not adversely impact ground or surface waters.
	Pond must be isolated and have no discharge to other surface waters such as drainage canals.
	Minimum water depth should be 18 inches.
	Minimum freeboard should be 1 foot.
	Side slopes should be between 1:3 and 1:1 (horizontal to vertical).
Groundwater Monitoring	A minimum of 1 monitoring well will be required near storage ponds.
	Additional monitoring wells may be required around the pond and/or within the application area.
Buffer Zones	500 foot minimum between periphery of application area and shallow water supply wells and Class I waters.
	May be reduced to 200 feet in unrestricted public areas and 100 feet in restricted areas providing Class I reliability is met.
	Application sites adjacent to developed areas will be reviewed individually to establish buffer zone requirements. Aerosol carry-over must be prevented.

Table 4-4 (Continued)

Factor	Regulation or Guideline
Buffer Zones (Con't)	100 foot minimum from spray and aerosol drift to outdoor public eating, drinking, or bathing facilities.
Public Notification	Shall be done by public mailing, strategically placed warning signs and/or other approved method.
Other	The irrigation system should be designed to prevent clogging by algae.
	All exposed pipes, application/distribution facilities and appurtenances should be labeled "non-potable".
	Spray equipment should be installed or modified to minimize aerosol carry-over to buffer areas.
	Hose bibbs, spigots or other hand-operated connections cannot be present.

EXISTING FACILITIES

Section 5
EXISTING FACILITIES

This Section describes the processes following secondary treatment at WWTP's 9N and 9S. These processes include filtration, disinfection, and effluent pumping and transmission.

WWTP 9N

WWTP 9N was constructed in 1979 and has a design capacity of 4.5 mgd. Treatment processes at WWTP 9N include preaeration, activated sludge (contact-stabilization), clarification, filtration, disinfection and underground injection of final effluent. A schematic process flow diagram for the WWTP 9N effluent processing system is shown on Figure 5-1.

FILTRATION

Filtration is provided by 6 gravity filters manufactured by Infilco-Degremont, Inc. Each filter unit consists of 3 individual cells. The surface area of each cell is 96 square feet and the total filter surface area of the 6 units is 1,728 square feet. Based on a design filtration rate of 2.0 gallons per minute per square foot (gpm/ft.^{2}), the average day filtration capacity at WWTP 9N is 3,145 gpm or 4.53 mgd. This matches the design capacity of the treatment plant.

DISINFECTION

Disinfection is accomplished by chlorination upstream and downstream of the filters. During normal operations, 5 mg/L of chlorine solution is fed at each of these two points for a total dosage of 10 mg/L. The chlorine residual in the

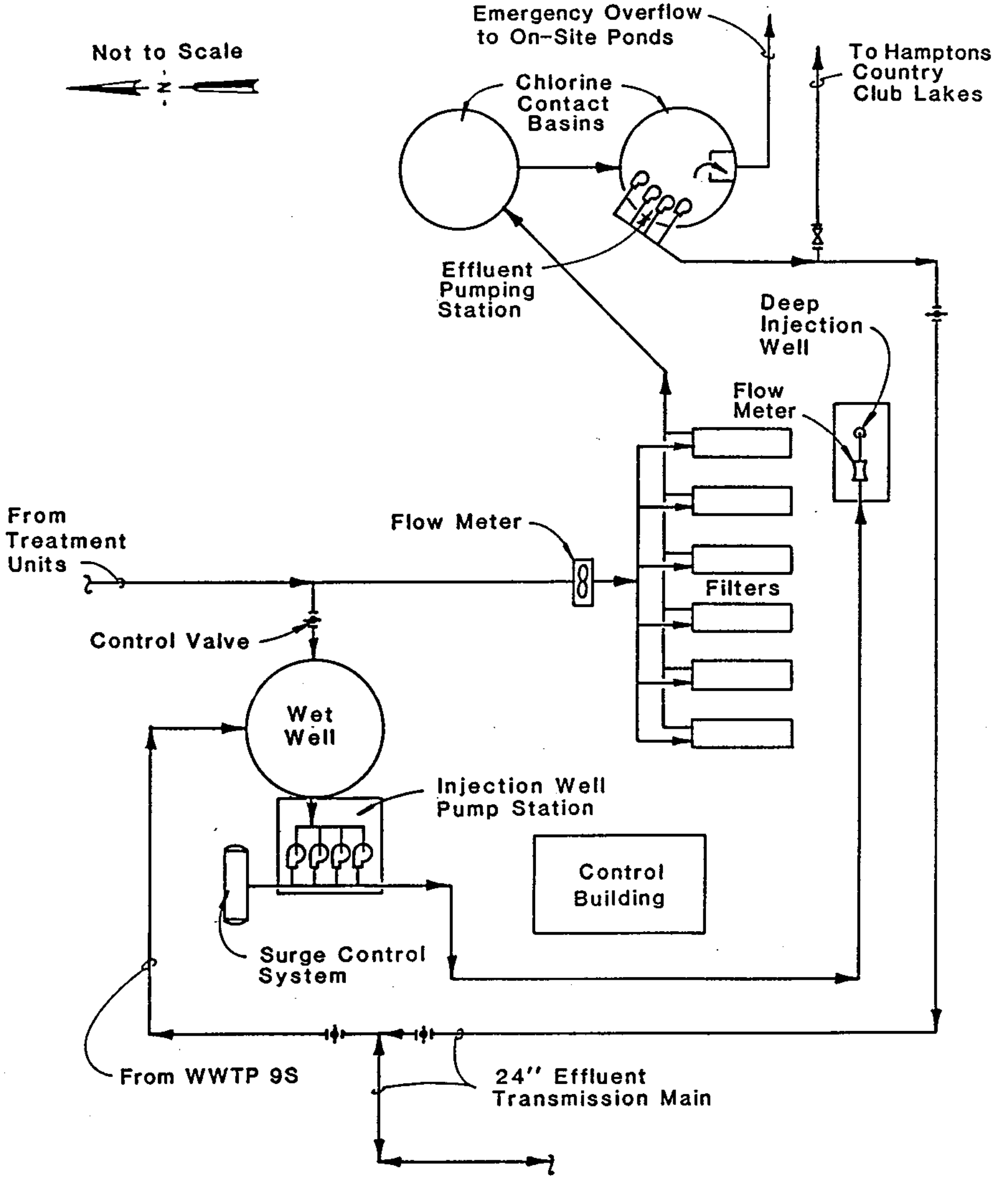

FIGURE 5-1
WWTP 9N Effluent Pumping System

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effluent is consistently greater than 1.0 mg/L; meeting the criteria for high level disinfection by the FDER. Chlorination facilities include four 500-lb/day chlorinators with a combined capacity of 2,000 lbs/day.

EFFLUENT PUMPING AND TRANSMISSION

Flow from the secondary clarifiers can follow one of two flow paths as follows:

1. enter the injection pump station wet well for underground injection, or;

2. receive advanced treatment through filtration and disinfection.

Filtration and disinfection is employed only when the effluent is to be reused on-site. A small percentage of the plant flow is currently used for site irrigation, washdown, chlorine solution makeup and pump seal water. This flow is filtered, disinfected and then pumped from the chlorine contact tank to a nearby hydropneumatic tank.

Effluent which is not reused is disposed of by underground injection. As shown on Figure 5-1, effluent from the secondary clarifiers enters the injection pump station wet well for disposal. The wet well is a converted above-grade steel tank that was formerly used for alum coagulation treatment. The tank is 80-feet in diameter with 12-foot sidewall height. The wet well also receives effluent from WWTP 9S for underground injection.

The injection pumping station is capable of pumping the total flow from both plants to the injection well for disposal. The injection well station consists of 4 pumps with the following characteristics:

Pump No.	Motor Horsepower	Design Capacity
P-01-1-1	100	3,000 gpm @ 96'
P-01-2-1	50	1,400 gpm @ 104'
P-01-1-2	100	3,000 gpm @ 96'
P-01-2-2	50	1,400 gpm @ 104'
	Total	8,800 gpm or 12.7 MGD

Provisions have been made at the pump station for additional pumps should they be needed in the future.

Prior to the deep injection well becoming operational, WWTP 9N effluent was pumped to a lake system within the Hamptons Golf Course and the housing developments of Century Village and American Homes. The PBCWUD was required by FDER to stop discharge to the lakes system when it was discovered that water from the lakes was discharging continuously to adjacent drainage canals in violation of the plant's operating permit. This discovery led to implementation of the deep injection well system.

The lake system pumping station, which is still operable, consists of 4 vertical turbine pumps with 50 horsepower motors mounted at the chlorine contact tank of WWTP 9N. The four units are identical, each with a design capacity rating of 2,000 gpm at 70 feet of system head. The design head of these pumps is relatively high for a surface water discharge system. However, they are required because the discharge pipeline is only 12 inches in diameter and substantial pressure loss is incurred due to its limited capacity. Effluent disposal to the lakes system is permitted for emergency use only.

WWTP 9S

WWTP 9S has a design capacity of 3.0 mgd and is similar to WWTP 9N in design and operation. Treatment processes include, preaeration, activated sludge (contact-stabilization), filtration and disinfection. The plant was initially constructed in 1969 and has been expanded in phases. A schematic process flow diagram for the WWTP 9S effluent pumping system is shown on Figure 5-2.

FILTRATION

Filtration is provided by 4 gravity filters manufactured by Infilco-Degremont, Inc. Each filter unit consists of 3 individual cells. The surface area of each cell 96 square feet and the total filter surface area is 1,152 square feet. Based on a design filtration rate of 2.0 gpm/ft², the average day filtration capacity at WWTP 9S is 2,304 gpm or 3.3 mgd.

DISINFECTION

Disinfection is accomplished by chlorination at 4 points in the plant flowstream. These 4 points are the raw influent force main, the contact chamber in the treatment units, the effluent weir in the treatment units and the influent pipe to the chlorine contact tank. Currently, the total chlorine dose averages 8.0 mg/L. The chlorine residual is consistently greater than 1.0 mg/L.

Chlorination facilities include one-500 lb/day chlorinator serving the raw influent force main, two-100 lb/day

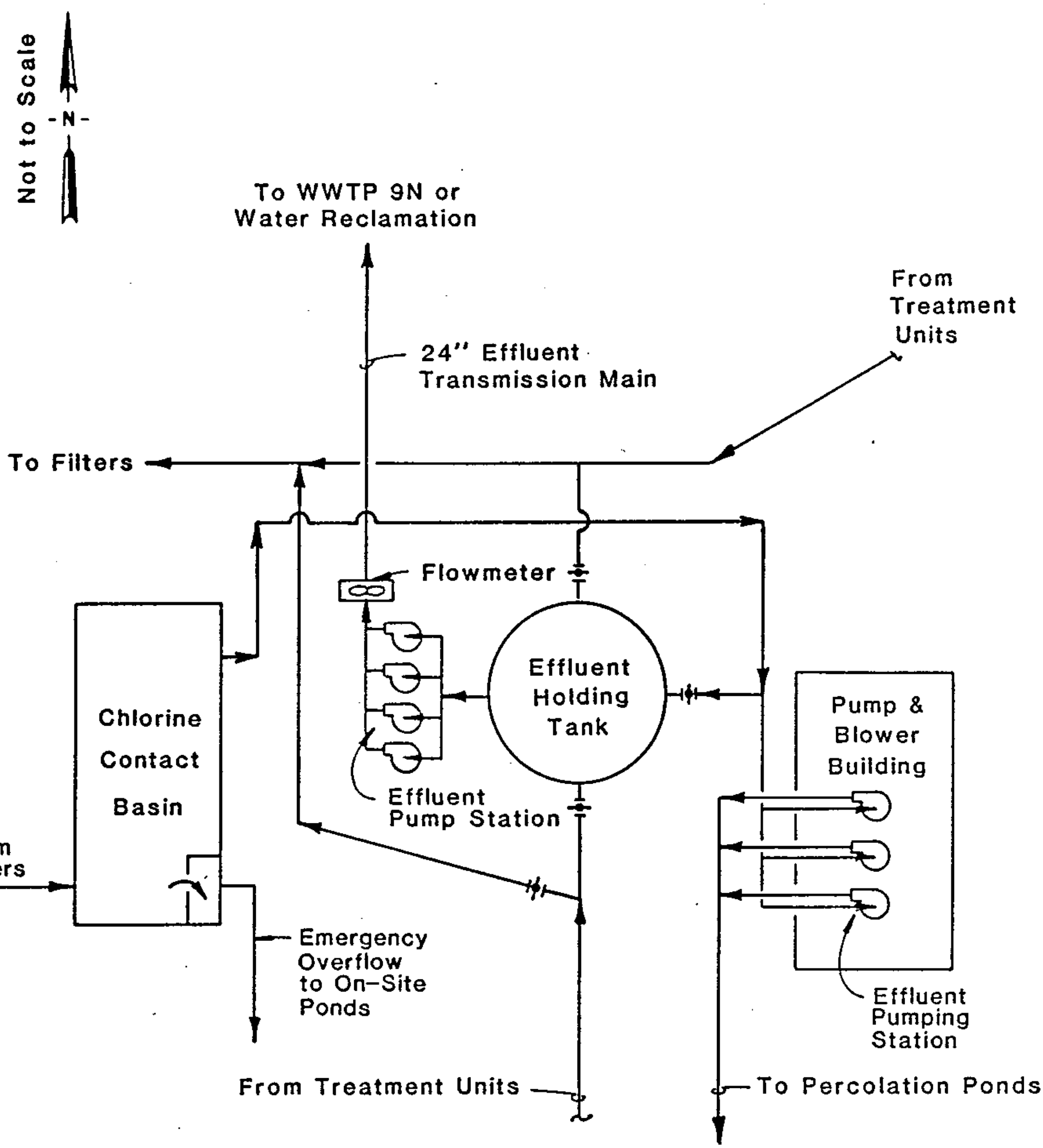

FIGURE 5-2
WWTP 9S
Effluent Pumping System

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chlorinators serving contact chambers in treatment units, two-50 lb/day chlorinators serving the weirs in the treatment units and one-500 lbs/day chlorinator serving the chlorine contact tank. The total chlorinator capacity is 1,300 lbs/day. Current chlorine usage averages 100 lbs/day.

EFFLUENT PUMPING AND TRANSMISSION

As shown in Figure 5-2, all flow from WWTP 9S is filtered, disinfected and pumped to WWTP 9N for underground injection. The effluent is transported to WWTP 9N via a 24-inch diameter ductile iron pipeline routed along S.W. 3rd Street and U.S. 441 (State Road 7). At WWTP 9N, the pipeline outfalls into the injection pump station wet well. The FDER requires that this transmission main carry only advanced secondary effluent. This requirement is based upon the plan to use this main for supplying golf courses with treated effluent for use in irrigation.

The WWTP 9S effluent pump station consists of 4 pumps with the following sizes:

Pump No.	Motor Horsepower	Design Capacity
P-02-1-1	15	1,400 gpm @ 30' TDH
P-02-1-2	15	1,400 gpm @ 30' TDH
P-02-1-3	15	1,400 gpm @ 30' TDH
P-02-1-4	15	1,400 gpm @ 30' TDH
	TOTAL	5,600 gpm or 8.1 mgd

Prior to construction of the deep injection well at WWTP 9N, effluent disposal at WWTP 9S was accomplished by discharge to percolation ponds. The ponds cover 24 acres and have a capacity of 1.54 mgd. At higher flows, effluent overflow to adjacent surface drainage canals was occurring in violation of the plant's operating permit.

The percolation pond pumping station consists of three horizontally-mounted centrifugal pumps equipped with 60 horsepower motors. The three units are identical, each with a design capacity rating of 1,550 gpm at 40 feet. The percolation pond disposal system is still operable and is permitted for alternate disposal.

FACILITY IMPROVEMENTS AND OPERATIONS PLAN

Section 6
FACILITY IMPROVEMENTS AND OPERATIONS PLAN

To provide service to the users listed in the assumed phased service plan presented in Section 3, new facilities will be needed. Identification of piping improvements was accomplished by computer analysis of the effluent transmission system using the NETWK (Network) program. Information on the program and the specific analyses are presented in Appendix A.

TRANSMISSION, PUMPING AND STORAGE

TRANSMISSION

During 1987, assumed to be the first year of operation, the potential users listed in the assumed phased service plan would be served by pipeline extensions from the existing State Road 7 effluent transmission main and extensions from the existing effluent transfer main between WWTP 9N and the Hamptons Country Club lake system. An estimate of the length and diameter of the pipeline extensions cannot be made at this time since the location of the user's storage facility has not been determined. For planning purposes, a 12-inch diameter pipe may be adequate for most extensions to individual users.

Once the location of the user's storage facility is determined, the pipe size can be determined by utilizing the NETWK computer program for analyzing piping and pumping system described in Appendix A. The example analyses presented in Appendix A are based on pipeline extensions to the users property line.

PUMPING

During the first year of operation, the users listed in the assumed phased service plan could be served by the existing

WWTP 9S effluent transfer pump station and the existing WWTP 9N effluent transfer pump station which formerly pumped to the Hamptons Country Club lake system. Users along State Road 7 would be served by the WWTP 9S pump station and users along Lyons Road, including the Hamptons Country Club, Century Village, American Homes, and the Boca Raton Municipal Golf Course, would be served by the existing WWTP 9N pump station.

During the second year of operation, projected demands from the Mission Bay development would increase to the point that WWTP 9S would not have adequate flow to continue serving Boca Greens. Service to Boca Greens could be picked up by WWTP 9N. A new pump would be needed at the WWTP 9N chlorine contact basin for service to Boca Greens. Eventually, this pump station would also assist WWTP 9S in meeting projected demands from the Mission Bay development.

For the remainder of the 5-year assumed phased service plan, no other pumping improvements are anticipated. The NETWK program should be utilized to evaluate existing pumps and size new pumps once the specific characteristics of each potential user's systems are known.

STORAGE

Each user would need to provide a storage facility for receiving and storing reclaimed water. The storage facility is needed because the existing PBCWUD facilities are not capable of delivering each user with this required flow during the typical, evening irrigation period. Reclaimed water will be delivered to the user's storage facility and withdrawn as needed.

The storage system would need to comply with state and local regulations as outlined in Section 4. Ponds containing effluent must be isolated from other ponds that connect to drainage canals or other surface waters. It is likely that some site work would be required to comply with these regulations. Storage facilities may include lined or unlined earthen ponds or steel or concrete tanks. Unlined ponds present the lowest initial cost but have the disadvantage that some of the effluent would be lost by percolation into the ground. Lined ponds have a higher capital cost but are not subject to water loss due to percolation.

The highest capital cost alternative is a steel or reinforced concrete storage tank. A tank sized to hold 500,000 gallons would require a 14-foot sidewater depth and be 78 feet in diameter. Concern about groundwater and surface water contamination would be eliminated, however.

MONITORING AND CONTROL

EFFLUENT DISTRIBUTION

It is proposed that the delivery of effluent to the users' storage facilities be performed on a sequential basis where only one user at a time would be served from each independent pumping and transmission system. When the user has received his allotment of effluent, the valve serving his site would be closed and the next user's valve would be opened. This sequence would be continued until all users had been served.

A sequential service system would be easier to operate and maintain than a system that delivers to all users at all times. The latter system would require rate-of-flow control systems at each user's site to assure an equitable distribution of the water. Monitoring and control of sequential effluent distribution system could be performed either manually or by remote telemetry.

MANUAL MONITORING AND CONTROL

Manual control would require an operator to visit each site at least twice per day -- once to open the valve on the delivery pipe and once to close the valve when the user had received his daily allotment of effluent. It is likely that additional staff would be needed to operate the effluent distribution system because current treatment plant operators and field personnel already have responsibility to their respective systems and would not be available to take on additional workload. For 24-hour operation, at least two, and possibly three, full-time operators would be needed to make the frequent site visits required for monitoring and control of effluent delivery. Due to the high, continuing cost of labor, manual monitoring and control is not recommended.

REMOTE MONITORING AND CONTROL

Remote monitoring and control could be accomplished with radio-based two-way telemetry system. This system would allow an operator to monitor and control effluent distribution from one central location. For System No. 9 the preferable location would be WWTP 9N. The system would be comprised of a central telemetry unit (CTU) at WWTP 9N and a remote telemetry unit (RTU) at each user's site.

Remote Stations

At each user's site, a local control station would be required. The station would consist of a flow meter, electrically-actuated control valve, an RTU capable of receiving and transmitting radio signals, and an antenna. At the site the operator would be able to perform the following tasks:

- Set the control valve in an OPEN-CLOSE-AUTOMATIC mode. In the automatic mode, the valve would be controlled from the CTU. The OPEN-CLOSE modes would allow control of the valve from the local site. In addition, the valve would be equipped with a clutch to permit manual operation.

- Read the instantaneous flow rate and totalized flow rate to the user.

The effluent pumps are controlled on wet well liquid level and, depending on plant flow, may not run continuously. If a pump would shut off while one of the local user valves were open, the valve would stay open until the pump came back on and the set quantity of water had been delivered. Thus, the flow to the user's local pond might not be continuous.

Based on the assumed phased service plan, there will be 6 RTU stations initially, assuming the Hamptons/Century Village/American Homes systems are served by one RTU. At this time it is not possible to accurately predict the number of ultimate users on the system. However, based on the number of potential users identified in Section 3, 15 to 20 does not appear unreasonable.

Central Station

The central control station would consist of a small mini-computer with CRT screen, keyboard, dual floppy disc drive, printer and base radio station. These facilities comprise the CTU. Most of the central equipment could be mounted on a desk top as graphically depicted on Figure 6-1.

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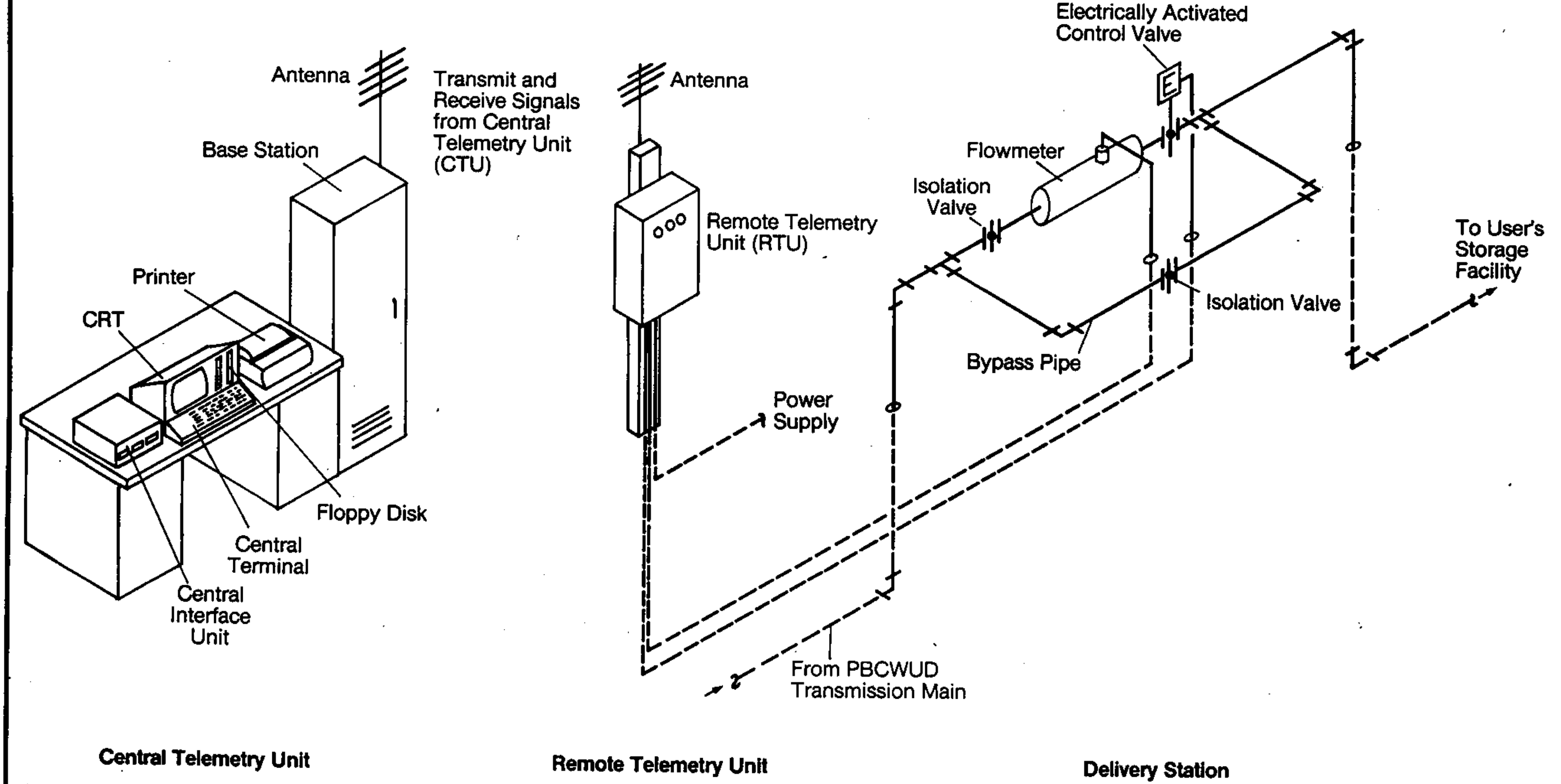

FIGURE 6-1.
Remote Telemetry Facilities.

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The main operator interface to the system would be through the CRT and keyboard. Monitoring data available to the operator would include the status, opened or closed, of each valve at the remote stations, and the instantaneous and totalized flow rate to each user. Control functions available through the keyboard would include programming the sequential order of delivery, and opening and closing valves at the remote stations.

The normal sequence of the control monitoring and control system would be as follows:

1. Sequence initiate.

2. Open user No. 1 valve.

3. Begin delivering flow to user No. 1. Totalize the flow.

4. When the quantity of water delivered equals the set point in gallons, open user No. 2 valve.

5. When user No. 2 valve is open, close user No. 1 valve.

6. Continue to the end of sequence and hold until next cycle.

The sequence as outlined above is based upon water volume delivered. It is recommended that this type of control system also be capable of operating based upon a time-of-day timer. The sequence of service could remain the same but the activation of valve changes would be set by the timer. This mode of operation is advantageous because it would enable delivery of all the effluent to users' sites regardless of variations in the treatment plant daily flow rates. Another advantage would be that both the plant operators and the users would have a firm schedule of delivery times.

Data on the daily and monthly volume of effluent delivered to each user would be available to the operator through the CRT screen, as well as a printout from the printer. The printer would also function as a status change/alarm device, provide permanent records showing user name, alarm condition or status change event, date and time, as well as return-to-normal messages. The primary functions of the disc drive are to record all alarms, events, control actions, operator entries, and load the operating program and data base.

Two-way communication would be needed between each remote station and the central station. The system would need to be fairly reliable, but backup systems such as redundant backup computers or base station radios would not be required. The system could be down for a day or two without major problems. It would be desirable to detect if the communication between the local station and central had failed. However, the communication and/or control system can fail for a few days with no major impact. Manual control of the valves locally would be required in the event that the communication and control system were not operating.

Storage Water Level Monitoring

A method for remote monitoring of the water level in the User's storage facility should also be provided. A simple, float-type switch should be adequate for most applications. The switch would be set to activate an alarm at the CTU whenever the water level in the storage facility reached the design high water level. The operator at the CTU would then divert flow to another user or the deep injection well and, thus avert an overflow occurrence at the storage facility.

OTHER FACILITIES

A continuous, automatic turbidimeter would be required by the FDER at the chlorine contact tank of each treatment plant. Accessories would include a small pump to deliver effluent samples to the turbidimeter, and an alarm device to indicate high turbidity levels. The turbidimeter and accessories will require housing in a water-tight field panel.

SUMMARY

The following facilities would be required for implementation of the PBCWUD water reclamation system:

1) Piping - pipe extensions from 24-inch effluent transmission main along State Road 7 and the 12-inch effluent transfer main at WWTP 9N to user's storage facility.

2) Pumping - low-head pump station at WWTP 9N to serve users along State Road 7.

3) Storage - facility at each user's site to receive and store reclaimed water.

4) Remote telemetry system - radio-based telemetry system to enable operator at WWTP 9N to monitor and control reclaimed water delivery to each user. Facilities to include CTU, RTU's, and flowmeter/valve station at each user's site. System would also be capable of monitoring water level in user's storage facility.

5) Automatic turbidimeters at each WWTP to monitor turbidity levels in final effluent.

POLICY RECOMMENDATIONS

Section 7
POLICY RECOMMENDATIONS

It is recommended that the PBCWUD develop policies which will establish uniform guidelines and conditions for providing reclaimed water service. Presented below are recommended items of policy which the PBCWUD should consider. The policies presented are oriented towards large-scale reclaimed water users such as golf courses. This list is intended to be a guide and should be modified to suit the PBCWUD's specific requirements.

DESIGN AND CONSTRUCTION

1. The User shall be responsible, and bear all costs, for the design and construction of all facilities required to provide reclaimed water service to his property. Such facilities shall include, but not necessarily be limited to, pipeline extensions from the PBCWUD forcemain, valves, meters, remote telemetry stations, onsite storage facilities, site and modifications, and associated cost items.

2. Design and construction practices shall be in accordance with PBCWUD standards. Drawings and specifications for all facilities connected to PBCWUD facilities shall be reviewed and approved by the PBCWUD prior to construction. The PBCWUD reserves the right to inspect construction for conformance with said approved drawings and specifications as it deems necessary.

3. The User's design of onsite facilities shall be based on hydraulic criteria provided by the PBCWUD.

4. The User is responsible for the design and construction of all irrigation facilities on his property.

5. The User is responsible for the design and construction of all new and modified facilities, including sitework, and is required to comply with local, state and federal regulations.

PERMITTING

1. The User shall prepare drawings and specifications for construction of new facilities and prepare other documentation, as required by the permitting agencies and furnish these documents, at the User's cost, to the PBCWUD. The PBCWUD will then be responsible for submitting the permit application package to the permitting agencies for the purpose of obtaining a construction permit.

2. At the completion of construction, the User shall prepare record drawings and other documentation, as required, and furnish this documentation at the User's cost, to the PBCWUD. The PBCWUD will then be responsible for submitting the permit application package to the permitting agencies for the purpose of obtaining an operating permit.

OPERATION AND MAINTENANCE

1. The PBCWUD shall be responsible for providing reclaimed water which complies with the water quality requirements contained in the Florida Department of Environmental Regulation Rule Chapter 17-6, Florida Administrative Code.

2. The PBCWUD shall be responsible for operation and maintenance of the treatment, pumping, and transmission system up to the point of delivery (connection to user's storage facility). PBCWUD operation and

maintenance responsibility shall include the meter, control valve, and remote telemetry station. Beyond the point of delivery, the User bears all responsibility for operation, maintenance, and compliance with regulations and permit requirements with the exception that the PBCWUD will be responsible for controlling delivery of reclaimed water and preventing storage facility overflows.

3. Should the User require reclaimed water at different pressures, or different quality, or in any way different from that normally supplied by the PBCWUD, he shall be responsible for the necessary devices to make these adjustments and obtaining approvals as needed.

4. The PBCWUD reserves the right to deliver reclaimed water to the User's storage facility at any time during a 24-hour period. The delivery time may not coincide with the irrigation period.

5. The PBCWUD reserves the right to temporarily discontinue service to any portion of, or the entire, reclaimed water system, as deemed necessary by the PBCWUD.

6. Minimum quantities to be delivered shall be established by agreement. Quantities over the minimum shall be at the PBCWUD's discretion based on availablilty.

LEGAL, FISCAL, AND ADMINISTRATIVE

1. The existence of a reclaimed water main adjacent to or near the premises of an applicant for the service does not necessarily mean that service is available to that location. New users will be added as uncommitted flow becomes available.

2. To determine the presence of any potential hazards to the public potable water system, the Palm Beach County Health Department and/or the PBCWUD shall have the right to enter upon the premises of any User. Each User of reclaimed water service shall, by application, give prior written consent to such entry upon his premises.

3. Ownership of all reclaimed water facilities up to and including the point of delivery (control valve, meter, remote telemetry station) shall be deeded to the PBCWUD. Beyond the point of delivery, the User shall retain ownership for all reclaimed water facilities.

4. All reclaimed water facilities and appurtenances, when constructed or accepted by the PBCWUD shall become and remain the property of the PBCWUD. No person shall by payment of any charges provided herein, or by causing any construction of facilities accepted by the PBCWUD, acquire any interest or right in any of these facilities, or any portion thereof, other than the privilege of having their property connected for reclaimed water services.

5. No facilities shall be installed under the provisions outlined herein and accepted by the PBCWUD for maintenance unless it is in a dedicated public right-of-way or dedicated public easement. Any new easement shall have a minimum width of twenty-five (25) feet. No obstruction of whatever kind shall be planted, built or otherwise created within the limits of easement or right-of-way without written permission of the PBCWUD. In addition, easements shall be provided to give access to the User's storage facility and groundwater monitoring wells.

6. The PBCWUD shall be responsible for obtaining rights-of-way or easements on publically-owned land.

7. All Users will enter into a formal agreement with the PBCWUD as a condition of being provided reclaimed water service.

8. User rates shall be reviewed annually and adjusted as necessary based on the prescribed cost-of-service methodology.

ECONOMIC CONSIDERATIONS

Section 8
ECONOMIC CONSIDERATIONS

This section presents an estimate of the costs of the reclaimed water system for PBCWUD System No. 9. An estimate of the user cost per thousand gallons is presented based on the assumed water sales shown in Section 3.

COST CATEGORIES

The costs for reclaimed water service are divided into three main categories:

1. Capital
2. Operation and Maintenance
3. Administrative and General

These costs are discussed individually in the following paragraphs as they pertain to the PBCWUD reclaimed water system.

CAPITAL COSTS

Capital costs represent costs for the construction of new facilities or modifications to existing facilities. As stated in Section 7, it would be the PBCWUD's policy that the capital outlay for facilities that directly benefit an individual user should be borne by that user. Examples of such facilities include pipeline extensions, meters, control valves, remote telemetry stations, onsite storage systems, and irrigation system improvements.

It is recommended that the PBCWUD finance and administer the construction of capital expenditures for those facilities which benefit the water reclamation system as a whole.

These facilities, presented in Section 6, include the following:

1. The Central Telemetry Station at WWTP 9N

2. Two new pumps at WWTP 9N with yard piping improvements.

3. Two new automatic turbidimeter stations at each WWTP.

OPERATION AND MAINTENANCE COSTS

The PBCWUD would be responsible for operation and maintenance (O&M) of the wastewater treatment, pumping, and transmission system up to and including the reclaimed water delivery station at each user's site. O&M costs directly attributable to the reclaimed water system include:

1. Labor - effluent filtration systems, air compressors (for pneumatic operation of filter valves), remote telemetry system, effluent pumping and water quality sampling and testing.

2. Electricity - filtration systems, air compressors, effluent pumps.

3. Chemicals - chlorine

4. Miscellaneous - replacement parts, outside laboratory testing services.

The items listed above represent operation and maintenance labor and expense required solely for the purpose of providing the required advanced treatment and delivery of the reclaimed water.

ADMINISTRATIVE AND GENERAL COSTS

Administrative and general (A&G) tasks include the following:

1. Fiscal - meter reading, billing, accounting
2. Engineering - plan review, construction inspection, liaison and coordination
3. Legal - agreement preparation, easement acquisition

COST RECOVERY

Recovery of capital, O&M, and A&G costs can best be accomplished through a user charge rate system. A user charge for reclaimed water can be developed by dividing the total sum of the annual costs for debt service on capital improvements, O&M and A&G by the total annual volume of reclaimed water sold. This calculation yields an estimate of the cost per volume of reclaimed water sold and is expressed in terms of dollars per 1,000 gallons. The user charge concept is equitable because each user pays an amount equal to his pro rata share of the cost to construct and operate the system.

Cost estimates for each of the annual cost items are presented below. Assumptions used in developing these costs are presented in Appendix B.

CAPITAL COSTS

The estimated capital cost for new facilities, identified in Table 8-1, is $237,000. Based on financing at a 10-percent interest rate for a period of 20 years, the estimated annual cost for debt service is $27,900.

Table 8-1
ANNUALIZED COST FOR CAPITAL IMPROVEMENTS[1]

Facility	Capital Cost	Annual Cost[2]
Central Telemetry Station	$ 100,000	$ 11,800
Pumps and yard piping at WWTP 9N	125,000	14,700
Automatic Tubidimeter Stations	12,000	1,400
TOTAL	$ 237,000	$ 27,900

[1]Assumptions are presented in Appendix B.

[2]Annual cost based on interest rate of 10% for period of 20 years, purchase in 1987.

O&M AND A&G COSTS

The estimated O&M costs for the reclaimed water system are given in Table 8-2. Costs have been estimated for each year of the five-year period 1987 through 1991.

Annual A&G costs are also presented in Table 8-2. It was assumed that A&G costs are 20 percent of the annual O&M costs. This percentage is based upon typical values for other utility systems.

USER CHARGE ESTIMATE

Table 8-3 presents an estimate of the user charge rate for the PBCWUD to provide reclaimed water service. The average annual user charge is estimated to be $0.12/1,000 gallons. Projections of annual water sales are based on the assumed phase service plan presented in Section 3.

This estimate is presented for the purpose of assessing the feasibility of the water reclamation system. It should be noted that the $0.12/1,000 gallons use charge estimate is based on selling most of the available wastewater from the System No. 9 WWTP's. Lower than assumed sales will result in higher unit costs.

ANNUAL CHARGE ESTIMATE

Table 8-4 presents an estimate of the annual user charge which would be billed to users with varying amounts of consumption. It should be noted that these estimated charges do not include the cost of facilities constructed and operated by the user.

Table 8-2
ANNUAL O&M AND A&G COSTS

Item	Annual Cost 1987	1988	1989	1990	1991
O&M					
Labor	$ 74,300	$ 78,100	$ 82,000	$ 86,100	$ 90,400
Parts/Replacement	17,800	18,700	19,700	20,700	21,700
Electricity	33,600	38,800	40,700	48,600	55,900
Chemicals	18,500	22,400	26,300	27,700	28,300
Subtotal	$144,200	$158,000	$168,700	$183,100	$196,300
A&G	$ 14,900	$ 15,600	$ 16,400	$ 17,200	$ 18,100
TOTAL	$159,100	$173,600	$185,100	$200,300	$214,400

Table 8-3
PRELIMINARY USER CHARGE ESTIMATE

Item	Annual Cost 1987	1988	1989	1990	1991
Debt Service	$ 27,900	$ 27,900	$ 27,900	$ 27,900	$ 27,900
Operation and Maintenance	144,200	158,000	168,700	183,100	196,300
Administration and General	14,900	15,600	16,400	17,200	18,100
SUBTOTAL	$187,000	$201,500	$213,000	$228,200	$242,300
Annual Reclaimed Water Sales[1] (in million gal.)	1,600	1,740	1,870	2,000	2,120
User Charge Estimate[2] ($/1,000 gal.)	$ 0.12	$ 0.12	$ 0.11	$ 0.11	$ 0.11

[1] Based on assumed phased service plan presented on Table 3-3

[2] User Charge = Annual Cost ÷ Water Sales

Table 8-4
PRELIMINARY ESTIMATE OF ANNUAL CHARGE

Reclaimed Water Usage (gal/day)	Estimated Annual Charge[1]
100,000	$ 4,380
200,000	8,760
300,000	13,140
400,000	17,520
500,000	21,900
750,000	32,850
1,000,000	43,800
1,500,000	65,700
2,000,000	87,600

[1]Based upon $ 0.12/1,000 gallons

FEASIBILTY ASSESSMENT

Section 9
FEASIBILITY ASSESSMENT

The feasibility of the reclaimed water system was assessed by evaluating feasibility in each of the five categories listed below:

1. Technical - Is the project physically capable of performing its intended function?
2. Economic - Do the project's benefits exceed its costs and is the project the least cost alternative?
3. Financial - Can the project's capital, O&M and A&G costs be funded?
4. Political - Can the project meet legal and regulatory requirements?
5. Social - Are potential users and the general public in favor of the project?

TECHNICAL

From a technological perspective, no components of the proposed water reclamation system present unusual difficulties. Water quality requirements for land application are currently being met by both treatment plants. Delivery of reclaimed water can be accomplished by pipeline extensions and installation of a pump station at WWTP 9N. At each user's site, a receiving and storage facility and delivery station consisting of a flow meter, RTU and control valve are required.

Each user's application site would be evaluated to determine what modifications would be needed to comply with the regulations on land application systems. In most cases, the anticipated modifications would not be technically difficult.

ECONOMIC

The proposed system would be economically feasible if 1) the benefits resulting from the reclaimed water project exceed the costs, and 2) there is no cheaper method of accomplishing similar results. Some benefit is obtained from the nitrogen and phosphorus content of the reclaimed water. In St. Petersburg, Florida it has been reported that the reclaimed water provides up to 50 percent of the nutrient requirements of turf grasses. The South Florida Water Management District (SFWMD) estimates the value of the treated wastewater, calculated in terms of reduced fertilization and application costs, to be $0.05 per thousand gallons. The estimated user charge presented in Section 8 is $0.12 per thousand gallons. Thus, the net cost to users may be as low as $0.07 per thousand gallons.

Although this is some cost benefit from the nutrient content of treated wastewater, it is safe to assume that any savings in fertilizer costs would not be great enough to offset the total cost, including capital improvements, of the reclaimed water. Therefore, the project is not economically feasible based on fertilizer benefits alone.

The primary objective of water reclamation in the System No. 9 service area is to provide an alternative to the fresh water supply currently used for irrigation of golf courses, lawns, parks and nurseries. The most cost-effective, acceptable, alternative is treated wastewater, although it can only satisfy a fraction of the total irrigation demand.

Fresh water supplies in South Florida are susceptible to contamination by salt water, encroaching from coastal areas, and hazardous materials, leaching into water supplies from improper waste disposal practices. Exploitation of the fresh water resource today may have a negative economic impact on future generations if they have to pay the cost for obtaining fresh water from distant, uncontaminated, supply sources or implement sophisticated treatment processes to remove contaminants.

Within the context of resource management, water reclamation within System No. 9 may be economically feasible in the future. However, for the near future, there does not appear to be any serious threats to water supplies in the System No. 9 service area. As long as an adequate supply of groundwater and surface water exists, a reclaimed water system to serve the System No. 9 service area does not appear to be economically feasible.

FINANCIAL

Financial feasibility is dependent upon the ability of the PBCWUD and the Users to finance their respective components of the reclaimed water system. The PBCWUD can finance construction of its portion of the system components as the capital outlay is relatively small and annual costs can be recovered through a user charge rate system.

Financing of the User's components may present some difficulties. Methods of financing will vary depending on ownership of the golf course or other irrigable property. In most cases, a financing plan could probably be developed to suit the individual requirements of each User.

POLITICAL

The political feasibility of the water reclamation project can be measured by the support given by local political leaders and the agencies responsible for regulating such projects. Local political support exists and is evident by the investment that Palm Beach County has made towards preparation of this document.

The FDER and the SFWMD also support reuse projects. These agencies are responsible for promoting the State Water Use Plan policy to promote water conservation "by use and reuse of water of the lowest acceptable quality for the purpose intended". The FDER is providing support to reuse projects by providing a flexible set of regulations and standards. The regulations facilitate reuse by defining the requirements for technical and political implementation. The FDER manual entitled "Land Application of Domestic Wastewater Effluent In Florida", has served to stimulate reuse by land application.

The SFWMD is the principal agency promoting reuse by land application. The SFWMD now requires all golf courses to determine the feasibility of obtaining and using treated wastewater for irrigation. This requirement must be met by golf course owners as a requirement for being issued a consumptive use permit. The SFWMD will exempt users that irrigate with wastewater from water use restrictions imposed during periods of water shortage.

In summary, wastewater reuse by land application appears to be politically feasible.

SOCIAL

One measure of social feasibility would be whether potential users respond favorably to the use of treated wastewater for irrigation of golf courses. During the telephone interviews of the major irrigation water users conducted during this study, the response from most golf course representatives was favorable. Golf course maintenance managers are knowledgeable of past successes from the use of wastewater for irrigation of golf course turf.

Another key component of the social feasibility evaluation is the acceptance of wastewater reuse by homeowners adjacent to irrigated areas. Any fears or concerns can probably be overcome by informing the public about existing water reclamation systems projects such as the St. Petersburg reuse system, the JDM golf course irrigation system is northern Palm Beach County, and the ENCON system in Jupiter.

CONCLUSION

A water reclamation project within the PBCWUD System No. 9 service area appearS to be feasible from all aspects except economics. Economics continues to favor irrigation from on-site ponds or ground water. More stringent state regulations or prolonged drought conditions will likely be required to entice users to join the proposed system. Thus, a dedicated, continuing effort will be required to implement the project. A summary of the key factors affecting implementation is summarized below.

FACTORS HINDERING IMPLEMENTATION

The key factors hindering implementation include:

1. Resistance by users to the cost of new facilities and user charges for reclaimed water. This is considered to be the major deterrent to project implementation.

2. Overcoming public concern over the health aspects of wastewater reuse in areas adjacent to residential development. This is not anticipated to be a major problem.

FACTORS FAVORING IMPLEMENTATION

The key factors favoring implementation include:

1. The SFWMD may, in effect, require large users of irrigation water to implement water reclamation projects by cutting back on the allowable water usage granted in their Consumptive Use Permit.

2. Major pump stations and pipelines which could provide reclaimed water to the general vicinity of some users have already been constructed. Users would not have to absorb the costs of these facilities because they were required for operation of the underground injection effluent disposal system.

3. The treated effluent contains phosphorus and nitrogen; vital nutrients to turf grasses. The benefit of treated wastewater in terms of reduced fertilizer costs is estimated at $0.05/1,000 gallons.

4. The SFWMD would exempt users from water use restrictions during periods of water shortages.

5. Fresh water supply would be reserved for uses that require high quality water.

APPENDIX A

APPENDIX A
COMPUTER ANALYSIS OF RECLAIMED WATER TRANSMISSION SYSTEM

This appendix describes the use of CH2M HILL's computer program NETWK in analyzing the reclaimed water transmission system. Included in this appendix is a general discussion of the NETWK program and the methodology used in preparing the computer files. The purpose of modelling the PBCWUD effluent transmission system is to evaluate the characteristics of the transmission system and the capability of the system to serve potential users.

HYDRAULIC ANALYSIS

GENERAL DISCUSSION

Computerized hydraulic analyses are used to predict the effects of system modifications without actually constructing the modifications in the field. The NETWK program is capable of simulating the operation of pipelines, pump station, reservoirs, and control valves. The program allows the user to evaluate unlimited combinations of facility improvements and provides the data necessary to determine the optimum method of operation.

Input

Input is the information that must be known and supplied to the computer. For purposes of this discussion, it consists of two categories:

- o Physical information, such as pipeline size, interior roughness, pump characteristic curves, and pump station location. This information describes the system's physical facilities and is known as the "model."

- System variables, such as water demands at various locations.

Output

The output of the computer analysis is the pressure at any point in the system and the flow rate and velocity within each pipe. It should be noted that the output data are not a complete analysis of system performance because the computer calculates instantaneous flow rate from the supply facilities but does not calculate whether this flow can be maintained or whether adequate storage is available for a longer period of time. These determinations must be made by the user.

SPECIFIC DISCUSSION

The following is a discussion of the methodology used in developing the computer models of the PBCWUD water reclamation system. Two models have been developed; one for the users to be served from the 24-inch transmission main along State Road 7 and one for the users to be served from the 12-inch transmission main along Lyons Road.

Pipes

For each pipe, an arbitrary number of up to 5 digits, must be input. The nodes (or junction numbers) at each end of the pipe must be input followed by its length, diameter and roughness coefficient.

The transmission pipelines, shown on Figures A-1 and A-2, show the numbered pipe segments preceded with a "P". Most of the sections are 12 or 24-inches in diameter with an assumed roughness coefficient or "C-factor" of 140. Lengths were measured from record drawings.

FC18009.F0

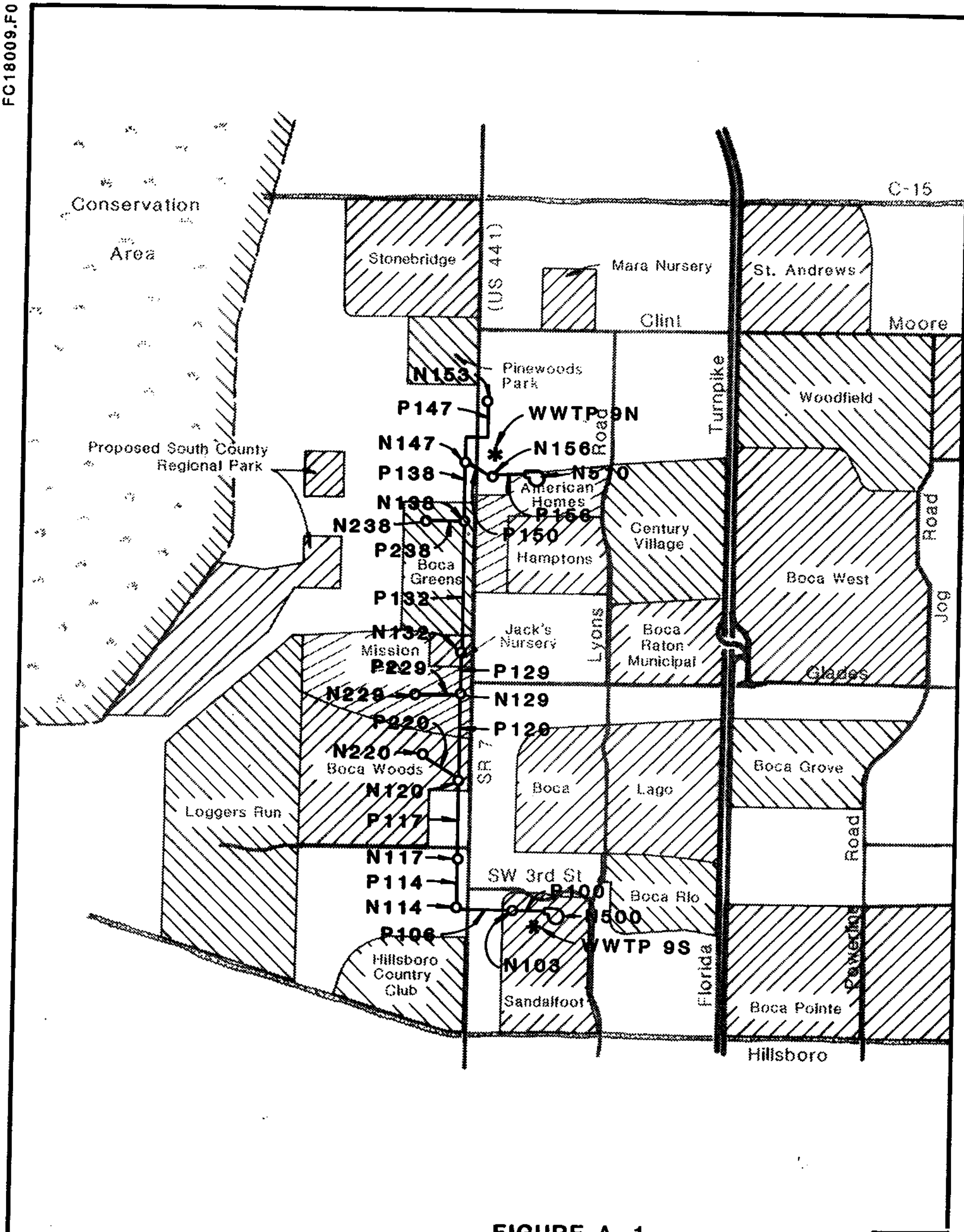

FIGURE A-1
Pipe and Node Designations
State Road 7 System

CH2M HILL

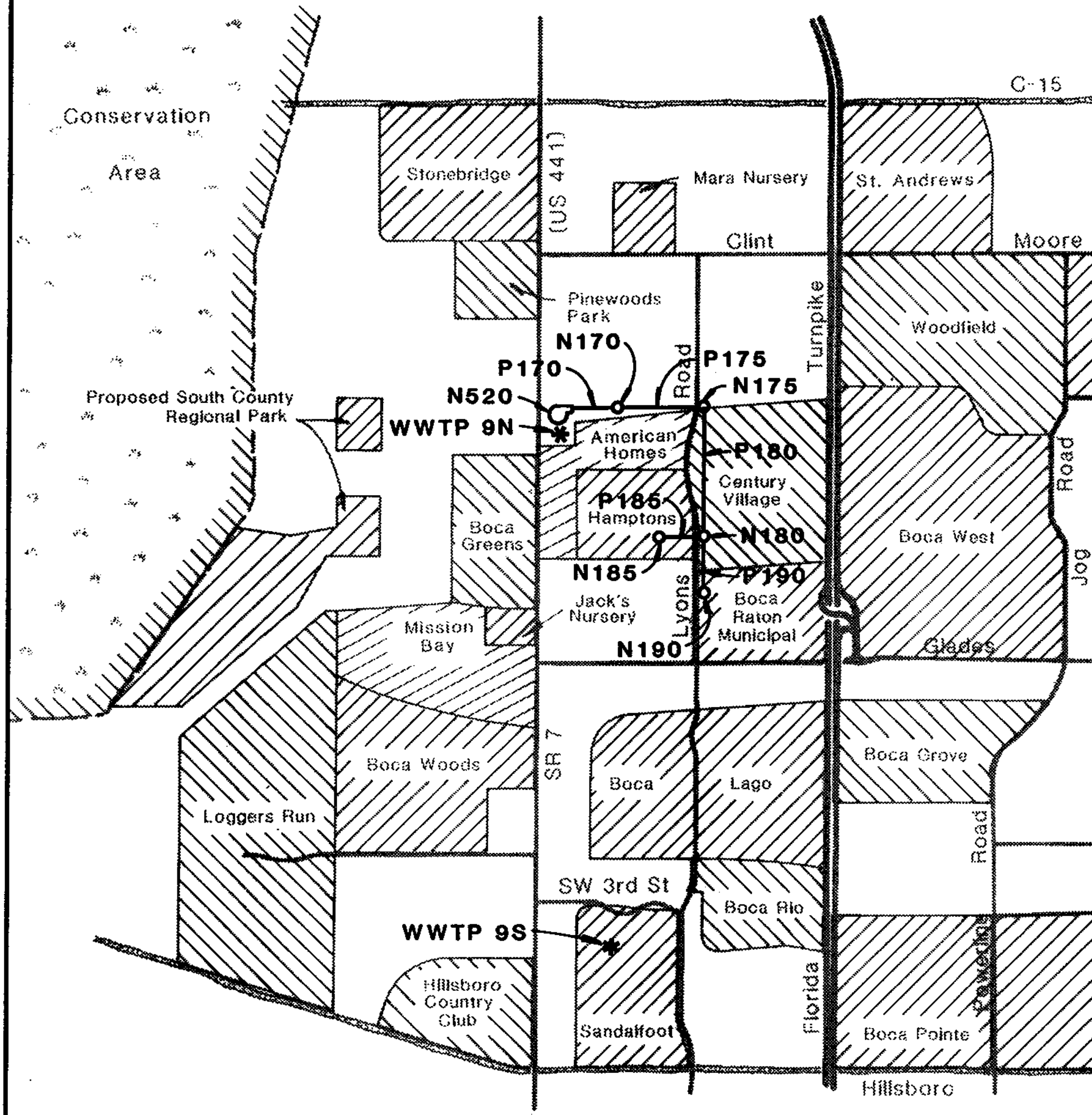

FIGURE A-2
Pipe and Node Designations
Lyons Road System

CH2M HILL

Nodes

A node is assigned wherever a pipe terminates or is connected to another pipe(s) and wherever a special appurtenance such as a pump station or reservoir is located. Input data for pipe nodes include node number, water demand at that node, and ground elevation.

Nodes have been located at the following locations:

Node No.	Location
N 132	Jack's Nursery
N 153	WWTP 9N Wet Well
N 185	Hamptons Country Club
N 190	Boca Raton Municipal
N 220	Boca Woods
N 229	Mission Bay
N 238	Boca Greens
N 500	Existing WWTP 9S pump station
N 510	Existing P.S. at WWTP 9N at Chlorine Contact Tank
N 520	Proposed P.S. at WWTP 9N Chlorine Contact Tank

In addition to these nodes, other nodes have been located as shown in Figures A-1 and A-2. These nodes have been located to facilitate adding additional pipes to the model.

Minor Losses

Minor losses can be added to account for friction losses caused by flow obstructions such as fittings and valves. Input data includes pipe number and the sum of the K factors.

Reservoirs

A reservoir is a facility which can receive or contribute water to the pipe network. Reservoir input data includes node number and the elevation of the discharge point above mean sea level.

For this analysis, the reservoirs will include the pond at Boca Greens and the WWTP 9N wet well. They will be modeled as such because they represent points of free discharge. The discharge elevation at the WWTP 9N wet well is greater than that at the Boca Greens pond. Therefore, flow should be more likely to go to the pond than the wet well.

Source Pump

The WWTP 9N and 9S pump station have been modeled as nodes with a negative demand. For example, if the effluent pump station at WWTP 9S is pumping 2.4 MGD or 1,670 gpm, this value would be input as a demand of -1,670 gpm at N500.

EXAMPLE OF COMPUTER MODEL RUN

The following example computer model run is presented to provide the reader with a better understanding of the use of the NETWK program in analyzing the proposed PBCWUD water reclamation system.

This example analyzes reclaimed water service to the Boca Greens Golf Course. The following assumptions have been made:

- o The WWTP 9S effluent pump station will pump the reclaimed water at a rate of 1,670 gpm.
- o Only Boca Greens will be receiving reclaimed effluent. Valves at other users' sites are closed.
- o Main-line valves on the effluent transmission main are open. Thus, if the Boca Greens valve was closed, effluent could travel to the WWTP 9N wet well for disposal down the injection well.

- A 12-inch-diameter extension from the existing 24-inch effluent transmission main in front of Boca Greens has been assumed.

INPUT FILE

File Name: PBC1.IN

The input file was created by entering PIPE, NODE, MINOR LOSSES, RESERVOIRS, and data as explained previously.

OUTPUT FILE

File Name: PBC1.OUT

A printout of the output file is presented at the end of this Appendix. An explanation of the output file is presented below.

Pipes

As an example of typical output data, refer to Pipe 238 on the output sheet. This is the 12-inch extension serving Boca Greens. The output reads as follows:

Pipe	Nodes						Velo-	Head	HLOSS
No.	From	To	Length	Diam.	Coef.	Flow Rate	city	Loss	/1000
238	138	238	200.	12.0	140.0	1,670.00	4.74	1.14	5.72

According to the output excerpt shown above, Pipe 238 has a length of 200 feet, a 12-inch diameter and a coefficient of friction (measure of inside wall roughness) of 140. The flow rate is 1,670 gallons per minute at a velocity of 4.74 feet per second and the head loss (energy loss) is 1.14 feet total or 5.72 feet per 1,000 feet of pipe.

Nodes

Output data for Node 238 at the discharge point to the Boca Greens pond is as shown in the following excerpt:

NODE DATA:

Node No.	Demand (CFS)	(GPM)	Elev	Head	Pressure	HGL Elev
238	3.721	1,670.00	17.00	.00	.00	17.00

The discharge at Node 238 is shown as 1,670 gpm. This represents the total flow from the WWTP 9S pump station since no flow is going to Node 153 which is the WWTP 9N wet well. The Boca Greens pond (N238) has been modeled as a reservoir with a water surface of 17.0 feet. The discharge elevation is 17.00-feet MSL, the head is 0 in feet and the pressure is 0 in psi. The HGL elevation, elevation plus pressure head, is 17.00-feet MSL.

RESERVOIRS are not shown separately in the output file. Rather they are shown under NODE DATA under the assigned node number. For example, Node 500 represents the WWTP 9S effluent pump station. The negative demand of -1,670 gpm indicates the pump station is supplying the pipe system at this flow rate. A positive demand indicates water being drawn from the pipe system.

ANALYSIS OF SYSTEM TO SERVE BOCA GREENS FROM WWTP 9S

No. of computer runs = 1

Input file name: PBC1.IN

Output file name: PBC1.OUT

Conclusion

Output file shows that only 3.11 feet of head would be realized at the WWTP 9S effluent transfer pump station. Existing pumps can deliver required flow to Boca Greens easily.

ANALYSIS OF SYSTEM TO SERVE BOCA GREENS FROM WWTP 9N

No. of computer runs = 1

Input file name: PBC2.IN

Output file Name: PBC2.OUT

Conclusion

Output file shows that calculated head is actually negative indicating that treated effluent might actually flow by gravity to Boca Greens. Final outcome will depend on type and location of storage facility at Boca Greens.

It is likely that a pump station will be required since WWTP 9N may also serve Mission Bay. The pump station will require low-head pumps.

NETWK 8.21, 7-JUL-85 CH2M HILL, INC. Pipe Network Analysis
FILES: Input- PBC1.IN Output- PBC1.OUT
RUN DATE: 14-FEB-86 TIME: 3:42 PM

PBC1.IN
PBCWUD SYSTEM NO. 9 WATER RECLAMATION
NETWK ANALYSIS OF EFFLUENT PUMPING AND TRANSMISSION SYSTEM
WWTP 9S PUMP STATION ON W/ 1 PUMP RUNNING, NO OTHER PUMPS ON
FLOW IS BEING DELIVERED TO BOCA GREENS AT N238, NO OTHER USERS BEING SERVED
ASSUME WWTP 9S FLOW = 2.4 MGD OR 1,670 GPM

"SPECIF" PEAKING FACTOR = 1.0000

PIPES	14
NODES	15
SOURCE PUMPS	0
BOOSTER PUMPS	0
RESERVOIRS	1
MINOR LOSSES	9
PRVS	0
NOZZLES	0
CHECK VALVES	0
BACK PRES. V.	0

RESERVOIRS:

NODE	ELEVATION
238	17.00

MINOR LOSSES:

PIPE NO.	MINOR LOSS K	LENGTH	PLUS EQUIVALENT LENGTH
100	2.38	10.00	184.71
106	2.93	3100.00	3355.48
114	.30	1620.00	1646.16
117	.30	2900.00	2926.16
120	.60	3600.00	3652.32
132	.56	2300.00	2348.83
138	1.28	3700.00	3811.61
150	3.23	340.00	621.64
156	3.34	90.00	288.61

NET SYSTEM DEMAND : -1670.00

SUM OF POSITIVE DEMANDS : .00

UNITS OF SOLUTION ARE:
DIAMETERS - INCH
LENGTH - FEET
HEADS - FEET
ELEVATIONS - FEET
PRESSURES - PSI
FLOW - GPM
HAZEN-WILLIAMS FORMULA USED FOR COMPUTING HEAD LOSSES

PIPE DATA:

PIPE NO.	NODES FROM	TO	LENGTH	DIAM	COEF	FLOW RATE	VELOCITY	HEAD LOSS	HLOSS /1000
100	500	103	185.	20.0	140.0	1670.00	1.71	.09	.47
106	103	114	3355.	24.0	140.0	1670.00	1.18	.66	.20
114	114	117	1646.	24.0	140.0	1670.00	1.18	.32	.20
117	117	120	2926.	24.0	140.0	1670.00	1.18	.57	.20
120	120	129	3652.	24.0	140.0	1670.00	1.18	.71	.20
129	129	132	800.	24.0	140.0	1670.00	1.18	.16	.20
132	132	138	2349.	24.0	140.0	1670.00	1.18	.46	.20
138	138	147	3812.	24.0	140.0	.00	.00	.00	.00
147	147	153	330.	24.0	140.0	.00	.00	.00	.00
150	147	156	622.	24.0	140.0	.00	.00	.00	.00
156	156	510	289.	16.0	140.0	.00	.00	.00	.00
220	120	220	200.	12.0	140.0	.00	.00	.00	.00
229	129	229	200.	12.0	140.0	.00	.00	.00	.00
* 238	138	238	200.	12.0	140.0	1670.00	4.74	1.14	5.72

NODE DATA:

NODE NO.	DEMAND (CFS)	(GPM)	ELEV	HEAD	PRESSURE	HGL ELEV
103	.000	.00	17.00	4.02	1.74	21.02
114	.000	.00	17.00	3.37	1.46	20.37
117	.000	.00	17.00	3.04	1.32	20.04
120	.000	.00	17.00	2.47	1.07	19.47
129	.000	.00	17.00	1.76	.76	18.76
132	.000	.00	17.00	1.60	.69	18.60
138	.000	.00	17.00	1.14	.50	18.14
147	.000	.00	17.00	1.14	.50	18.14
153	.000	.00	31.00	-12.86	-5.57	18.14
156	.000	.00	17.00	1.14	.50	18.14
220	.000	.00	17.00	2.47	1.07	19.47
229	.000	.00	17.00	1.76	.76	18.76
500	-3.721	-1670.00	18.00	3.11	1.35	21.11
510	.000	.00	18.00	.14	.06	18.14
238	3.721	1670.00	17.00	.00	.00	17.00

NETWK 8.21, 7-JUL-85 CH2M HILL, INC. Pipe Network Analysis
FILES: Input- PBC2.IN Output- PBC2.OUT
RUN DATE: 14-FEB-86 TIME: 3:59 PM

PBC2.IN
PBCWUD SYSTEM NO. 9 WATER RECLAMATION
NETWK ANALYSIS OF EFFLUENT PUMPING AND TRANSMISSION SYSTEM
NEW PS AT WWTP 9N IS ON AT N510
FLOW IS BEING DELIVERED TO BOCA GREENS AT N238, NO OTHER USERS BEING SERVED
ASSUME 0.72 MGD OR 500 GPM IS REQUIRED AT BOCA GREENS

"SPECIF" PEAKING FACTOR = 1.0000

PIPES	14
NODES	15
SOURCE PUMPS	0
BOOSTER PUMPS	0
RESERVOIRS	1
MINOR LOSSES	9
PRVS	0
NOZZLES	0
CHECK VALVES	0
BACK PRES. V.	0

RESERVOIRS:

NODE	ELEVATION
238	17.00

MINOR LOSSES:

PIPE NO.	MINOR LOSS K	LENGTH	PLUS EQUIVALENT LENGTH
100	2.38	10.00	184.71
106	2.93	3100.00	3355.48
114	.30	1620.00	1646.16
117	.30	2900.00	2926.16
120	.60	3600.00	3652.32
132	.56	2300.00	2348.83
138	1.28	3700.00	3811.61
150	3.23	340.00	621.64
156	3.34	90.00	288.61

NET SYSTEM DEMAND : -500.00

SUM OF POSITIVE DEMANDS : .00

UNITS OF SOLUTION ARE:
DIAMETERS - INCH
LENGTH - FEET
HEADS - FEET
ELEVATIONS - FEET
PRESSURES - PSI
FLOW - GPM
HAZEN-WILLIAMS FORMULA USED FOR COMPUTING HEAD LOSSES

PIPE DATA:

PIPE NO.	NODES FROM	TO	LENGTH	DIAM	COEF	FLOW RATE	VELOCITY	HEAD LOSS	HLOSS /1000
100	500	103	185.	20.0	140.0	.00	.00	.00	.00
106	103	114	3355.	24.0	140.0	.00	.00	.00	.00
114	114	117	1646.	24.0	140.0	.00	.00	.00	.00
117	117	120	2926.	24.0	140.0	.00	.00	.00	.00
120	120	129	3652.	24.0	140.0	.00	.00	.00	.00
129	129	132	800.	24.0	140.0	.00	.00	.00	.00
132	132	138	2349.	24.0	140.0	.00	.00	.00	.00
* 138	147	138	3812.	24.0	140.0	500.00	.35	.08	.02
147	147	153	330.	24.0	140.0	.00	.00	.00	.00
* 150	156	147	622.	24.0	140.0	500.00	.35	.01	.02
* 156	510	156	289.	16.0	140.0	500.00	.80	.04	.15
220	120	220	200.	12.0	140.0	.00	.00	.00	.00
229	129	229	200.	12.0	140.0	.00	.00	.00	.00
* 238	138	238	200.	12.0	140.0	500.00	1.42	.12	.61

NODE DATA:

NODE NO.	DEMAND (CFS)	(GPM)	ELEV	HEAD	PRESSURE	HGL ELEV
103	.000	.00	17.00	.12	.05	17.12
114	.000	.00	17.00	.12	.05	17.12
117	.000	.00	17.00	.12	.05	17.12
120	.000	.00	17.00	.12	.05	17.12
129	.000	.00	17.00	.12	.05	17.12
132	.000	.00	17.00	.12	.05	17.12
138	.000	.00	17.00	.12	.05	17.12
147	.000	.00	17.00	.20	.09	17.20
153	.000	.00	31.00	-13.80	-5.98	17.20
156	.000	.00	17.00	.22	.09	17.22
220	.000	.00	17.00	.12	.05	17.12
229	.000	.00	17.00	.12	.05	17.12
500	.000	.00	18.00	-.88	-.38	17.12
510	-1.114	-500.00	18.00	-.74	-.32	17.26
238	1.114	500.00	17.00	.00	.00	17.00

ANALYSIS OF SYSTEM TO SERVE HAMPTON/CENTURY VILLAGE/ AMERICAN HOMES LAKE SYSTEMS AND BOCA RATON MUNICIPAL GOLF COURSE

No. of computer runs = 2

Input File names: PBC20.IN, PBC25.IN

Output File names: PBC20.OUT, PBC25.OUT

Conclusion

This existing 12-inch pipe which outfalls at the Hamptons lake can be used. A 12-inch extension can be made to serve the Boca Raton Municipal Golf Course.

The above output files show that pumps at WWTP 9N must deliver 46 feet of head to serve the Hamptons system and at least 62 feet of head to serve the Boca Municipal Golf Course. The existing vertical turbine pumps at the WWTP 9N chlorine contact tank should be adequate.

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NETWK  8.21,  7-JUL-85  CH2M HILL, INC. Pipe Network Analysis
FILES: Input- PBC20.IN                          Output- PBC20.OUT
RUN DATE: 14-FEB-86 TIME: 10:27 AM

PBC20.IN--PBCWUD SYSTEM 9 WATER RECLAIMATION
ANALYSIS OF SERVICE TO LAKE AT HAMPTONS/CENT. VILL./AMER. HOMES
  AND THE BOCA RATON MUNICIPAL GOLF COURSE
MAJOR FACILITIES INCLUDE:EXIST. 12" MAIN TO HAMPTONS, NEW P.S. AT WWTP 9N
  CL2 TANK(N 520), NEW 12" MAIN EXTENSION TO BOCA MUNICIPAL(N190)
HAMPTONS/C.V./A.H. DEMAND = 1.3 MGD, BOCA MUN. DEMAND = 0.7 MGD
TOTAL DEMAND = 2.0 MGD OR 1,390 GPM
NEW P.S.(N 520) MUST DELIVER 1,390 GPM
THIS ANALYSIS LOOKS AT SERVICE TO HAMPTONS SYSTEM ONLY

"SPECIF" PEAKING FACTOR =      1.0000

PIPES           5
NODES           6
SOURCE PUMPS    0
BOOSTER PUMPS   0
RESERVOIRS      1
MINOR LOSSES    0
PRVS            0
NOZZLES         0
CHECK VALVES    0
BACK PRES. V.   0

RESERVOIRS:
 NODE  ELEVATION
  185        .00

NET SYSTEM DEMAND        :     -1390.00

SUM OF POSITIVE DEMANDS :          .00

UNITS OF SOLUTION ARE:
DIAMETERS -   INCH
LENGTH -      FEET
HEADS -       FEET
ELEVATIONS -  FEET
PRESSURES -   PSI
FLOW -        GPM
HAZEN-WILLIAMS FORMULA USED FOR COMPUTING HEAD LOSSES
```

PIPE DATA:

PIPE NO.	NODES FROM	TO	LENGTH	DIAM	COEF	FLOW RATE	VELOCITY	HEAD LOSS	HLOSS /1000
170	520	170	100.	12.0	120.0	1390.00	3.94	.54	5.41
175	170	175	6500.	12.0	120.0	1390.00	3.94	35.18	5.41
180	175	180	2000.	12.0	120.0	1390.00	3.94	10.83	5.41
* 185	180	185	100.	12.0	120.0	1390.00	3.94	.54	5.41
190	180	190	3000.	12.0	120.0	.00	.00	.00	.00

NODE DATA:

NODE NO.	DEMAND (CFS)	(GPM)	ELEV	HEAD	PRESSURE	HGL ELEV
170	.000	.00	.00	46.55	20.17	46.55
175	.000	.00	.00	11.37	4.93	11.37
180	.000	.00	.00	.54	.23	.54
190	.000	.00	.00	.54	.23	.54
520	-3.097	-1390.00	.00	47.09	20.41	47.09
185	3.097	1390.00	.00	.00	.00	.00

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NETWK  8.21,  7-JUL-85  CH2M HILL, INC. Pipe Network Analysis
FILES: Input- PBC25.IN                          Output- PBC25.OUT
RUN DATE: 14-FEB-86 TIME: 10:38 AM

PBC25.IN--PBCWUD SYSTEM 9 WATER RECLAIMATION
ANALYSIS OF SERVICE TO LAKE AT HAMPTONS/CENT. VILL./AMER. HOMES
  AND THE BOCA RATON MUNICIPAL GOLF COURSE
MAJOR FACILITIES INCLUDE:EXIST. 12" MAIN TO HAMPTONS, NEW P.S. AT WWTP 9N
  CL2 TANK(N 520), NEW 12" MAIN EXTENSION TO BOCA MUNICIPAL(N190)
HAMPTONS/C.V./A.H. DEMAND = 1.3 MGD, BOCA MUN. DEMAND = 0.7 MGD
TOTAL DEMAND = 2.0 MGD OR 1,390 GPM
NEW P.S.(N 520) MUST DELIVER 1,390 GPM
THIS ANALYSIS LOOKS AT SERVICE TO BOCA MUNICIPAL ONLY(N 190)

"SPECIF" PEAKING FACTOR =      1.0000

PIPES           5
NODES           6
SOURCE PUMPS    0
BOOSTER PUMPS   0
RESERVOIRS      1
MINOR LOSSES    0
PRVS            0
NOZZLES         0
CHECK VALVES    0
BACK PRES. V.   0

RESERVOIRS:
 NODE  ELEVATION
  190         .00

NET SYSTEM DEMAND        :     -1390.00

SUM OF POSITIVE DEMANDS :          .00

UNITS OF SOLUTION ARE:
DIAMETERS -  INCH
LENGTH -     FEET
HEADS -      FEET
ELEVATIONS - FEET
PRESSURES -  PSI
FLOW -       GPM
HAZEN-WILLIAMS FORMULA USED FOR COMPUTING HEAD LOSSES
```

PIPE DATA:

PIPE NO.	NODES FROM	TO	LENGTH	DIAM	COEF	FLOW RATE	VELOCITY	HEAD LOSS	HLOS /100
170	520	170	100.	12.0	120.0	1390.00	3.94	.54	5.4
175	170	175	6500.	12.0	120.0	1390.00	3.94	35.18	5.4
180	175	180	2000.	12.0	120.0	1390.00	3.94	10.83	5.4
185	180	185	100.	12.0	120.0	.00	.00	.00	.0
* 190	180	190	3000.	12.0	120.0	1390.00	3.94	16.24	5.4

NODE DATA:

NODE NO.	DEMAND (CFS)	(GPM)	ELEV	HEAD	PRESSURE	HGL ELEV
170	.000	.00	.00	62.25	26.97	62.25
175	.000	.00	.00	27.06	11.73	27.06
180	.000	.00	.00	16.24	7.04	16.24
185	.000	.00	.00	16.24	7.04	16.24
520	-3.097	-1390.00	.00	62.79	27.21	62.79
190	3.097	1390.00	.00	.00	.00	.00

APPENDIX B

APPENDIX B
ASSUMPTIONS FOR ECONOMIC ANALYSIS

Chapter 7 contain general statements of policy which are fundamental to the economic analysis. Presented below are specific assumptions made during the economic analysis:

1. Capital Improvements costs would be financed at an interest rate of 10% for a period of 20 years. Annual debt service costs will be uniform over the 5 year study period.

2. O&M costs were developed from interviews with PBCWUD staff. O&M costs escalated at 5% per year through study period.

3. A&G costs were assumed to be 20% of total annual O&M costs.

4. Annual water sales were based on estimates presented in Chapter 3.

5. Components of the O&M cost include labor for operation, maintenance and repair of the tertiary filters, air compressors (for filter valve operation), proposed telemetry system and proposed pump station(s) at WWTP 9N. Other labor costs include additional sampling, monitoring and testing of effluent quality and groundwater quality. O&M expenses include electricity costs for above equipment and chlorine costs for disinfection.

6. 1986 labor costs assumed at $11/hour including fringes.

7. 1986 electricity costs assumed at $0.08/KWH

8. 1986 chlorine costs assumed at \$234/ton.

9. PBCWUD debt service, O&M and A&G costs for the recently completed effluent transfer pump station at WWTP 9S, the effluent transfer main along S.R. 7, and the injection pump station and deep injection well at WWTP 9N have <u>not</u> been included in the costs for the water reclamation system. It was assumed that these facilities were required for the underground injection disposal system and should not be allocated to the water reclamation system.

10. All costs include 25% contingency.

11. User is charged a fixed fee for an agreed daily volume of reclaimed water delivered to his facilities. If the water is made available by PBCWUD and the User elects not to receive it, he will still be charged for agreed volume.

12. No major treatment plant modifications are required to implement the water reclamation system.