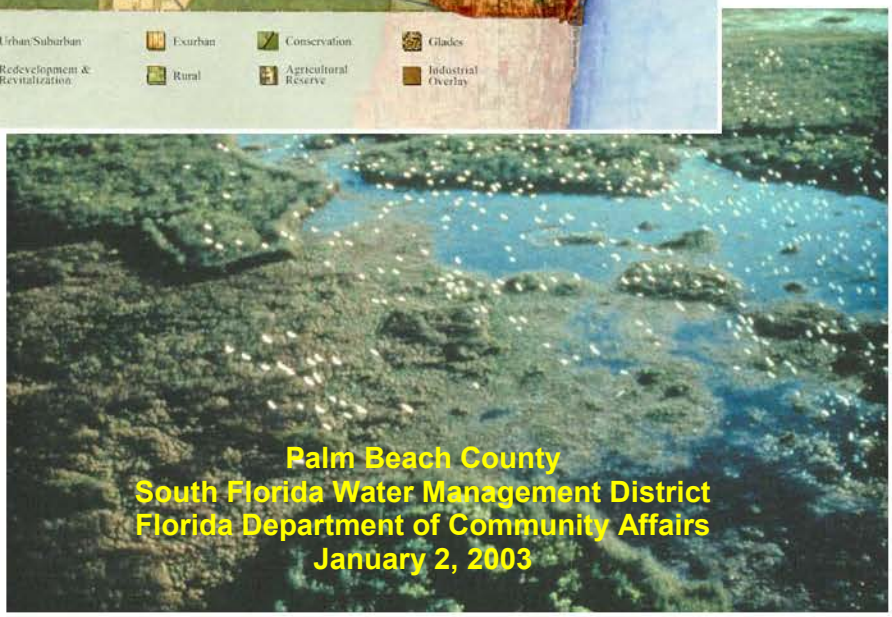
Linking Land Use & Water Supply Planning

Palm Beach County Pilot Project

Contract 03-DR-37-10-60-01-002
First Contract Deliverable
Inventory Part 2:
Documentation and Data Tables



Palm Beach County
South Florida Water Management District
Florida Department of Community Affairs
January 2, 2003

T:\Planning\Comprehensive\UTILITY\Water & LU Planning\First deliverable covers.doc

Linking Land Use & Water Supply Planning

Palm Beach County Pilot Project

Contract 03-DR-37-10-60-01-002
First Contract Deliverable
Inventory Part 2:
Documentation and Data Tables

TABLE OF CONTENTS

LIST OF TABLES

Permit Tables by Water Treatment Plant

E X E C U T I V E S U M M A R Y

Palm Beach County has been designated by the Florida Department of Community Affairs as one of the five Pilot Communities providing an early implementation of new State requirements to link land use and water supply planning. These communities are located in each of the water management districts and were selected to provide a diversity of community situations and sizes. The intent of the pilot projects is to gain experience and fine-tune the State's assistance to local governments in Florida for the preparation of plan amendments and programs to link land use and water supply planning.

This document is being submitted along with a CD-ROM containing the required GIS layers in ArcView format and other cartographic documents that we considered necessary to fully describe Palm Beach County's case. These two pieces of information constitute the first contract deliverable for Palm Beach County's Pilot Project linking land use and water supply planning, as currently required by the State.

Because of the complexity of the water supply situation in Palm Beach County, we are providing an extensive description of the service area and existing facilities and programs, with a map depicting all the municipal service providers, water utility authorities including special districts, the County's service area, and unincorporated areas served by other providers.

We are also including portions of the County's "Raw Water Master Plan" prepared by one of the Water Utilities Department's consultants, with detailed descriptions of our service area, the wellfields capital plan, and a special chapter on alternative water resources that the County has been developing and implementing since the early 90's. We have included this special chapter because those alternative water facilities and programs are part of the County's current conditions, and are contained in master plans developed by the Water Utilities Department and adopted by the County.

CD-ROM Cartographic Documents

The CD-Rom contains folders with WUD layers depicting all existing facilities, service areas including a mandatory reclaimed water service area, and aquifer protection overlays. The folders were prepared in two different versions of ArcView format: Geodatabase and Shapefiles, to facilitate reading of these documents by users with different versions of ArcView. Also included are folders with additional layer files, composite maps in ArcMap and *.pdf formats for easy reproduction of hard copies, and a map depicting the County's water service areas. Also included are metadata files with technical description of the sources and type of geographic information, methodology utilized to produce or translate layers, and other data directed to GIS specialists manipulating this information.

Service Area Characteristics

This section is the complete second chapter of the County's Raw Water Master Plan described above. It provides an overview of the hydrogeology settings, water sources, and the current water supply situation in the County. The County water service area had been divided in the past based on acquired utilities and numbered the Water Treatment Plants (WTP) accordingly. Today the County has moved to a regional operation by interconnecting the distribution systems and creating a unified service area. This section provides a detailed description of the active WTPs capacities and wellfield descriptions with specific maps, tables and graphics.

Summary of Existing Capacity and Current Demand
This table summarizes and compiles data from the three main sources of information utilized to prepare this report. The table provides a quick view of existing wellfield and treatment capacity by active plant; current finished water demand averaged over the 12-month period from October 2001 through September 2002. Wholesale water components served by Palm Beach County include the City of Atlantis (annual average of 0.49 mgd), the City of Greenacres which is part of our service area, and multiple municipal interconnects located throughout Palm Beach and Broward counties, with a combined annual average usage of 1.1 mgd.

Alternative Water Resources in Palm Beach County's Service Area
As indicated above, the County is actively pursuing and implementing alternative water resources, consistent with SFWMD's LEC Plan and the sub-regional water supply plans developed for Palm Beach County. The County has been proactively expanding alternative water resources including Aquifer Storage and Recovery (ASR) Wells, Reclaimed Water Irrigation Systems, with an adopted mandatory Reclaimed Water Service Area, Indirect Water Recharge via Constructed Wetlands, and Reuse of Membrane Concentrate. This section, which is the complete Chapter 6 of the Raw Water Master Plan, provides a description of the status of each of these alternative water resources.

Existing Wellfield Capital Improvement Plan
The service area's water supply is drawn from the surficial aquifer system underlying most of eastern Palm Beach County. Raw water is withdrawn by wells grouped near the County's four active WTPs. There's a total of 70 wells grouped in 4 wellfield areas. The County has three on-going capital improvement projects related to the 4 existing wellfields. They include rehabilitation of existing wells, wellfield emergency power provisions, and wellfield abandonment program. This section was also taken in its entirety from the Raw Water Master Plan, Chapter 8.

Current Water Permits
Permitting for our water supply and treatment facilities is generally a three-step process. Step 1 involves obtaining a water use permit from the South Florida Water Management District (District). A copy of our current Water Use Permit (Permit No. 50-00135-W) is provided. Although the current Water Use Permit does not expire until September 2004, the County is actively pursuing a 20-year permit with the District. Further information on this permit will be provided in the second and third deliverables, as the negotiations between the County and the District progress. Step 2 involves obtaining Health Department permits for water supply and treatment facilities as they are constructed. Copies of the latest Notice of Permit Issuance, as provided by the Florida Department of Health, are provided for each of the four water treatment plants. While these construction phase permits expire after the construction is completed, each treatment facility is issued and annual drinking water operating permit by the Florida Department of Health during Step 3 of the permitting process. A copy of each operating permit is provided. An extensive listing of all permits issued by the District, Florida Department of Health, Florida Department of Environmental Protection, and the Palm Beach County Department of Environmental Resource Management is provided for each of the four treatment plants. Each plant is operated in accordance with Chapter 403 of the Florida Statutes and Florida Administrative Code Rules 62-550, 62-555, and 62-560.

1 Introduction

Background

Palm Beach County Water Utilities Department (County), located in Palm Beach County, Florida (**Figure 1-1**) serves a permanent population of approximately 370,000 people. The water utility service area extends southward from 45th Street in West Palm Beach to the Palm Beach County/ Broward County line and eastward from west of US 441 to just east of Congress Avenue as shown in **Figure 1-2**. The service area's water supply is drawn from the surficial aquifer system that extends from land surface to approximately 200 feet below land surface (bls). Raw groundwater is withdrawn by wells grouped near the County's four Water Treatment Plants (WTPs). Groundwater, once withdrawn, is treated by lime softening, ozonated lime softening, and membrane softening processes. The South Florida Water Management District (SFWMD), Palm Beach County Health Department (PBCHD) and the Florida Department of Environmental Protection (FDEP) regulate withdrawal and treatment quantities, water quality, and treatment facilities.

Table 1-1 provides an overview of the current permitted well capacities for each of the County's wellfields as documented in the SFWMD Water Use Permit No. 50-00135-W approved by the SFWMD Board in September 1999. This permit allocates an annual-system-wide withdrawal of 19,104 million gallons (52.34 million gallons per day [mgd]) and a system-wide maximum day not to exceed 75.40 mgd through 2004.

Wellfields are planned to be expanded as the County continues to experience population growth and increased water demands. This Raw Water Master Plan ("Master Plan") provides an evaluation of where, when, and how the County should expand their raw water system to meet the needs of their service area through build out in the year 2024. This Master Plan also contains the supporting information for application to the SFWMD for a 20-year duration (through 2024) water use permit for the raw water supply system.

Table 1-1
Summary of WTP Wellfield Capacities

WTP Well-field	No. of Wells	Total Design Wellfield Capacity (mgd)	FDEP Firm Wellfield Capacity [a] (mgd)	Permitted 2004 Raw Water Max Day Allocation (mgd)
2	14	18.4	15.6	14.0
3	16	23.6	18.6	16.0
8	16	23.0	20.2	20.2
9	24	39.6	35.7	25.2
Total	**70**	**104.9**	**90.4**	**75.4**

[a] Firm Wellfield Capacity is the installed capacity of the wellfield with the two highest capacity wells out of service.

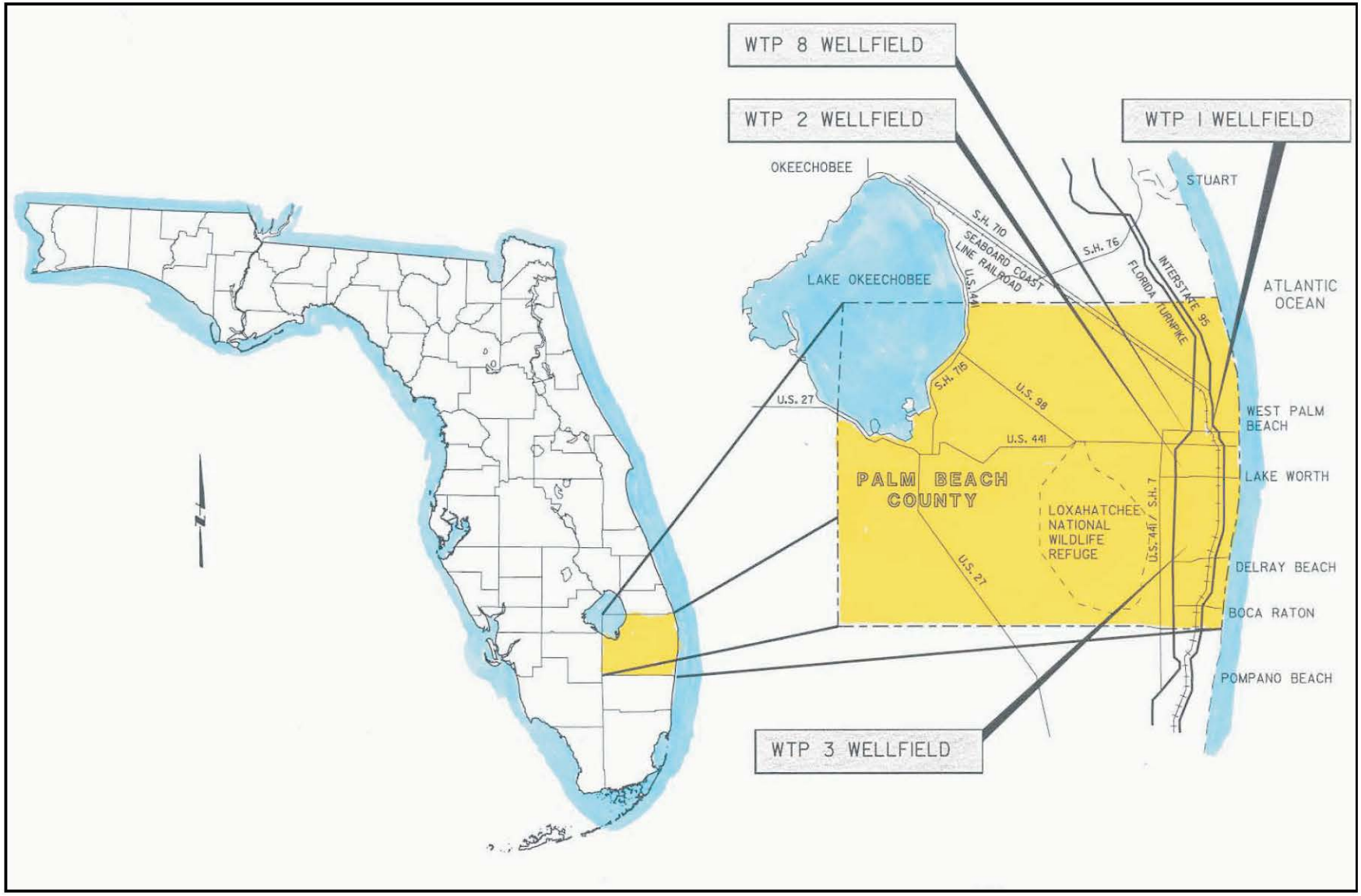


Figure 1-1
Location Sketch

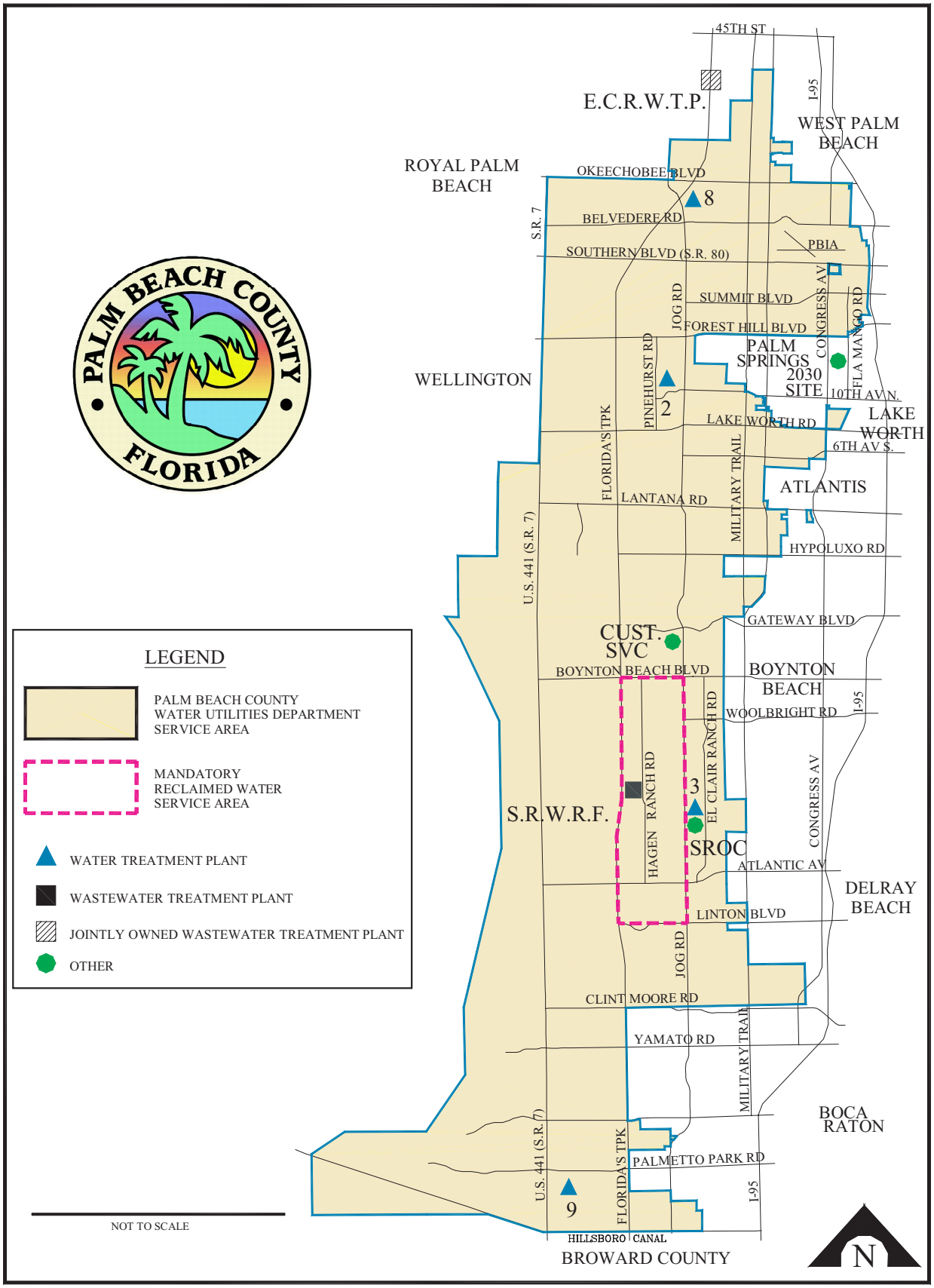


Figure 1-2
Service Area Map

Purpose and Scope

This Master Plan is designed to serve as a guide for the future expansion of water withdrawal facilities within the County service area, and to promote a strategy for the development of sustainable sources of water through the year 2024. This Master Plan is the first of its kind for the County and is based upon historical and recent information associated with County service area demographics, water resources, water demands, completed capital improvements, anticipated capital expenditures and relevant local, state, and federal regulations. The study area of this document is defined by the boundaries of the County's current service area.

Population projections are the basis for defining the improvements needed to maintain as well as enhance the County's selected level of service. The current population projections are based on the 2000 census, and have been verified by Palm Beach County Planning and Zoning to be consistent with the Palm Beach County Comprehensive Plan, the 1997 PBCWUD Water and Wastewater Master Plan, and historical and current planning efforts.

Water Management Regulations

As Palm Beach County is planning for its future water resources needs, the SFWMD has established a Lower East Coast Regional Water Supply Plan (LEC Plan) and Minimum Flows and Levels (MFLs) for District water bodies anticipating increased demands on the state's water resources. The County has participated in numerous SFWMD planning and discussion sessions related to regional water supply issues and has developed a local program of water supply alternatives. These alternatives include Aquifer Storage and Recovery, artificial aquifer recharge, and reuse water irrigation areas. The County's program uses many of the methods recommended in the regional studies. A brief overview of the regional water supply programs as they relate to Palm Beach County is presented below.

LEC Regional Water Supply Plan

Palm Beach County is located within the SFWMD LEC Plan Study Area. In 1997, the SFWMD LEC regional water supply evaluation of water storage facilities became part of the Central and Southern Florida Project Comprehensive Review (Restudy) process being conducted by the U.S. Army Crops of Engineers. The Restudy work was completed in April 1999 and published as the Central and Southern Florida Comprehensive Review Study Final Feasibility Report and Programmatic Environmental Impact Statement. The Restudy is being implemented under the Comprehensive Everglades Restoration Plan (CERP) and the LEC has been updated to include the CERP. Selected CERP projects will be implemented every five years through 2020 in such a way as to balance regional water needs. The projects will be designed to increase stored and delivered water under the authority given to the SFWMD by Chapter 373 Florida Statutes (F.S.) (SFWMD, May 2000).

Minimum Flows and Levels

As part of the SFWMD's requirements under Chapter 373, F.S., the LEC Plan includes the definition of Minimum Flows and Levels (MFL) for MFL water bodies and has become a reference for the subsequent rules added to the Florida Administrative Code (F.A.C.). Rule 40E-8, F.A.C., is the core rule that ties the LEC Plan recommendations into the regulations and incorporates the SFWMD "Basis of Review for Water Use Permit Applications –September 2001" (BOR). MFLs are further defined in the following Rules:

40E-2, F.A.C. – Consumptive Use (incorporates the BOR into this rule)
40E-20 F.A.C. – General Water Use Permits
40E-21, F.A.C. – Water Shortage Plan
40E-22, F.A.C. – Regional Water Shortage Plans

The BOR Section 3.9 states the following:

> "Applications for consumptive use permits for water uses that directly or indirectly withdraw water from MFL water bodies must meet the criteria in this section, in addition to all other conditions for permit issuance in Chapters 40E-2 or 40E-20, as applicable. Applications that meet the criteria in this section are considered to comply with Rule 40E-2.301(1)(j), F.A.C. Consumptive use permit applications shall be reviewed based on the recovery or prevention strategy approved at the time of permit application review."

Five MFL water bodies are currently defined in 40E-8:

- The Caloosahatchee River
- Lake Okeechobee
- The Everglades
- The Biscayne aquifer
- The Lower West Coast aquifers

In the LEC Plan deals specifically with Lake Okeechobee, the Everglades and the Biscayne aquifer. The whole of the LEC Planning Area is broken into smaller service areas as shown in **Figure 1-3**. The County's wellfields (WTP2, 3, 8, and 9) are located in the LEC Service Area 1 (LECSA 1) and shown on **Figure 1-4**.

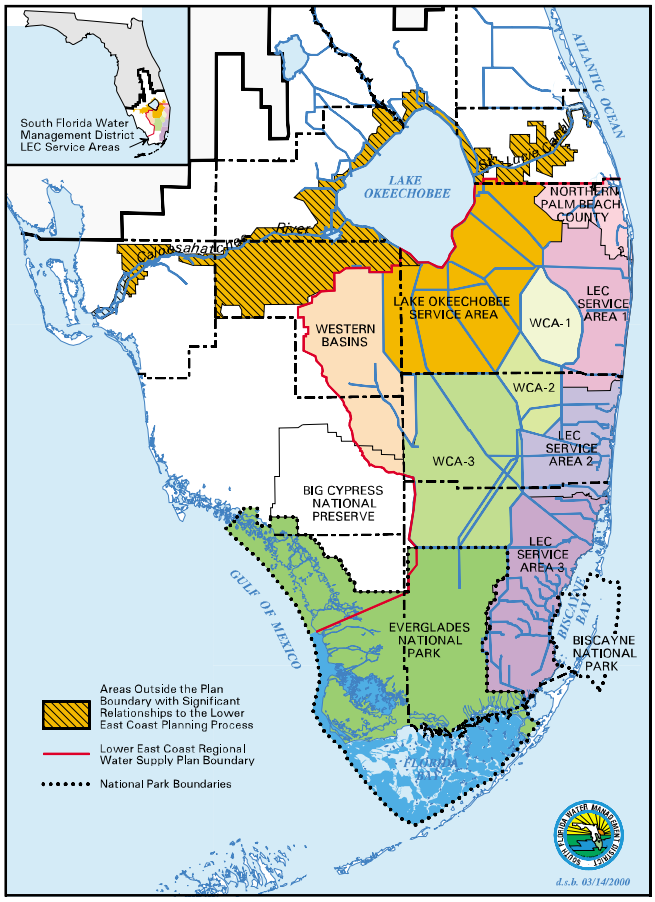


Figure 1-3
Major Features of the Lower East Coast Planning Area (from LEC May 2000)

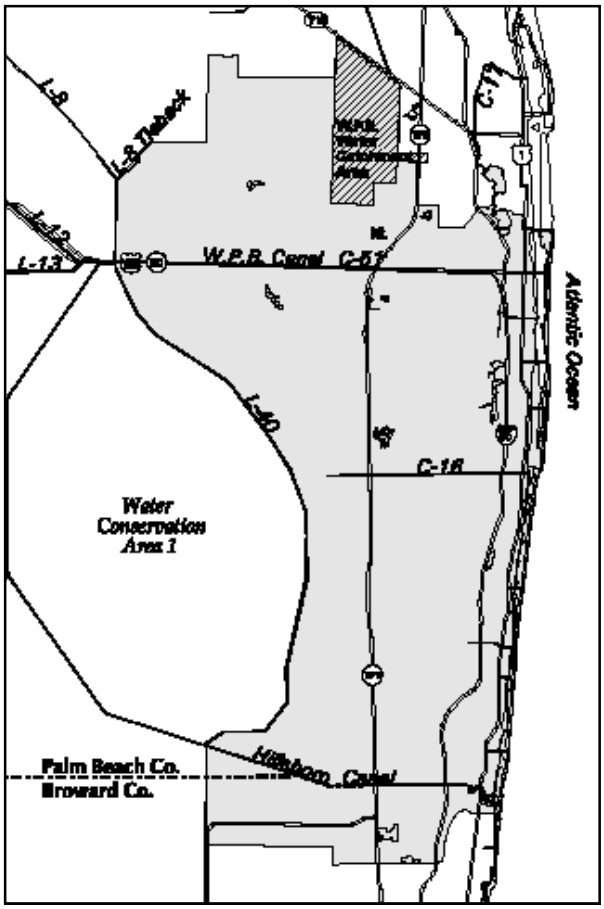


Figure 1-4
Lower East Coast Service Area 1 (from LEC Plan, May 2000)

Regulation Compliance

Water that reaches the PBCWUD service area is indirectly supplied by Lake Okeechobee (an MFL water body) through the WCA1 (an Everglades MFL water body) by the Lake Worth Drainage District (LWDD) and SFWMD canal systems (SFWMD, 2000a). Therefore, by definition in 40E-8.021(5), PBCWUD wellfields are classified as an indirect withdrawal from a MFL surface water body. A direct withdrawal from a MFL would take water for consumption directly from the MFL water body. An indirect withdrawal is any withdrawal of water for consumption that receives water from an MFL water body or its tributary.

The County's wellfield groundwater withdrawal is from the Biscayne aquifer, as defined in the LEC Plan, that extends into the Palm Beach County from Broward County. A concern with water use from the Biscayne is the potential promotion of saline water intrusion from either the coast or upconing. The County wellfields are situated to the east (WTPs 2, 3, and 8) and west (WTP 9) of Florida's Turnpike and are not likely to induce saline water intrusion along the coast provided canal levels east of the wellfields are controlled at the currently held stage levels. Additionally, the report prepared for PBCWUD titled, Hillsboro Canal Monitoring and Test Well Installation for System 9 Wellfield, Project No. 97-132 (Montgomery Watson, 1999) and several older studies conducted around the County wellfields to the north of WTP 9, indicate that the County's wells do not induce saline water movement upwards from the base of the aquifer.

The SFWMD has created two new subsections in the BOR section 3.9 that address MFL strategies: Subsection: 3.9.1 – Evaluations for MFL Water Bodies Subject to a Recovery Strategy and 3.9.2 - Evaluations for MFL Water Bodies Subject to a Prevention Strategy. The Everglades, Caloosahatchee River are the only MFL water bodies that require recovery strategies. The BOR 3.9.1(1) and (2) require that a previously permitted water user directly or indirectly withdrawing from an MFL water body, should provide reasonable assurances that a recovery strategy will correct the withdrawal and that impacts from the previously permitted allocation will not increase. Palm Beach County water users would be defined as an indirect withdrawal because they depend on the controlled stages of the LWDD canal system that is a tributary of the Everglades water conveyance system through WCA 1.

Recovery strategies for the Everglades will be enacted by SFWMD through the CERP. A portion of the CERP addresses the impact of existing water uses described in the LEC Plan, as are prevention strategies for Lake Okeechobee. In the LEC Plan, the County is modeled with a projected 2020 average day water demand of 28.6 mgd for WTPs 2 and 8 and 45.2 mgd from WTPs 3 and 9. This is a total 2020 average day demand of 73.8 mgd for the County System (SFWMD, 2000a). According to the SFWMD the average day demand for the County of 73.8 mgd will be allotted for in the recovery strategies developed for the Everglades (SFWMD, 2001b).

The projected 2024 average day for the County system that was developed in the most recent water use permit renewal request is 88.7 mgd. The approximately 15 mgd increase in water supply needs over that projected in the LEC Plan will be mitigated by the County's alternative water supply programs. The County is proactively expanding their alternative water use programs using ASR, Reclaimed Water Irrigation Systems, Wetland Treatment Systems (artificial aquifer recharge) and Reuse of Membrane Concentrate methodologies. Palm Beach County is the leading local government in southern Florida in the development of alternative water supplies. The SFWMD's goal for reduction of raw water use is 20 percent water reclamation. The County has met the SFWMD's goal for water reclamation and is continuing to implement other alternative water use methodologies. The County's alternative water use program is discussed in more detail in Section 7 – Alternative Water Use.

REPORT ORGANIZATION

The Raw Water Master Plan contains the following sections:

- **Executive Summary** – Contains a brief overview of the information and recommendations contained in the Raw Water Master Plan document.
- **Section 1 – Introduction** – Provides an explanation of the Raw Water Master Plan objectives and an overview of the document organization.
- **Section 2 – Service Area and Well Descriptions** – Presents a detailed description of the hydrogeologic setting, service area nomenclature, current water treatment plant capacities, and treatment processes of the County's active WTPs.
- **Section 3 – Raw Water Demand Projections** – Provides an analysis of the current and projected future raw water and finished water demands relating to population through the year 2024.
- **Section 4 – Groundwater Model Development** – This section documents the development and calibration of the two groundwater flow models that were used to evaluate the effect of projected withdrawals from the County's wellfield system.
- **Section 5 – Evaluation of Future Withdrawals** – The two groundwater flow models were run for the planning periods 2009, 2014, and 2024 to evaluate the impact of future wellfield withdrawals. The results from these model runs are discussed in this section.
- **Section 6 – Alternative Water Use Programs** – The County is actively implementing alternative water use programs such as aquifer storage and recovery (ASR), wetlands recharge, and reclaimed water systems. This section discusses the County's current and future alternative water use programs and shows how they return water to the natural system.
- **Section 7 – Field Testing and Evaluation Results** – Provides a description of existing wellfield testing methods and procedures relating to well drawdown, specific capacity, sand and silt production, and reviews, tabulates, and evaluates results from the testing of water supply wells at Wellfields 2, 3, 8 and 9. This section also presents recommendations for rehabilitation and/or improvement to the existing wells.
- **Section 8 – Existing Wellfield Capital Improvement Plan** – Capital improvements are recommended in this section by wellfield system. Recommendations are made based on the results of raw water demand projections, planned WTP expansions, field testing information, and groundwater flow modeling. System pipeline maintenance will also be presented for wellfield systems 2, 3, 8 and 9.
- **Section 9 – Wellfield Expansion Capital Improvements Plan** – Capital improvements are recommended for the expansion of existing County wellfields to meet projected 2024 raw water demands. Recommendations are made based on the results of raw water demand projections, planned WTP expansions, and wellfield groundwater modeling. Palm Beach County Environmental Resources Management coordination (PBCERM) requirements for the protection of future well sites and proposed pipeline routing is presented. This section presents an expansion and cost schedule, correlated to the raw water supply improvement and expansion schedule, including milestones for permitting, design, acquisition, construction, and operational startup of new facilities. The schedule shows the recommended improvements and expansions from year 2001 through year 2024.
- **Section 10 – References.** Many references have been utilized in the preparation of this Master Plan and are listed in this section.

2 Service Area Characteristics

Overview

The County relies solely on groundwater for potable water supply. This groundwater is found in a shallow, unconfined to semi-confined aquifer that underlies the entire eastern portion of the County. The County has commissioned numerous studies and evaluations concerning the protection and prudent use of this resource. These studies cover issues such as the potential for groundwater contamination and saline water intrusion, efficient use of water supply facilities, and alternative water supply strategies. This document does not attempt to fully summarize the extensive work conducted relative to the County's water supply. However, it highlights critical information. Conclusions drawn from this work as it relates to implementation of a responsible groundwater supply plan, support future water demands of the County's system.

The County's raw water supply system consists of 70 water supply wells. These wells are grouped into four wellfield areas. The wells have been constructed over the past 30 years to meet increasing demands. Many of the older wells have been rehabilitated to maintain capacity and maximize efficiency. This section summarizes the hydrogeologic setting, service area nomenclature, current wellfield capacities, and treatment processes of the County's active WTPs.

Hydrogeologic Setting

Topographically, the County service area lies between the low-lying Everglades to the west and the higher elevations of the Atlantic Coastal Ridge to the east (**Figure 2-1**). The area from east to west is relatively flat with the ground surface elevations ranging from approximately 25 feet along the coastal ridge to approximately 16 feet above sea level in the Everglades.

Many studies and publications have been written concerning the geology and hydrogeology of the Palm Beach County area over the past 40 years. General regional hydrogeology was documented by Parker and others (1955) and later summarized by Miller (1990) and Randazzo and Jones (1997). County specific information has been provided in reports by Schroeder and others (1954), Rodis and Land (1976), Scott (1977) and Fish and Stewart (1991). More detailed, site specific data can be obtained from reports written by Land and others (1973), Rodis (1972), Fischer (1980), and Swayze and Miller (1984) among others. In recent years, the United States Geological Survey (USGS), the South Florida Water Management District (SFWMD), and private water resources organizations and consultants have continued to work on defining the aquifer systems of Palm Beach County in more detail.

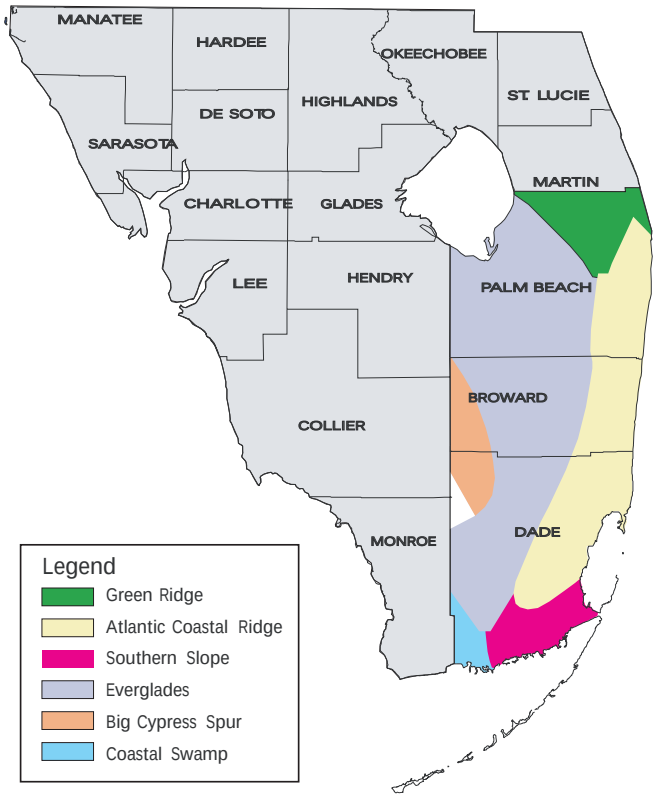


Figure 2-1
Physiographic Regions of S.E. Florida
(Modified From Cooke, 1939)

Surficial Aquifer System Lithology

The surficial aquifer system is composed of various lithologic units. Miller (1987) defines a series of lithologic cross-sections that suggest the surficial aquifer system units range in age from the Pliocene Tamiami Formation at the base to the Pleistocene Pamlico Formation at the surface. The aquifer system is predominantly made up of limestones, sands, shells, silts, and calcareous clays (marls). The geologic formations that have been identified in Palm Beach County are the Tamiami Formation (Mansfield, 1939), the Caloosahatchee Formation (Matson and Clapp, 1909), the Fort Thompson Formation, the Anastasia Formation (Sellards, 1912), and the Pamlico Sand (Parker and Cooke, 1944). These lithologic units are mostly of the Pleistocene age with the exception of the Tamiami Formation which is Pliocene and the Caloosahatchee Marl which is a transitional unit between the Pliocene and Pleistocene. The calcareous clays of the Miocene Hawthorn Formation and, in some areas the Tamiami Formation, form the base of the surficial aquifer. A summary of the stratigraphic units of the surficial aquifer is presented in **Table 2-1** and described below.

Pamlico Formation

The Pamlico Formation (Parker and Cooke, 1944) is a name applied to marine deposits that occur at or near land surface. The Pamlico is composed predominantly of quartz sand with minor amounts of shell that may occur as bedded layers (Shine et. al, 1989). In lower lying areas such as wetlands, the Pamlico sand has been covered by recent organic deposits.

Table 2-1
Stratigraphic Section and Generalized Hydrogeologic Units for Palm Beach County

Series	Stratigraphic and Hydrologic Units	Palm Beach County Lithology	Aquifer	Approximate Thickness of Aquifer
Holocene	Undifferentiated alluvium and terrace deposits	Sand with local shell beds 0 to 12 ft thick	Surficial Aquifer System (Raw Water Supply source)	160 to 250 feet
Pleistocene	Pamlico Formation	Fine to medium sand 0 to 50 feet thick		
	Anastasia Formation	Sandy limestone and marl 0 to 200 feet thick		
	Fort Thompson Formation	Interbedded sand, shell, and limestone 0 to 40 feet thick		
Pliocene	Caloosahatchee Formation	Marl with minor sand and silt 0 to 50 feet thick		
	Tamiami Formation	Marl with beds of fossiliferous limestone 0 to 100 feet thick		
Miocene	Hawthorn Group:	Phosphatic sand, clay, and minor limestone 500 to 700 feet thick	Upper Confining Unit	600 to 700 feet

Modified from Randazzo and Jones, 1997. Lithologic unit thickness vary with location.

Anastasia Formation

The Anastasia Formation (Sellards, 1912) is composed of Pleistocene marine deposits that are found below the Pamlico Terrace sands along the east coast of Florida from central Palm Beach County northward (Cook and Mossom, 1929). The Anastasia is contemporaneous with the Miami Oolite Formation found along the coast to the south of Palm Beach County. The Anastasia Formation ranges in consistency from pure coquina to consolidated and unconsolidated mixtures of sand, sandy limestone, sandstone, and shell. Vertically the Anastasia Formation grades from sands and shells to calcareous sandstone, biogenic limestone and coquina rock. In most areas the limestone and coquina intervals contain solution cavities that are highly transmissive.

Fort Thompson Formation

The Fort Thompson Formation is a sequence of sands and shells with intermittent layers of marine marls and limestones (Sellards, 1919). In Palm Beach County the Fort Thompson Formation is found in the southern and western portions of the County and is contemporaneous with the Anastasia Formation found to the east. The contact between the two formations is gradational.

Caloosahatchee Formation

The Caloosahatchee Formation (Matson and Clapp, 1909) underlies the Anastasia and Fort Thompson Formations. The formation spans the Pliocene and Pleistocene and is composed of sandy, shelly marls with occasional occurrences of thinly bedded, sandy limestone (Brooks, 1968; Enos and Perkins, 1977).

Tamiami Formation

The Tamiami Formation (Mansfield, 1939) was correlated from Broward County into southeastern Palm Beach County by Causaras in 1986. The formation is composed of permeable shelly limestones and shelly sands.

Hydrogeology

The surficial aquifer system provides the water source for most public water supply wellfields in southeastern Florida. The aquifer system is generally unconfined and extends from land surface to a depth of approximately 200 to 400 feet below land surface. Recharge to the aquifer occurs locally by rainfall that permeates through the surficial sands or by leakage into the aquifer from area canal systems and Water Conservation Area 1.

The base of the surficial aquifer system is defined as, "…the first continuous occurrence of sediments having estimated hydraulic conductivities less than 50 feet per day or clay and silt constituents in concentrations greater than 15-percent" (Shine et. al, 1989). This definition corresponds with the upper units of the Miocene Hawthorn Group.

Miller (1987) divided the productive portion of the surficial aquifer into three geographical zones. The first zone (Zone 1) corresponds to the "zone of secondary permeability" discussed by Swayze and Miller (1984) and corresponds to the northern most extent of the Biscayne aquifer. It is located parallel to the coast, east of US 441, and extends southward from Juno Beach to Broward County. This zone underlies most of the County and is locally known as the Turnpike aquifer.

The Zone 2 is located west of US 441, is discontinuous and slightly less permeable. According to Miller (1987), Zone 2 extends through the northwest-central portion of the County and can be found in pockets along the coast. There are no cavernous limestones to contribute to a higher permeability in Zone 2. The Zone 3 as defined by Miller has a low permeability and covers most of western Palm Beach County beyond WCA 1.

Transmissivities in Zone 1 range from 1,000 square feet per day (sq ft/day) to 100,000 sq ft/day (Swayze and Miller, 1984); and are the result of cavernous limestones and calcareous sandstones present. The

transmissivities in northwestern Zone 2 average about 5,400 sq ft/day in the vicinity of Jupiter (Miller, 1987). The lithology of this Zone 2 is reportedly well sorted, poorly consolidated sands and shells (Schneider, 1976, Swayze and others, 1981) and is Pleistocene in age probably corresponding to the Fort Thompson and possibly the upper Caloosahatchee Formation. Zone 3 has low transmissivity (Scott, 1977) and is predominantly composed of poorly sorted to unsorted marls. Portions of the aquifer in Zone 3 may also respond as semi-confined to confined (Miller, 1987).

Groundwater Recharge

The shallow aquifer system is recharged by rainfall on the land surface and infiltration from area canals and other surface water bodies. Discharge from the aquifer occurs by evapotranspiration, discharge to canals, the Atlantic Ocean and other surface water bodies, and by wellfield production. The direction of groundwater flow in the shallow aquifer is east towards the coast.

The surface water canals in Palm Beach County penetrate the sediments overlying the surficial aquifer system and form an indirect connection between the surface and production zone of the aquifer. Water levels in canals and lake systems support local groundwater levels. Groundwater levels near maintained (controlled surface water levels) canal and lake systems are often at or near the water level elevation in those systems. Water can flow either from the groundwater into the canals or from the canals into the groundwater depending on the local climatic conditions and water management.

Regional Groundwater Quality

Groundwater within the shallow aquifer in eastern Palm Beach County is of a quality suitable for the production of potable water with conventional lime softening and membrane softening treatment technologies. The groundwater is generally hard and alkaline with varying amounts of dissolved iron and hydrogen sulfide. In most of Palm Beach County elevated levels of humic and fluvic acids derived from the partial breakdown of organic matter impart color to the groundwater (Berner and Berner, 1987). In the western portions of the surficial aquifer system, west of US 441, chloride concentrations increase with depth and can be above 250 milligrams per liter (mg/L) the maximum contaminant level set by the Florida Department of Environmental Regulation (Chapter 62-550, F.A.C.). These elevated chlorides tend to occur in the aquifer at depths greater than 200 feet below land surface where the aquifer lithology is less transmissive (Swayze and Miller, 1984). This higher chloride water is termed "conate sea water" indicating that the chloride laden water is derived from sea water trapped in the geologic past that has not been adequately flushed from the sediments at the aquifer's base.

Saline water intrusion from the Atlantic Ocean is an additional concern in coastal areas of Palm Beach County east of US Highway 1. A complex hydrologic relationship exists between the saline and fresh water within the aquifer in coastal areas. When water level elevations are reduced inland because of drought or withdrawals, saline water tends to move inland. Canal systems with controlled surface levels in Palm Beach County were designed for flood control during the rainy seasons and to maintain higher water level elevations inland to prevent saline water encroachment from the ocean.

Surface Water

The pre-development water table levels in southeastern Florida were at or near land surface according to the information reported in Miller (1987) and the dominant flow direction was south and southwest.

Lake Okeechobee was connected to the coastal areas by a series of drainage and flood control canals in the early 1900's reducing the groundwater levels in the surrounding areas. Construction of secondary drainage canals with water control structures allows for better water management. The surface water management system can control releases to the ocean during periods of heavy rainfall to prevent area

flooding and retain stored water in coastal areas during droughts. During drought conditions this canal management practice can provide water for agricultural uses, wellfield recharge and protection against coastal saline water intrusion.

Lake Worth Drainage District (LWDD) controls the dominant surface water system in north and central Palm Beach County. LWDD is a Florida Corporation that was created in 1915 under the General Drainage Laws of the State of Florida. The LWDD takes delivery of water from the SFWMD canal system and distributes it over an area of approximately 208 square miles. Distribution of water throughout LWDD is accomplished using the 511 miles of drainage ditches, 20 major water control structures and numerous minor structures. The water control structures are used to hold the water levels higher than sea level promoting groundwater recharge and preventing saline water intrusion from the coast during the winter dry season. During heavy rainfall of the summer wet season the control structures are opened to release water and control area flooding (www.lwdd.net).

County Service Area

Historically, the County water utility service areas have been divided based on the original areas served by the acquired utilities. Each of the acquired utilities, known then as systems, were numbered. As the County grew, the system designation was dropped in favor of a more descriptive identification by Water Treatment Plant (WTP). The County has moved to a regional operation by interconnecting the distribution system among the existing WTPs, creating a unified service area. This service area is shown in **Figure 2-2** and extends from WCA No. 1 east to Military Trail in the south end of the County and between Congress Avenue and Interstate 95 in the north end of the service area. The southern service area boundary follows the Broward County/ Palm Beach County line and the northern boundary is between Okeechobee Boulevard and 45th Street in West Palm Beach.

Active Water Treatment Plants

There are four active County WTPs (2, 3, 8 and 9) that are permitted to provide approximately 73 million gallons per day (mgd) of finished water capacity for consumer demand. **Table 2-2** provides general information for each of the active WTPs.

Table 2-2
Active Water Treatment Plant Capacities/Processes

Facility	Treatment Capacity (MGD)	Treatment Process	Comments
WTP 2	14.5	Ozonated Lime Softening	The lime softening plant will be decommissioned and 30 mgd of membrane softening and bypass and blend installed by 2015.
WTP 3	15.3	Membrane Softening (9.3 mgd) and Lime Softening (6 mgd)	The lime softening plant will be decommissioned and an additional 20.7 mgd of membrane softening and bypass and blend installed by 2005.
WTP 8	16.0	Ozonated Lime Softening	The lime softening plant will be decommissioned and 24 mgd of membrane softening and bypass and blend installed by 2020.
WTP 9	27.0	Membrane Softening	No change in treatment capacity or method is anticipated for this WTP through 2022

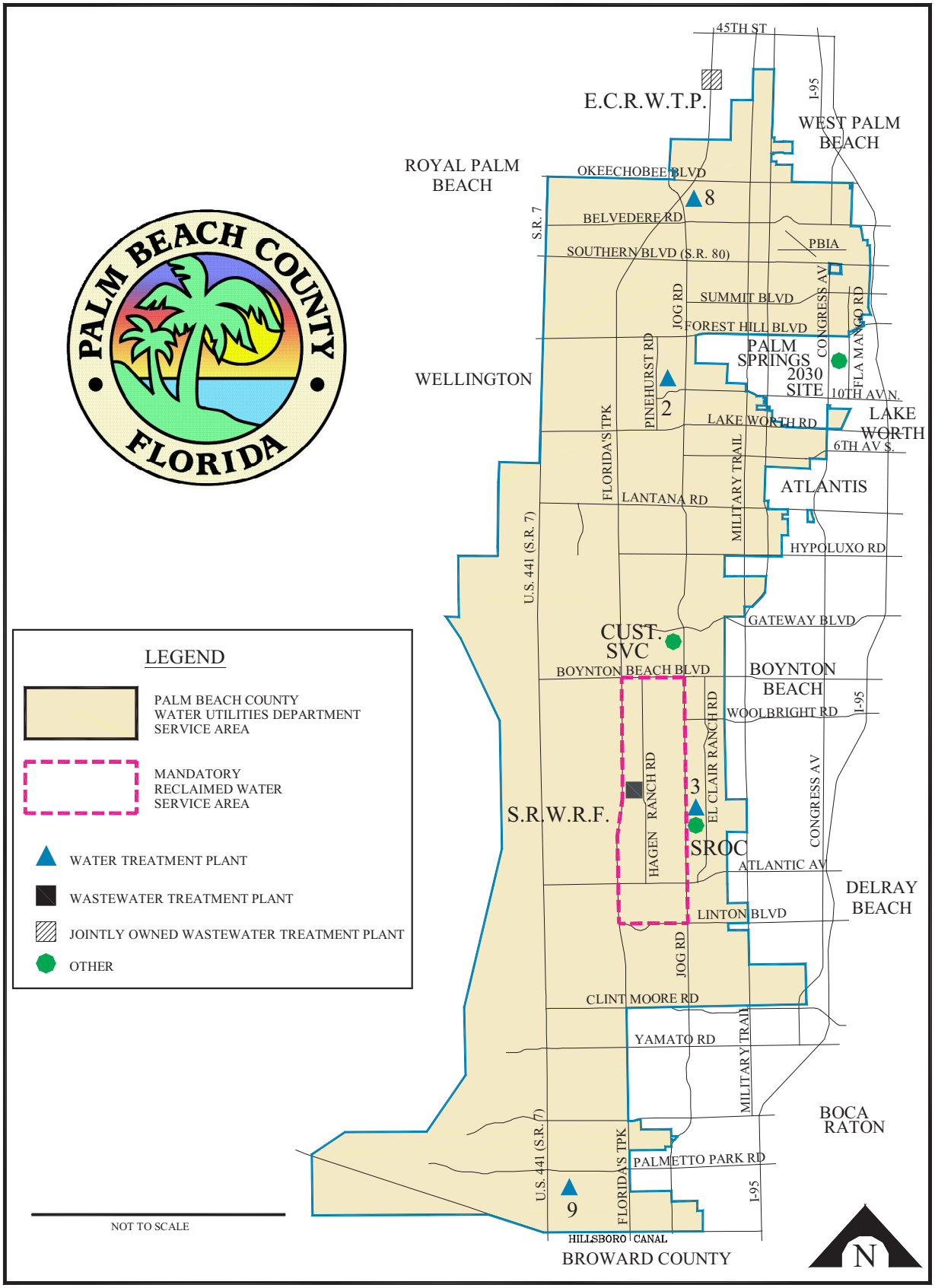


Figure 2-2
Service Area Map

WTP and Wellfield Descriptions

A description of each active WTP (2, 3, 8 and 9) and the associated wellfield is given below. The wellfields previously associated with Palm Beach County's WTPs 1 and 7 were assigned to WTP 8 and the wells are numbered accordingly. However, due to the location of these wells and the absence of raw water piping to physically connect the wells with WTP 8, they were plugged and abandon in February, 2002 (WUD 00-136).

WTP 2 Wellfield

WTP 2 is located to the east of Pinehurst Drive just north of 10th Avenue in West Palm Beach. The associated wellfield is located to the east and west of Pinehurst Drive, north of the L-10 canal crossings and south of Forest Hill Boulevard as shown on **Figure 2-3**. The wellfield currently consists of 14 wells with a total raw water pumping design capacity of 18.4 mgd. Wells 2W-1 through 2W-7 were constructed in the early 1970s and the remaining wells 2W-9 through 2W-15 were constructed between 1983 and 1996. The County proposes to replace the existing 14.5 mgd ozonated lime softening plant with a 30 mgd facility by the year 2015. The new plant will include a 25.5 mgd membrane softening plant with bypass and blend provisions for 4.5 mgd. Thirteen new production wells (27.4 mgd capacity) will be required to augment the existing wells and provide an adequate water source for the planned membrane softening WTP. A summary of the WTP 2 wellfield capacity is provided in **Table 2-3**.

The County and PBC Parks and Recreation have worked closely in the area of WTP 2 wellfield to design the Cholee Park lake system. This lake system will provide recharge to the groundwater in the vicinity of the wellfield and promote wetland preservation within the park. An interconnection with the LWDD L-10 Canal will maintain water level elevations in Cholee Park and provide groundwater recharge in the wellfield area.

WTP 3 Wellfield

WTP 3 is located in Delray Beach east of Jog Road between LWDD's L-30 and L-31 canals. The existing WTP has a capacity of 15.3 mgd (9.3 mgd membrane softening plus 6 mgd lime softening). The County plans to decommission and demolish the lime softening plant after construction is completed for the membrane facility. The 25.5 mgd membrane plant will have provisions to use an additional 4.5 mgd of raw water bypass and blend capacity for a total finished water production capacity of 30 mgd. Construction of the membrane facility expansion began in 2002 and will be complete by 2005.

The WTP 3 Wellfield is currently located between Florida's Turnpike and just east of Jog Road between the LWDD's L-29 and L-31 canals as shown in **Figure 2-4**. The eastern portion of the wellfield was constructed during the 1970's and consist of wells 3W-1 through 3W-7. Since 1988, the County has added nine wells, 3W-8 through 3W-10 along Jog Road at the WTP 3 site and 3W-13 through 3W-18 west of Hagen Ranch Road. The existing wellfield pumping design capacity is 23.9 mgd. In two recent modifications of the County's existing water use permit (March 2001 and July 2001), wells 3W-1 through 3W-7 were up-rated to 1,000 gallons per minute and ten new production wells were approved by the SFWMD. The installation of new pump facilities for the existing wellfield is on-going and the new production wells will be constructed in 2002-2003 (WUD00-136). The wellfield capacity after improvement and expansion will be approximately 45.3 mgd. The existing and planned production wells will provide raw water adequate for the planned expansion of WTP 3. A summary of the WTP 3 wellfield capacity by well is provided in **Table 2-4**.

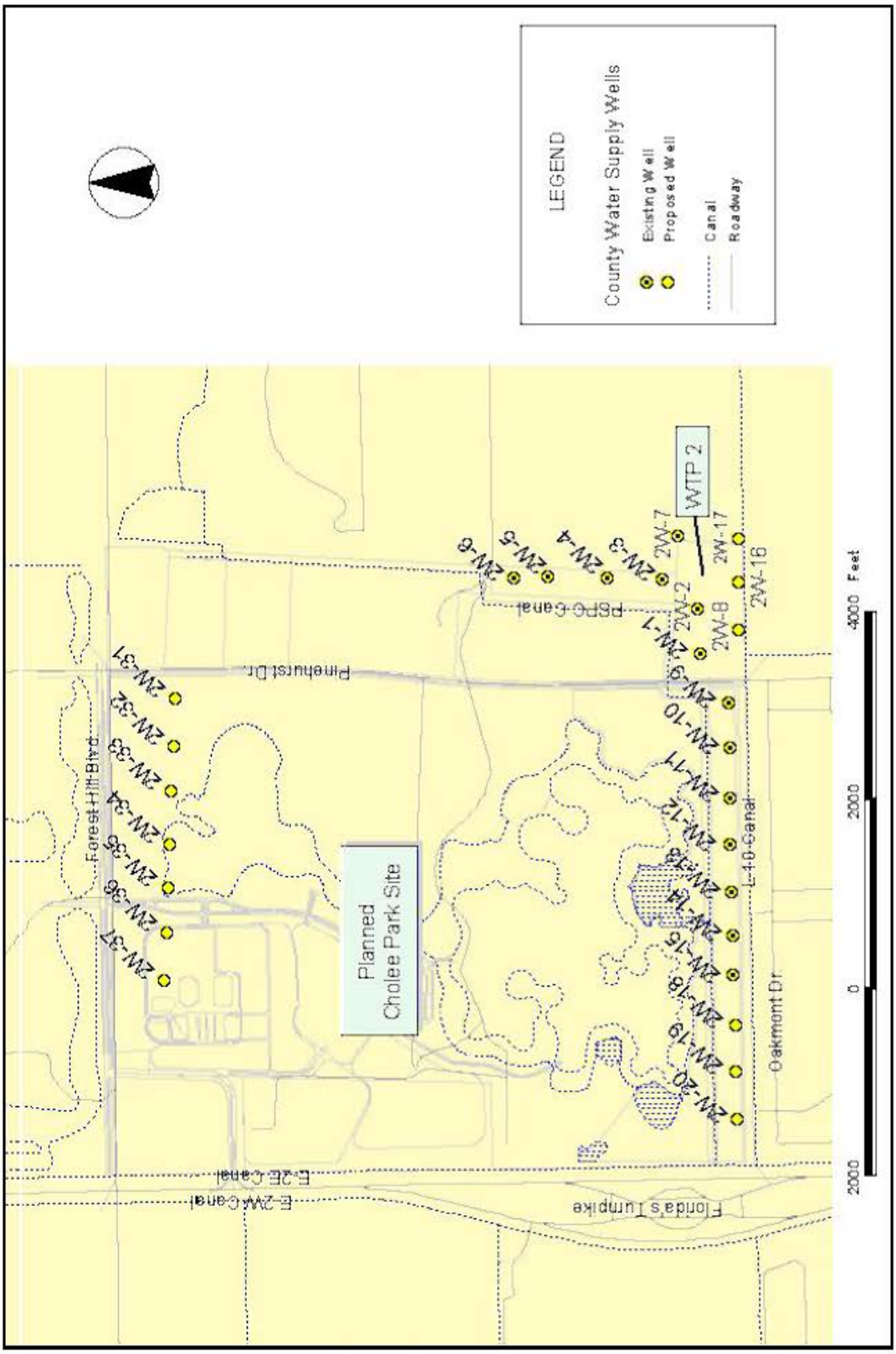


Figure 2-3
WTP 2 Wellfield

Table 2-3
Summary of the WTP 2 Wellfield

EXISTING WELLS YEAR 2000			NEW WELLS FOR MEMBRANE WTP YEAR 2015		
Well	Design Capacity (gpm)	Status	Well[a]	Design Capacity (gpm)	Status
2W-1	700	Existing	2W-1	700	Existing
2W-2	700	Existing	2W-2	700	Existing
2W-3	700	Existing	2W-3	700	Existing
2W-4	700	Existing	2W-4	700	Existing
2W-5	1,000	Existing	2W-5	1,000	Existing
2W-6	1,000	Existing	2W-6	1,000	Existing
2W-7	1,000	Existing	2W-7	1,000	Existing
2W-9	1,000	Existing	2W-9	1,000	Existing
2W-10	1,000	Existing	2W-10	1,000	Existing
2W-11	1,000	Existing	2W-11	1,000	Existing
2W-12	1,000	Existing	2W-12	1,000	Existing
2W-13	1,000	Existing	2W-13	1,000	Existing
2W-14	1,000	Existing	2W-14	1,000	Existing
2W-15	1,000	Existing	2W-15	1,000	Existing
			2W-8	1,000	Proposed
			2W-16	1,500	Proposed
			2W-17	1,500	Proposed
			2W-18	1,500	Proposed
			2W-19	1,500	Proposed
			2W-20	1,500	Proposed
			2W-31	1,500	Proposed
			2W-32	1,500	Proposed
			2W-33	1,500	Proposed
			2W-34	1,500	Proposed
			2W-35	1,500	Proposed
			2W-36	1,500	Proposed
			2W-37	1,500	Proposed
			Well sites 2W-21 through 2W-30 have been deleted due to conflicts with land use.		
TOTAL in gpm	12,800 gpm		TOTAL in gpm	31,800	
TOTAL in mgd	18.4 mgd		TOTAL in mgd	45.8	
[b] Capacity with two largest wells out of service	15.6 mgd		[b] Capacity with two largest wells out of service	41.5	
Maximum raw water required	15.3 mgd		Maximum raw water required	36.4	
Finished water production capacity	14.5 mgd		Finished water production capacity	30.0	

[a] All new wells proposed to serve the 2015 membrane WTP are currently permitted by the SFWMD at 1,000 gpm.

[b] Capacity with two largest wells out of service is reported to show an acceptable level of raw water standby capacity.

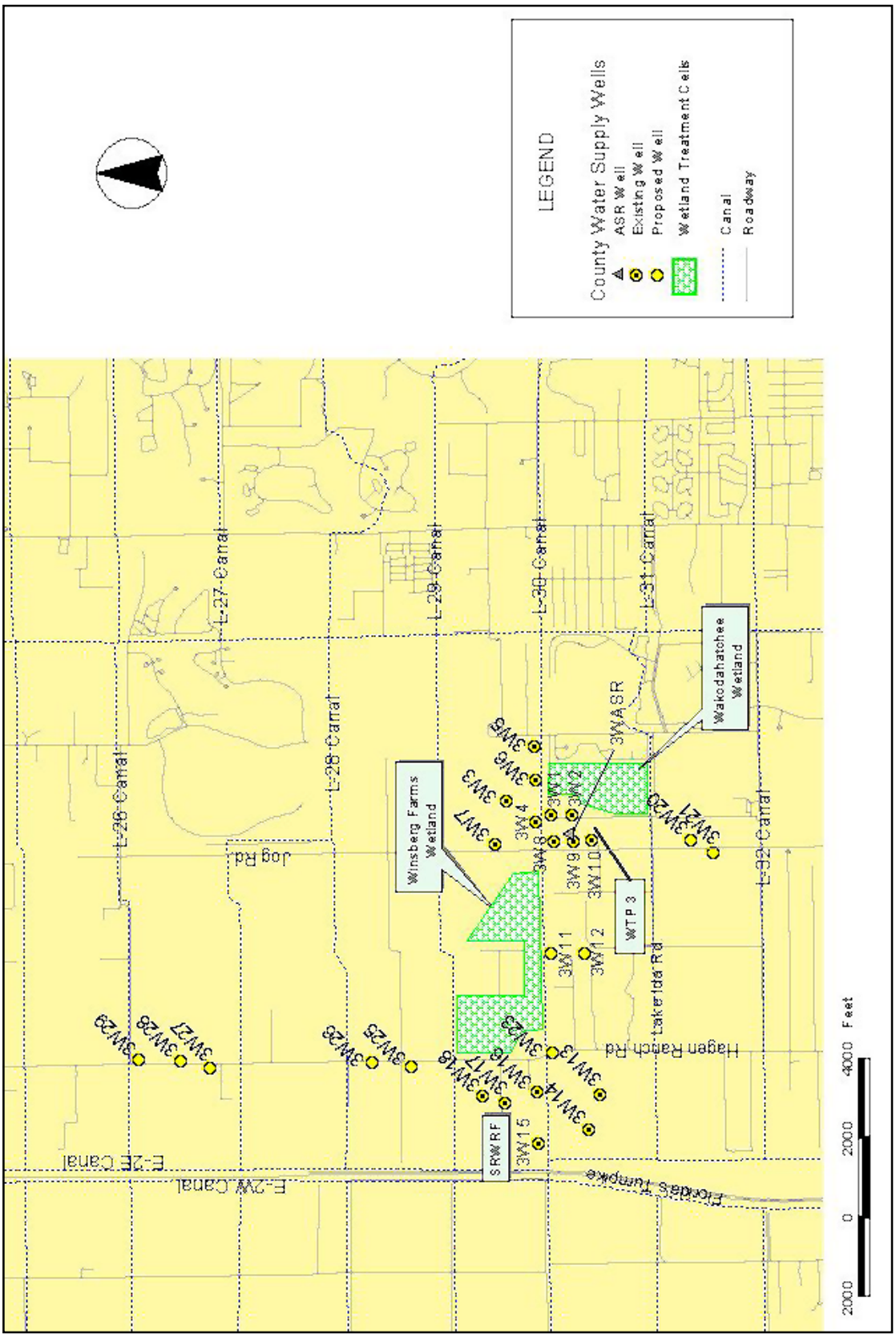


Figure 2-4
WTP 3 Wellfield

Table 2-4
Summary of the WTP 3 Wellfield

EXISTING WELLS YEAR 2000			NEW WELLS FOR MEMBRANE WTP YEAR 2002-2003		
Well	Design Capacity (gpm)	Status	Well	Design Capacity (gpm)	Status
3W-1	800	Existing	3W-1	1,000	Uprated
3W-2	800	Existing	3W-2	1,000	Uprated
3W-3	800	Existing	3W-3	1,000	Uprated
3W-4	700	Existing	3W-4	1,000	Uprated
3W-5	450	Existing	3W-5	1,000	Uprated
3W-6	800	Existing	3W-6	1,000	Uprated
3W-7	800	Existing	3W-7	1,000	Uprated
3W-8	1,250	Existing	3W-8	1,250	Existing
3W-9	1,250	Existing	3W-9	1,250	Existing
3W-10	1,250	Existing	3W-10	1,250	Existing
3W-13	1,050	Existing	3W-13	1,050	Existing
3W-14	1,050	Existing	3W-14	1,050	Existing
3W-15	1,050	Existing	3W-15	1,050	Existing
3W-16	1,750	Existing	3W-16	1,750	Existing
3W-17	1,050	Existing	3W-17R	1,500	New
3W-18	1,750	Existing	3W-18	1,750	Existing
			3W-11	1,000	Existing
			3W-12	1,000	New
			3W-20	1,000	New
			3W-21	1,000	New
			3W-23	1,500	New
			3W-25	1,500	New
			3W-26	1,500	New
			3W-27	1,500	New
			3W-28	1,500	New
			3W-29	1,500	New
			Well sites 3W-19 and 3W-22 deleted due to conflicts with land use. Well site 3W-24 is a future contingency site.		
TOTAL in gpm	16,600 gpm		TOTAL in gpm	31,900	
TOTAL in mgd	23.9 mgd		TOTAL in mgd	45.9	
[a] Capacity with two largest wells out of service	18.9 mgd		[a] Capacity with two largest wells out of service	40.9	
Maximum raw water required	17.9 mgd		Maximum raw water required	36.4	
Finished water production capacity	15.3 mgd		Finished water production capacity	30.0	

[a] Capacity with two largest wells out of service is reported to show an acceptable level of raw water standby capacity.

In addition to the wellfield, the County constructed a multi-purpose Aquifer Storage and Recovery (ASR) well in 1999. Once cycle testing is complete and final FDEP approval is granted, the well will be used to store raw water during lower demand periods for later use during high demand periods. ASR is one of the methods recommended by the SFWMD to relieve stress on the shallow aquifer during the dry season when demand is high.

WTP 8 Wellfield

WTP 8 and the associated wellfield are located north of Belvedere Road east of Jog Road. The existing ozonated lime softening plant is served by 16 existing production wells with a total pumping design capacity of 23.0 mgd. The existing wells were constructed or acquired between 1982 and 1996. The County proposes to up-rate the 16 mgd facility to 20 mgd by the year 2010. In 2020 the ozonated lime softening plant is scheduled for demolition and replacement with a 20.5 mgd membrane softening WTP with 3.5 mgd of bypass and blend for a total finished water production capacity of 25 mgd. Seven new production wells will be required to supply raw water for the planned WTP. The expanded wellfield capacity by 2020 will be approximately 36.7 mgd.

Existing wells near the Palm Beach International Airport along Belvedere Road and at Century Village on Okeechobee Boulevard east of the intersection with Haverhill Road were abandoned in February, 2002. These wells were formerly associated with the County's WTPs 1 and 7 but could not be efficiently used to supply WTP 8 with raw water. Wells 8W-19 and 8W-20 located directly east of the WTP 8 site are also scheduled for abandonment by 2003. None of the abandoned wells are included in the statement of existing wellfield capacity above. The WTP 8 wellfield is shown on **Figure 2-5** and a summary of wellfield capacity is presented in **Table 2-5**.

WTP 9 Wellfield

The WTP 9 wellfields are located in Boca Raton north of the Hillsboro canal and east of US 441. The existing 14.0 mgd lime softening plant is being replaced with a 27.0 mgd membrane softening facility. Wellfield 9 is located south of S.W. 65th Avenue and adjacent to Sandalfoot Cove Golf course and adjacent to the north side of the Hillsboro Canal as shown on **Figure 2-6**. This wellfield has a total of 24 wells with a total raw water pumping capacity of 39.6 mgd. Wells 9W-1 through 9W-7 were constructed in the early 1970's. Well 9W-1 was replaced in 1996 by 9W-1R. Wells 9W-8 through 9W-15 were constructed in 1982 and wells 9W-17 through 9W-25 were constructed along the Hillsboro Canal easement west of US 441 in 2000. Well site 9W-16 was dropped from construction due to land use conflicts. **Table 2-6** summarizes the wellfield capacity at WTP 9.

Wells 9W-17 through 9W-25 are located along the Hillsboro Canal to take advantage of the canal's capacity to recharge the Biscayne aquifer in this area. Wells 9W-21 through 9W-25 will also be used in conjunction with the Hillsboro ASR well currently under construction (WUD 98-66). This ASR well has been designed and permitted to store 5 mgd of raw water to minimize peak water supply demands at WTP 9. Actual recovery rates (i.e. flow, duration, etc.) will be determined during the operational testing phase of the well scheduled for 2002-2003.

Table 2-7 below provides a summary of the existing and proposed wellfield capacity for the County raw water supply system through 2024. Photographs of each existing well are provided in **Appendix A**. Detailed information for each individual well in the County's raw water database, including: date of construction, well diameter, casing depth, screen interval, pump type, etc., is provided in **Appendix G**.

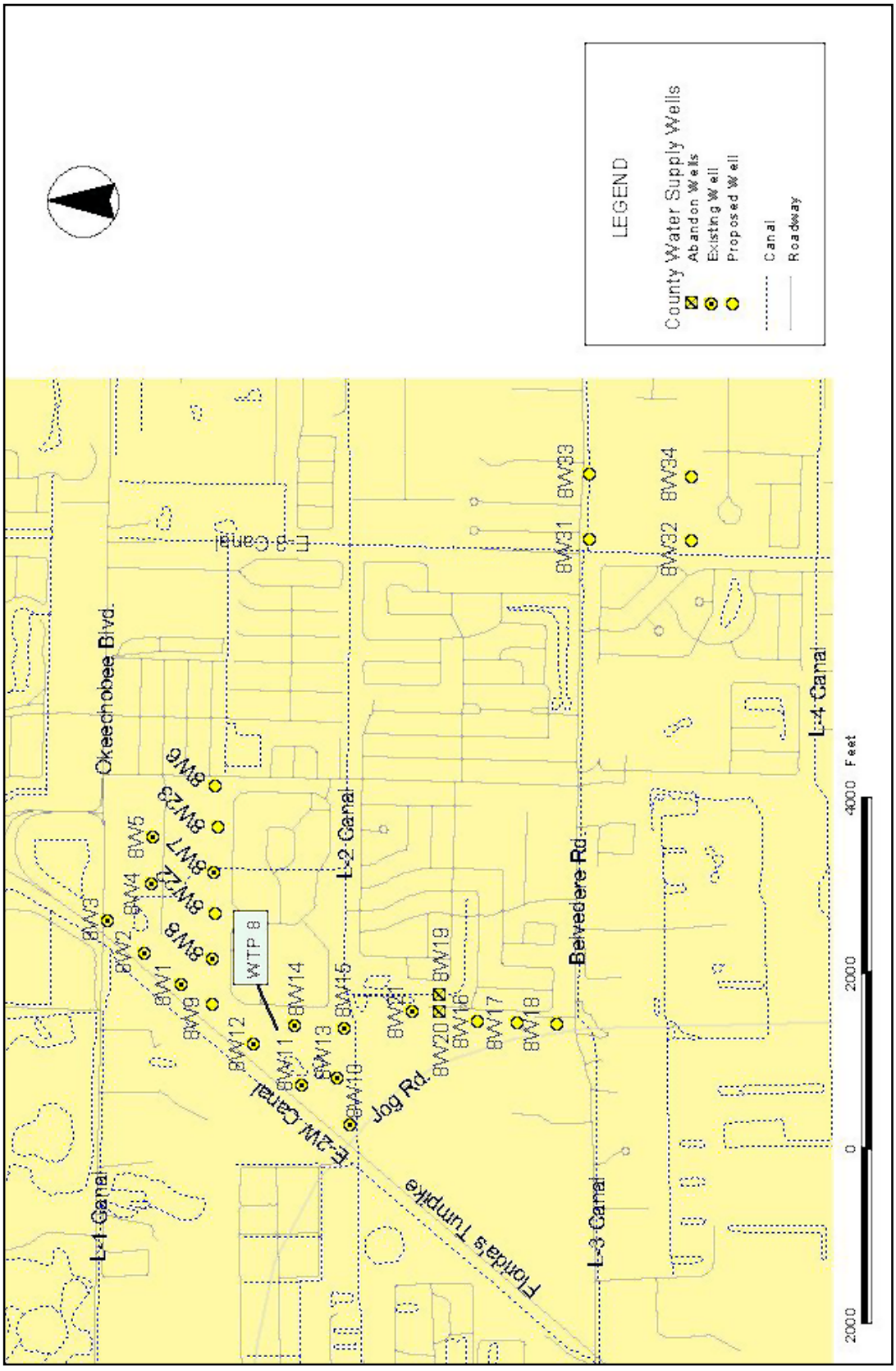


Figure 2-5
WTP 8 Wellfield

Table 2-5
Summary of the WTP 8 Wellfield

EXISTING WELLS YEAR 2000			NEW AND ABANDON WELLS YEAR 2003			WTP UP-RATING YEAR 2010			NEW MEMBRANE WTP YEAR 2020		
Well	Design Capacity (gpm)	Status	Well	Design Capacity (gpm)	Status	Well	Design Capacity (gpm)	Status	Well	Design Capacity (gpm)	Status
8W-1	1,000	Existing	8W-1	1,000	Existing	8W-1	1,000	Existing	8W-1	1,000	Existing
8W-2	1,000	Existing	8W-2	1,000	Existing	8W-2	1,000	Existing	8W-2	1,000	Existing
8W-3	1,000	Existing	8W-3	1,000	Existing	8W-3	1,000	Existing	8W-3	1,000	Existing
8W-4	1,000	Existing	8W-4	1,000	Existing	8W-4	1,000	Existing	8W-4	1,000	Existing
8W-5	1,000	Existing	8W-5	1,000	Existing	8W-5	1,000	Existing	8W-5	1,000	Existing
8W-7	1,000	Existing	8W-7	1,000	Existing	8W-7	1,000	Existing	8W-7	1,000	Existing
8W-8	1,000	Existing	8W-8	1,000	Existing	8W-8	1,000	Existing	8W-8	1,000	Existing
8W-10	1,000	Existing	8W-10	1,000	Existing	8W-10	1,000	Existing	8W-10	1,000	Existing
8W-11	1,000	Existing	8W-11	1,000	Existing	8W-11	1,000	Existing	8W-11	1,000	Existing
8W-12	1,000	Existing	8W-12	1,000	Existing	8W-12	1,000	Existing	8W-12	1,000	Existing
8W-13	1,000	Existing	8W-13	1,000	Existing	8W-13	1,000	Existing	8W-13	1,000	Existing
8W-14	1,000	Existing	8W-14	1,000	Existing	8W-14	1,000	Existing	8W-14	1,000	Existing
8W-15	1,000	Existing	8W-15	1,000	Existing	8W-15	1,000	Existing	8W-15	1,000	Existing
8W-19	1,000	Existing	8W-19	0	Abandon	8W-19	0	Abandon	8W-19	0	Abandon
8W-20	1,000	Existing	8W-20	0	Abandon	8W-20	0	Abandon	8W-20	0	Abandon
8W-21	1,000	Existing	8W-21	1,000	Existing	8W-21	1,000	Existing	8W-21	1,000	Existing
			8W-16	1,500	New	8W-16	1,500	Existing	8W-16	1,500	Existing
						8W-17	1,000	Proposed	8W-17	1,000	Existing
						8W-18	1,000	Proposed	8W-18	1,000	Existing
						8W-6	1,000	Proposed	8W-6	1,000	Existing
									8W-9	1,000	Proposed
									8W-22	1,000	Proposed
									8W-23	1,000	Proposed
									Well sites 8W-24 through 8W-27are designated for future contingency sites.		
									8W-31	1,000	Proposed
									8W-32	1,000	Proposed
									8W-33	1,000	Proposed
									8W-34	1,000	Proposed
TOTAL in gpm		16,000	TOTAL in gpm		15,500	TOTAL in gpm		18,500	TOTAL in gpm		25,500
TOTAL in mgd		23.0	TOTAL in mgd		22.3	TOTAL in mgd		26.6	TOTAL in mgd		36.7
[a] Capacity w/2 largest wells out of service		20.2	[a] Capacity w/2 largest wells out of service		18.7	[a]Capacity w/2 largest wells out of service		23.0	[a]Capacity w/2 largest wells out of service		33.1
Max. raw water required		16.8	Max. raw water required		16.8	Max. raw water required		21.1	Max. raw water required		29.1
Finished water capacity		16.0	Finished water capacity		16.0	Finished water capacity		20.0	Finished water capacity		24.0

[a] Capacity with two largest wells out of service is reported to show an acceptable level of raw water standby capacity.

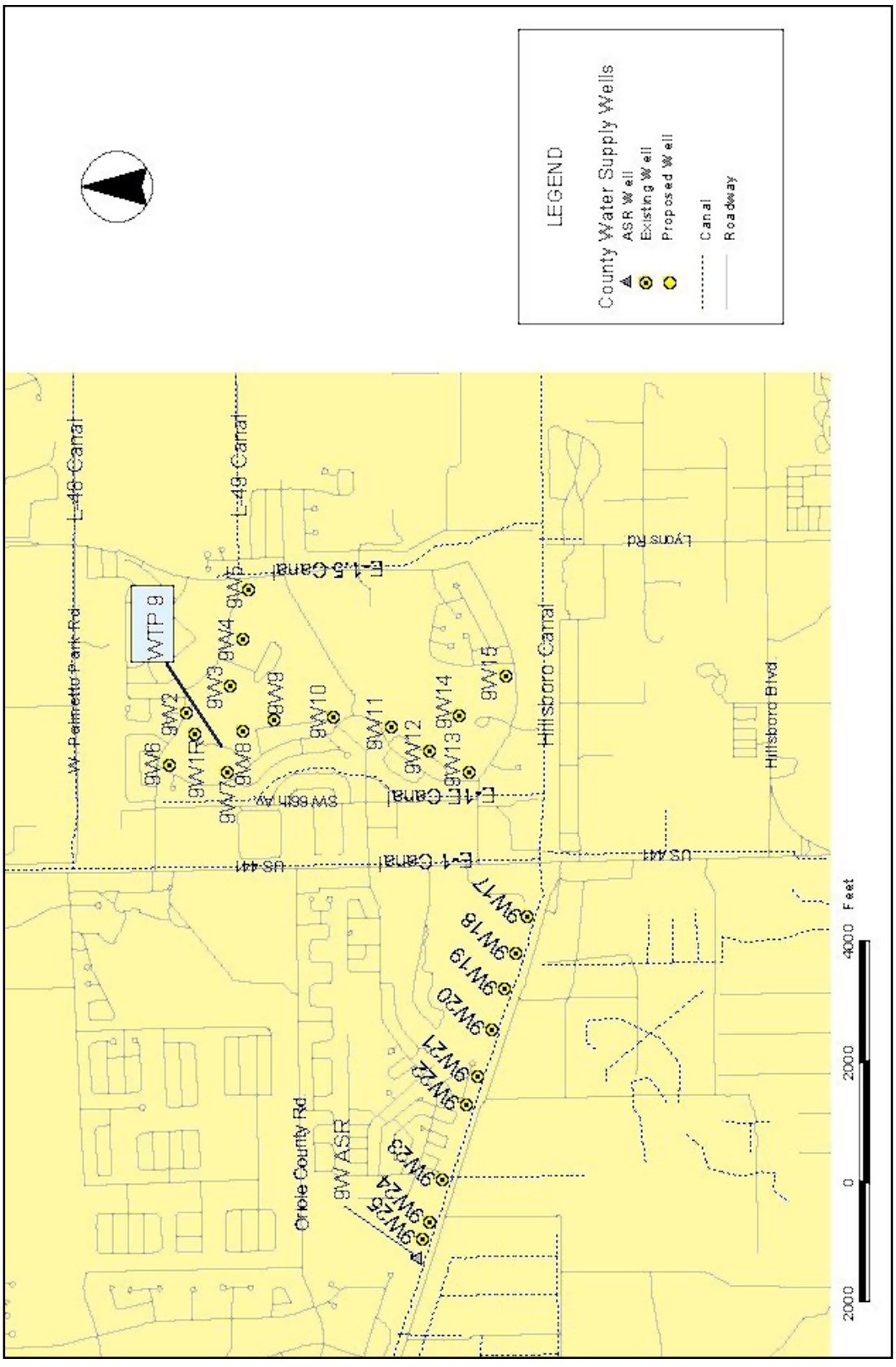


Figure 2-6
WTP 9 Wellfield

Table 2-6
Summary of the WTP 9 Wellfield

Well	Capacity (gpm)	Status
9W-1R	1,350	Existing
9W-2	1,000	Existing
9W-3	1,000	Existing
9W-4	1,000	Existing
9W-5	1,000	Existing
9W-6	1,000	Existing
9W-7	1,000	Existing
9W-8	1,000	Existing
9W-9	1,000	Existing
9W-10	1,000	Existing
9W-11	1,000	Existing
9W-12	1,000	Existing
9W-13	1,000	Existing
9W-14	1,000	Existing
9W-15	1,000	Existing
9W-16 was not constructed due to land use conflicts		
9W-17	1,350	Existing
9W-18	1,350	Existing
9W-19	1,350	Existing
9W-20	1,350	Existing
9W-21	1,350	Existing
9W-22	1,350	Existing
9W-23	1,350	Existing
9W-24	1,350	Existing
9W-25	1,350	Existing
TOTAL in gpm		**27,500 gpm**
TOTAL in mgd		**39.6 mgd**
Capacity with two largest wells out of service		**35.7 mgd**
Maximum raw water required		**32.8 mgd**
Finished water production capacity		**27.0 mgd**

[a] Capacity with two largest wells out of service is reported to show an acceptable level of raw water standby capacity.

Table 2-7
Summary of Existing and Proposed Well Capacity for the PBCWUD WTP Wellfield System

	Existing (2001)		Proposed (2002-2024)		Total through 2024	
WTP No.	No. of Wells	Wellfield Capacity (mgd)	No. of Wells	Wellfield Capacity (mgd)	No. of Wells	Wellfield Capacity (mgd)
2	14	18.4	13	27.4	27	45.8
3	16	23.9	10	22.0	26	45.9
8	16	23.0	11	13.7	25 [a]	36.7
9	24	39.6	0	0	24	39.6
Total System	**70**	**104.9**	**34**	**62.5**	**102**	**167.4**

[a] Wells 8W-19 and 8W-20 will be abandon in 2002.

TABLE 3-1

PALM BEACH COUNTY SERVICE AREA
Capacity, Current Demand
And Permit Conditions
January 2003

Facility	Existing Wellfield Capacity (mgd) (1)	Treatment Capacity (mgd) (1)	Current Demand (mgd) (2)	Permit Condition (3)
WTP 2	18.4	14.5	10.00	Current
WTP 3	23.9	15.3	10.39	Current
WTP 8	23.0	16.0	13.09	Current
WTP 9	39.6	27.0	12.62	Current
TOTALS	**104.9**	**72.8**	**46.10**	**N/A**

Sources:
1) Raw Water Master Plan, Montgomery, Watson, Harza, 2002

2) Finished water demand for fiscal year 2002. PBC Water Utilities, Engineering Department, 2003

3) For detailed information on conditions and duration of all permits see Permit Tables by water treatment plant in the last section of this report. Copies of all permits have also been included in that section. The County is currently processing a long-range water use permit with the SFWMD.

6 Alternative Water Resources

The County is actively pursuing and implementing alternative water resources. This program supports the SFWMD Lower East Coast Regional Supply Plan and Integrated Water Resource Strategy (IWRS) for reducing reliance on the regional shallow aquifer system. The IWRS for southeastern Palm Beach County involves various demand reducing, supply management, and augmentation techniques. The County is proactively expanding alternative water resources using several means including:

- Aquifer Storage and Recovery Wells
- Reclaimed Water Irrigation Systems
- Wetlands Treatment Cells
- Reuse of Membrane Concentrate

The County's alternative water resources program is multifaceted in that many benefits are realized.

- Minimizing dependence upon Surficial Aquifer and regional water supply system;
- Maintaining a steady raw water supply for water treatment plants;
- Reducing the amount of fresh water drained from the land and discharged to the ocean;
- Minimizing stressing of wellfields;
- Minimizing the "net" quantity of water withdrawn from the Surficial Aquifer;
- Providing landscaping water supply during drought conditions;
- Reducing reliance upon deep injection well system;
- Educating the public on the importance of water conservation in South Florida;
- Providing habitat for migratory birds and waterfowl and endangered species;
- Providing passive recreation opportunities for the public;
- Increasing suburban green space.

A summary of each alternative water resource is presented in this report section.

Aquifer Storage And Recovery Wells

Aquifer Storage and Recovery (ASR) is the simple concept of using an aquifer to inject excess fresh water for storage until times of high demand or water shortages, when it is then recovered. For example: high demand in Florida occurs during the dry season winter months with the influx of seasonal residents and tourists. ASR technology recovers the stored fresh water to accommodate times of peak demand.

The regional hydrology of southeastern Florida is conducive to utilizing ASR wells. A simplified version of the subsurface conditions in Palm Beach County is presented in **Figure 6-1**.

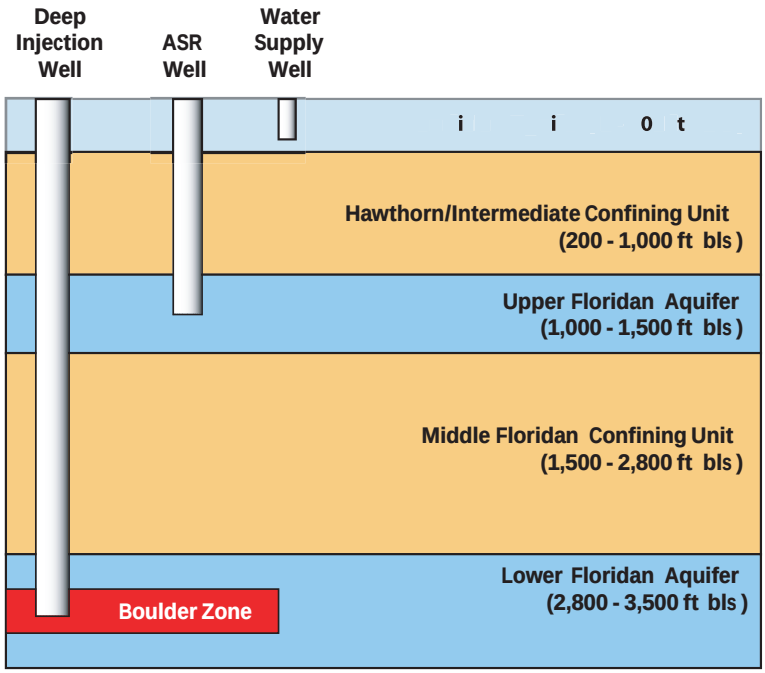


Figure 6-1
Regional Hydrogeology for Palm Beach County

Water supply for all four Palm Beach County water treatment plants is provided from wells extending into the Surficial Aquifer. The Surficial Aquifer is used for water supply because it has historically been able to satisfy demand and offers the most economical means of extracting water. Continued area development and population growth rates are creating concern with regard to future use of the Surficial Aquifer.

ASR wells offer the ability to utilize the Upper Floridan Aquifer. Water from the Surficial Aquifer is stored in the Upper Floridan during times of low demand. This water is then recovered and used to augment the water supply during times of high demand. It is anticipated that ASR technology will be used extensively throughout South Florida as an alternative water resource, as supported by the District's modeling results.

Several water use scenarios were modeled for the SFWMD's Lower East Coast regional water supply planning process and the Central & Southern Florida Project "Restudy" process. These models indicate ASR wells offer a significant water resource benefit for urban water supplies and the environment. Benefits to urban water supplies and environment include:

- Reducing dependence upon surface water resources during drought conditions,
- Minimizing stressing of wellfields,
- Maintaining a steady raw water supply for water treatment plants,
- Reducing the amount of fresh water drained from the land and discharged to the ocean during rainy periods.

ASR technology is a lower cost option than constructing supply wells and continuously pumping from the brackish Upper Floridan Aquifer. This method of water management is also relatively inexpensive in comparison to above ground storage. Land and tank farm construction costs, system operation, and required maintenance make the use of above ground storage tanks generally more expensive and cumbersome than storing the water underground using ASR technology.

The County is presently implementing two ASR well projects in southern Palm Beach County to meet local water demand during the dry season. The County has historically experienced fluctuations in water demand in the southern portion of the County. Additionally, the rising residential growth rate and continuing development of agricultural areas are increasing the overall water demand. The ASR wells will augment the raw water supply and minimize dry season withdrawals.

Water Treatment Plant 3 - ASR System

A raw water supply ASR system was constructed at WTP No. 3 in 1998. The system is presently in the testing and operational permitting phases. The ASR system consists of a 2 mgd ASR well, raw water supply line, raw water booster pump, and one Upper Floridan monitor well. All equipment and piping associated with the ASR well are located above grade on the plant site. A view of the system facing west is shown in **Figure 6-2**.

Figure 6–2
3W ASR System

ASR Well

The FDEP Class V ASR well was constructed as an open borehole in the Upper Floridan Aquifer to a total depth 1,155 feet below grade. The borehole was backfilled between 1,100 feet and 1,400 feet. The well consists of three concentric well casings. A 36-inch diameter steel surface casing was installed to a depth of 50 feet; followed by a 24-inch diameter

PVC casing to depth of 240 feet below grade. A 16-inch diameter PVC casing advanced to a depth of 1,050 feet.

Figure 6-3
3W ASR Wellhead

Above grade facilities include discharge head, connective piping, remote telemetry, nitrogen gas surge suppression system, reversible flow meter, and associated monitoring and operating controls. The well pump used for recovery is a submersible type with 100 feet of stainless steel flanged column pipe. The 316 stainless steel, multi-stage submersible turbine pump has a capacity of 1,500 gpm at 200 feet TDH, 125 horsepower motor. The ASR wellhead configuration is shown in **Figure 6-3**.

Floridan Monitor Well

A monitor well was constructed within the Upper Florida Aquifer on the WTP No. 3 site to monitor conditions in the open-hole depth of the ASR well. The monitor well consists of three casings. A 16-inch steel surface casing was installed within a 16-inch borehole to depth of 50 feet below grade.

A nominal 10-inch diameter borehole was advanced to depth 1,400 feet. A 10-inch steel casing was installed from the surface to depth 1,050 feet below grade. The 10-inch borehole was plugged with cement from 1,050 feet to 1,400 feet below grade to isolate the open-hole monitor zone. Cement grout was pumped inside the 16-inch borehole to stabilize the 10-inch casing.

Upper Floridan water is withdrawn from the aquifer through a 5-inch diameter Certaloc SDR 17 PVC casing. The 5-inch casing extends through the 10-inch steel casing to depth 1,050 feet. A bentonite seal was constructed between the 10-inch and 5-inch casings to prevent channeling of the Floridan water between the two casings. The Upper Floridan aquifer is protected from surface water migration and contamination via the bentonite seal. A 2-inch stainless steel sample line and blow-off line were constructed at the wellhead, as shown in **Figure 6-4**.

Figure 6-4
3W Monitor Well

Raw Water Supply

The 3W ASR well is intended to primarily function as an auxiliary raw water supply source. Locating the ASR well on the plant site facilitates the availability of a sufficient raw water supply source for the system. A 12-inch line connects the existing plant 30-inch raw water feed line to the ASR well. The current piping configuration allows raw water from wells 3W-8 through 3W-15 to be pumped into the ASR well for storage. Composite water from these wells will be used to "fill" the ASR bubble with raw water for storage. Each of the supply wells was constructed within the Surficial Aquifer to depth approximately 150 feet below grade. Individual wells are not dedicated to the ASR system. This strategy provides adequate redundancy of the raw water supply for the ASR.

A raw water booster pump is used to overcome the head associated with the wellhead construction features and ASR well depth. The 60 horsepower booster pump sits on a pedestal near the ASR well and is sized for 2,000 gallons per minute at 90 feet TDH. The booster pump is painted blue as shown in **Figure 6-5**.

Figure 6-5
Raw Water Booster Pump

Water Treatment Plant 9 – 9W ASR System

A raw water supply ASR system is presently under construction for WTP No. 9, in cooperation with the District. The ASR system consists of one 5 mgd ASR well, five 1.44 mgd surficial aquifer supply wells, and one Upper Floridan monitor well located along the Hillsboro Canal beginning at the intersection of State Road 7. The ASR system will provide a water supply for the treatment plant and indirect aquifer recharge to the adjacent Hillsboro Canal.

ASR Well

The 5 mgd Class V ASR well shall be constructed as an open borehole in the Upper Floridan Aquifer to total depth 1,200 feet below grade. The well consists of a 24-inch diameter steel casing advanced to a depth of 1,010 feet and a 12-inch column pipe with a submersible pump installed approximately 120 feet below grade. Above grade facilities include discharge head, connective piping, remote telemetry, and associated monitoring and operating controls. The well pump used for recovery shall be a submersible type with stainless steel welded column pipe. The pump shall be 316 stainless steel, multi-stage, capacity 3,500 gpm at 170 feet TDH, and 300 horsepower motor.

ASR Monitor Well

A Floridan Aquifer monitor well shall be constructed approximately 750 feet from the ASR well to monitor conditions in the open hole depth of the ASR well. A nominal 14-inch diameter borehole shall be advanced to depth 1,650 feet. The borehole shall be plugged with cement from 1,225 feet to 1,650 feet to isolate the upper section of the Floridan Aquifer. A 6.625-inch diameter fiberglass casing shall extend inside the 14-inch diameter steel casing to depth 1,007 feet. The open hole monitor zone shall extend from 1,007 feet to 1,225 feet below grade.

Surficial Supply Wells

Nine 1.44 mgd groundwater production wells (9W-17 through 9W-25) were constructed along the Hillsboro Canal. Five of these wells (9W-21, 9W-22, 9W-23, 9W-24, and 9W-25) will be used to "fill" the ASR bubble with raw water for storage during the wet season and provide raw water supply during the dry season. Each of the supply wells was constructed within the Surficial Aquifer to depth approximately 150 feet below grade. A 16-inch diameter stainless steel well screen extends between 90 and 150 feet below grade. Wells screens are attached to a 16-inch diameter Schedule 40 PVC casing. Each well is equipped with a submersible pump set approximately 50 feet below grade. Well pumps are 4-stage units rated for 1,500 gpm at 215 feet TDH with 100 horsepower motors. A typical supply well similar to those constructed for use at the 9W ASR is shown in **Figure 6-6**.

Figure 6-6
Typical 9W ASR Supply Well

Reclaimed Water System

In 1990, the County initiated a reclaimed water program at the Southern Region Water Reclamation Facility (SRWRF). Ten years later, the program has grown into the largest reclaimed water system in Southeast Florida with a capacity of 22 mgd. Implementing treatment of secondary wastewater effluent to reclaimed water standards for irrigation use constitutes an innovative alternative source of water supply. The use of reclaimed water also minimizes the conventional practice of disposal of secondary wastewater effluent by deep well injection. A brief description of the reclaimed water system and the benefits provided are discussed herein.

Reclaimed Water Capacity and Demand

The SRWRF 30 mgd wastewater treatment plant (**Figure 6-7**) was constructed in 1991 to replace five traditional wastewater treatment plants. Prior to the development of the reclaimed water system, all effluent was disposed via deep injection wells. The County has implemented multiple projects to recycle effluent and reduce use of the deep injection wells. These efforts have resulted in reuse of approximately 30 percent of the flow currently treated at the facility. The reclaimed water system has served as the County's primary alternative water resource.

Figure 6-7
Southern Region Water Reclamation Facility

At its inception, the reclaimed water system was restricted to use at the SRWRF. At the time, public perception of reclaimed water was considered uncertain. The initial 1990 phase of the reclaimed water program consisted of sand filters, a chlorine contact chamber, and high service pumps for a total production capacity of 4 mgd. The reclaimed water was pumped on-site to provide recycled water for plant processes and irrigation.

In 1996, the County proactively sought to increase local use of reclaimed water. The golf courses and large residential communities near the SRWRF provided a source of potential end-users of reclaimed water. Additional sand filters and transmission pipelines were constructed to increase the reclaimed water production capacity to 6 mgd. This expansion focused on users in the immediate vicinity of the SRWRF. A typical golf course irrigation system using reclaimed water is shown in **Figure 6-8**.

Figure 6-8
Golf Course Irrigation with SRWRF Reclaimed Water

In 1997, Palm Beach County Adopted a Reclaimed Water Ordinance (Ordinance No. 97-12) and established a Mandatory Reclaimed Water Service Area surrounding the SRWRF. The mandatory service area required new developments within a one-mile radius of the SRWRF to install and utilize reclaimed water. This innovative local government initiative is a model for other governments.

Public response to the County ordinance was improving such that in 1998, PBCWUD added an additional 16 mgd of filters and associated facilities. The expansion was required to accommodate demand projections from increased local development, residential usage, and golf courses. This expansion increased the total reclaimed water production capacity to 22 mgd, and enabled approximately 30% of the SRWRF effluent to be reused instead of deep injected into the Boulder Zone.

Recently the County has received many requests to extend the County's reclaimed water system to provide reclaimed water to communities and golf courses outside the mandatory service area. In response to the increasing reclaimed water demand, PBCWUD is designing a 6 mgd expansion to the SRWRF infrastructure to provide a total reclaimed water production capacity of 28 mgd in 2003.

As consumer demand for reclaimed water continues to increase, the County plans to expand the reclaimed water distribution piping system. The initial distribution system piping was constructed in 1997 (**Figure 6-9**) in association with the 1998, 16 mgd expansion of the SRWRF reclaimed water system. The County has designed a two-mile extension of the reclaimed water distribution system, which is scheduled for construction in 2002. Subsequent distribution system expansions are scheduled at five-year increments in 2007, and 2012. These expansions will be sufficient for the County to match reclaimed water needs with available SRWRF effluent as facility flows increase.

Aquifer Recharge Benefit

The County's reclaimed water program for golf course and residential irrigation in the areas of Jog Road and Hagen Ranch Road between Boynton Beach Boulevard and Delray West Road increases available water resources. The extensive use of reclaimed water serves to reduce ground water and surface water withdrawals for irrigation purposes.

Water reclamation and reuse present the opportunity for conservation of regional water resources and recharge of the surficial aquifer system. Implementation and continued expansion of the reclaimed water system will directly result in a reduced dependence on both the Surficial Aquifer and the regional water supply system. Reclaimed water can be stored underground by allowing part of the irrigation water to filter into the aquifer; thereby recharging the aquifer. At peak demand in the spring and during times of drought, reclaimed water can be used for irrigation, which reduces the demand on our drinking water supply.

Environmental and Public Benefits

The use of reclaimed water for irrigation purposes provides many benefits to the environment and the public. The nitrogen and phosphorus concentrations in reclaimed water promote healthy landscapes. There are no irrigation restrictions due to drought conditions or water restrictions associated with reclaimed water. Therefore, the use of reclaimed water helps residents and commercial facilities

Figure 6-9
SRWRF Reclaimed Water System Distribution Piping

maintain healthy and colorful landscape, as shown in **Figure 6-10**. Local landscape is an important consideration for the tourist-oriented culture present in south Florida.

Figure 6-10
Landscape Irrigated with Reclaimed Water from SRWRF

In addition to the improved landscape and aquifer recharge benefits; using reclaimed water significantly reduces the quantity of flow directed to the deep injection wells. All flow directed down the deep wells is essentially "lost" for future use. An equal volume of surficial aquifer water must be withdrawn to compensate for the wasted flow down the deep wells. Reducing our reliance on deep well disposal of effluent increases the available raw water supply.

Indirect Aquifer Recharge Via Wetlands

Wetlands offer extensive environmental benefits including flood water retention, shoreline protection, water-quality improvement, and wildlife habitat. The County began implementing wetland projects in 1997 (**Figure 6-11**) to accept secondarily treated wastewater to reduce the amount of effluent disposed through deep well injection. Prior to wetland development, all of this potential water resource was injected into the Boulder Zone for disposal. The deep injection strategy works well in preventing waste from migrating upward and contaminating the Surficial Aquifer. However, it does not offer any beneficial reuse, recycling, or water conservation measures. Given the limited fresh water supply available in the Surficial Aquifer, the County decided to actively pursue means of increasing recharge to the local groundwater supply; thereby reducing the net amount of water withdrawn. Indirect aquifer recharge using wetlands techniques has become a successful tool for educating the public on the importance of water conservation in South Florida. Visitors to the County wetlands are able to observe scenes from "native Florida" and gain an understanding of water resources issues unique to Florida.

The wetlands were designed to treat the highly treated secondary effluent with advanced natural biological processes to further reduce nutrient levels. Treated water from the wetlands percolates into the surficial aquifer, and may eventually be diverted into the LWDD L-30 Canal, where it would enhance water resources for irrigation of agricultural crops and to recharge the local groundwater. The beneficial use of water from the wetlands will help to reduce this area's reliance upon water from groundwater wells and the regional surface water system. Additionally, the wetlands are valuable in providing vegetated and open water habitat for migratory birds and waterfowl in this region.

Figure 6-11
Wakodahatchee Wetlands

Wakodahatchee Wetlands

The Wakodahatchee Wetlands (Seminole for "created waters") is located in suburban Delray Beach in southwestern Palm Beach County. The Wakodahatchee site is bounded on the north by the LWDD L-30 Canal, on the south by the LWDD L-31 Canal, on the east by the Palm Beach County Water Treatment Plant 3, and on the west by residential subdivisions. Several residential neighborhoods are located adjacent to the site. An aerial view of the Wakodahatchee Wetlands is shown in **Figure 6-12**.

Figure 6-12
Aerial View of Wetlands

System Description

The Wakodahatchee Wetlands are located approximately one mile east of the SRWRF. Highly treated chlorinated effluent is pumped from the SRWRF to the Wakodahatchee Wetlands through a 36-inch diameter transmission line installed parallel to the L-30 Canal. The Wakodahatchee Wetlands system is comprised of eight treatment cells (**Figure 6-13**) with a total design capacity at normal operating levels of approximately 20 million gallons. The wetland area totals 39 acres, with individual wetland cells ranging from 2.3 acres to 10.9 acres. The remaining area is occupied by interior and exterior berms, which have been planted with a diverse array of upland, native, and wetland plant species.

Water entering each of the inlet ponds is discharged into an initial 5-foot wide open water zone across the width of the wetland pond. Water gravity flows through a box culvert, along the length of each cell, into the next down gradient wetland. Each culvert has an adjustable weir to control the wetland stage elevation. Wetland water depths are expected to be controlled at an average depth of about 0.5 to 1.0 foot, but may be expected to rise as much as an additional 2 feet in response to direct rainwater inputs. Weir widths are sized to allow peak flows to be stored within the wetlands, and then rapidly lowered to the design elevation.

All flows through the constructed wetland are combined in the final vegetated cell before discharge into the wetland effluent pump station though an 18-inch diameter PVC pipe. Submersible pumps are controlled based upon the pump station wet well elevation. Water percolates from the ponds into the surficial aquifer. During the present testing period, the remaining flow from the wetlands is pumped to the existing Water Treatment Plant 3 deep injection well system. The County has applied for a National Pollutant Discharge Elimination System (NPDES) permit to discharge a portion of this flow into the LWDD L-30 Canal to increase the amount of indirect aquifer recharge.

Figure 6-13
Natural Treatment Cells

Environmental Benefit

Enhancement of approximately 56 acres of former percolation ponds into thriving wetland and open water habitats was completed in 1997. Approximately 70% of the wetland area is vegetated by native emergent, forested, and transitional wetland species designed to emulate South Florida wetland plant communities. The Wakodahatchee Wetlands is considered a significant wildlife resource for waterfowl, wetland-dependent birds, and other wildlife. According to monthly monitoring data prepared by PBC Department of Environmental Resource Management (ERM) and observations reported by the Audubon Society, Wakodahatchee currently provides habitat for 119 species of birds, including 12 priority waterfowl species and 12 priority migratory species. Additionally, at least two federally listed species and nine state listed species of birds nest at Wakodahatchee indicating the system is providing suitable avian habitat (**Figure 6-14**).

Figure 6-14
Wetland Bird

During its first year of operation, an average of 651 birds were noted during each monthly survey. The wetland increases the available local habitat for bird roosting, foraging, and nesting. Overall bird populations are expected to benefit from the constructed wetland. Several state listed endangered, threatened and species of special concern use the Wakodahatchee Wetlands, including the American alligator.

Public Benefit

Public use of the Wakodahatchee Wetlands is limited to avoid excessive vehicle congestion and pedestrian traffic in the plant and surrounding neighborhoods. Site circulation is through the entrance road off Jog Road. The site facilities include a parking lot, information kiosks, boardwalk, and interpretive signage.

Hiking circulation follows a route through a system of boardwalks into marsh and habitat islands. Hikers have the opportunity to walk along a path that varies in elevation from the top of the dike down through the marsh and open water and finally to the central islands. The boardwalk has a series of interpretive signage panels designed to inform and educate the hiker on the natural systems and wildlife. The trail is approximately one mile long, and was designed to be a series of loops with one entrance for security purposes (**Figure 6-15**).

Figure 6-15
Mile Long Boardwalk

Winsberg Farm Wetland Restoration

Based upon the demonstrated ecological success and public acceptance of the Wakodahatchee Wetlands, the County has decided to pursue another wetland project- the Winsberg Farm Wetland Restoration Project. The County has acquired 175 acres of agricultural land (**Figure 6-16**) for restoration to historic wetland, open-water, and upland habitats. The Winsberg Farm Wetland will be used by a variety of waterfowl and wetland-dependent wildlife species. The wetland will also provide valuable water resource, recreational, educational and research opportunities.

Figure 6-16
Winsberg Farm Site

System Description

The existing Winsberg Farms property consists of more than 200 acres of active row crop and a native plant nursery. The site is located in Palm Beach County and is bordered by Hagen Ranch Road to the west, Jog Road to the east, and the LWDD L-29 and L-30 Canals to the north and south, respectively. The future wetlands are comprised of three tracts totaling approximately 175 acres. These tracts surround an out parcel where the current landowners will continue to reside after the project is completed. The conceptual design of the Winsberg Farms Wetland is presented in **Figure 6-17**.

The site is divided into four-wetland cell in two parallel trains. Subtracting berms and public access areas, the total wetland restoration area is approximately 120 acres and the general flow path is from the west to the east. Up to 10 mgd of highly treated effluent from the SRWRF will enter wetland cells 1 and 2. Effluent from these two cells will by conveyed to cells 3 and 4 using weir gates to control the amount of flow. The wetland system will be designed and permitted as a percolation system. Under normal operating conditions, the wetland cells will only receive as much treated effluent from the SRWRF as can be removed through the combined effects of evapotranspiration and percolation. An auxiliary 4-mgd pump station will be constructed to route excess water from the wetland to the County's deep injection wells.

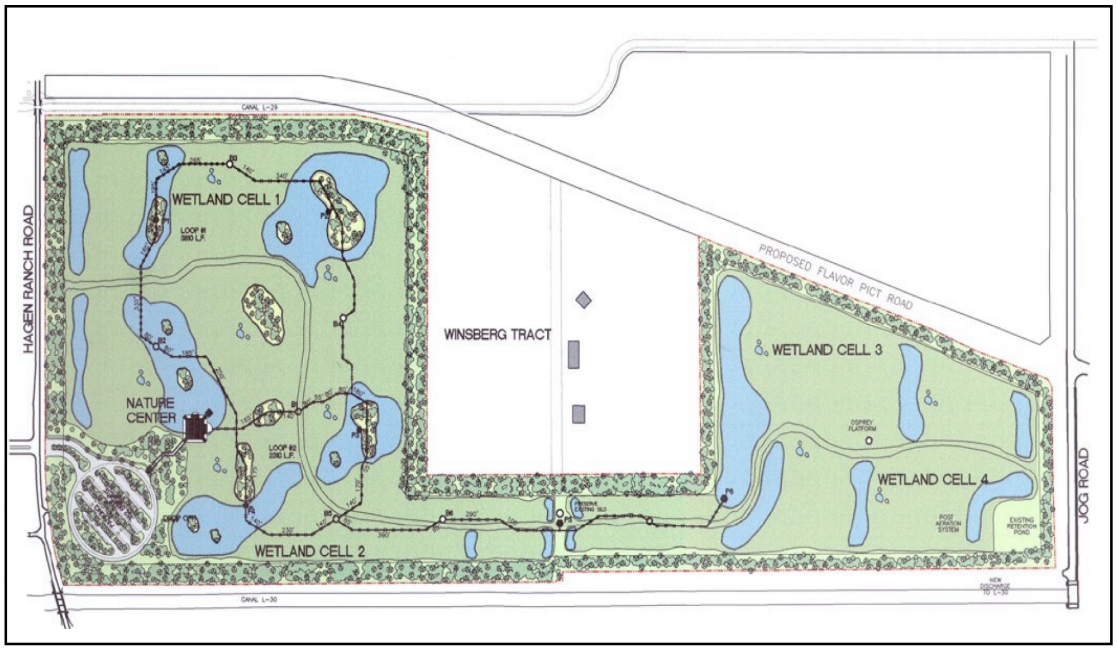


Figure 6-17
Conceptual Design of Winsberg Farm Wetland Restoration Project

The water balance in the wetland system is based on a normal operating depth in the emergent marsh zones of one foot. The total depth will increase to three feet during extreme rainfall events. This will allow for temporary storage of more than 73 million gallons.

Environmental Benefit

Palustrine emergent wetland areas will be primary habitat types constructed in this project. The wetland type is considered a decreasing habitat type in Florida and in the United States. Palustrine wetlands have declined more than any other wetland type in Florida due to conversion of land for agriculture and development. This wetland project will increase the total extent of natural areas in an otherwise urban setting by restoring 175 acres of vegetable farmland to a rich diverse native marsh, cypress swamp, tropical hammock, and pure flatwoods.

The Winsberg Farm Wetlands will improve abundance and diversity of native plant and animal species. This project will provide additional habitat for wildlife known to occur at the Wakodahatchee Wetland. Approximately 26 acres of open water areas will attract waterfowl and diving birds; 17.5 acres of uplands areas will provide shrubs and snags for nesting, resting, breeding and feeding activities; and the emergent marsh areas will attract wading birds and other wetland-dependent birds (**Figure 6-18**).

Figure 6-18
Wetland Bird Habitat

This wetland project will improve the availability of freshwater though recharge. These constructed wetland areas will provide a final "polishing" of 6 to 8 mgd of pretreated waste water and limit the amount of water that must be disposed through deep-well injection or similar methods. This treated water may eventually be discharged to the LWDD L-30 Canal, where it would be used to irrigate agricultural crops and recharge the groundwater. The quality of water in the receiving canals is expected to be maintained with the wetland discharge.

Public Benefit

The Winsberg Farm Wetland Project will increase suburban green space by 170 acres. The walking trails along the two miles of boardwalk will provide significant recreation opportunities for the community. The wetland will help educate the community on the importance of wetlands, environmentally beneficial alternatives for wastewater treatment and wildlife viewing.

In addition to the walking trails, the Winsberg Farms Wetland Project will include a 10,000 square foot world-class Interpretive Center. The Center will provide detailed information to the public on the hydrology, ecology, and restoration of South Florida ecosystems. This project will offer a living laboratory for school groups and community organizations.

Membrane Concentrate Reuse

PBCWUD's alternative water resources program incorporates components from the County's water treatment and wastewater treatment facilities. The SRWRF reclaimed water system is the primary resource "reuse" mechanism implemented by the County. In 1999, the County began routing a portion of the membrane treatment waste stream, (membrane concentrate) produced at Water Treatment Plant 3 Membrane Softening Facility (WTP) to the SRWRF (**Figure 6-19**). The membrane concentrate flow contains concentrated organics and minerals removed from the raw water. It is blended with the filtered secondary effluent upstream of the reclaimed water chlorine contact basins. A blend

ratio of at least five parts reclaimed water to one part membrane concentrate is maintained.

Figure 6-19
Membrane Concentrate Line between WTP 3 and SRWRF

Presently 1 mgd of membrane concentrate is used to augment the reclaimed water supply. WTP 3 is scheduled for expansion in the Year 2004. It is anticipated that an additional 3 mgd will be directed to SRWRF, for a total concentrate blend capacity of 4 mgd. Recycling the membrane concentrate not only increases the reclaimed water supply and contributes to aquifer recharge; it also reduces use of the deep injection well at WTP 3.

Net Raw Water Demand

By providing an alternative water supply for irrigation purposes and reducing the dependence on surface water and ground water resources, less fresh water is needed from the regional water supply system. The environmental benefit resulting from the use of alternative water resources extends the life of the Surficial Aquifer System.

Impact on Water Cycle

Traditional teaching indicates water is neither created nor destroyed. Rather it changes form continuously through the water cycle. The historical water cycle for South Florida municipalities is presented in **Figure 6-20**. The cycle begins with pumping surface water or groundwater to a water treatment facility. Treated water is then distributed to consumers. Wastewater is then collected from consumers and treated prior to disposal. Although the waste streams generated from the water and wastewater treatment processes are not destroyed, they are typically injected into the Boulder Zone; essentially rendering the water unavailable or lost for future use.

Alternative water resources enable municipalities to enhance the water cycle as shown in **Figure 6-21**. Augmenting the quantity of water available for raw water supply decreases the net withdrawal. Minimizing the amount of waste injected into the Boulder Zone through deep injection wells reduces the volume of lost water. The County's aggressive Alternative Water Resources Program enhances regional raw water supply by 1) recharging the Surficial Aquifer, 2) storing fresh water underground, and 3) recycling process waste streams.

A schematic of the County's program is provided in **Figure 6-22**. The Surficial Aquifer is recharged by wetlands, reclaimed water irrigation systems, blending membrane concentrate with reclaimed water and by using filter wash water to recharge local canals. The County's raw water supply is directly increased by aquifer storage and recovery wells and by blending raw water with filter wash water.

Net Raw Water Demand – Average Daily Flow

The increase in average daily raw water demand imposed on the Surficial Aquifer can be minimized by indirect and direct aquifer recharge. The County's Alternative Water Resources Program effectively reduces the raw water withdrawn for irrigation purposes from the Surficial Aquifer by 15 mgd currently and by 41 mgd in the Year 2024. A summary of the County's alternative water resources on an average daily flow basis is shown in **Figure 6-23**. It is important to note that the current reclaimed water irrigation demand is expected to significantly increase upon completion of reclaimed water pipeline capital improvements projects currently designed.

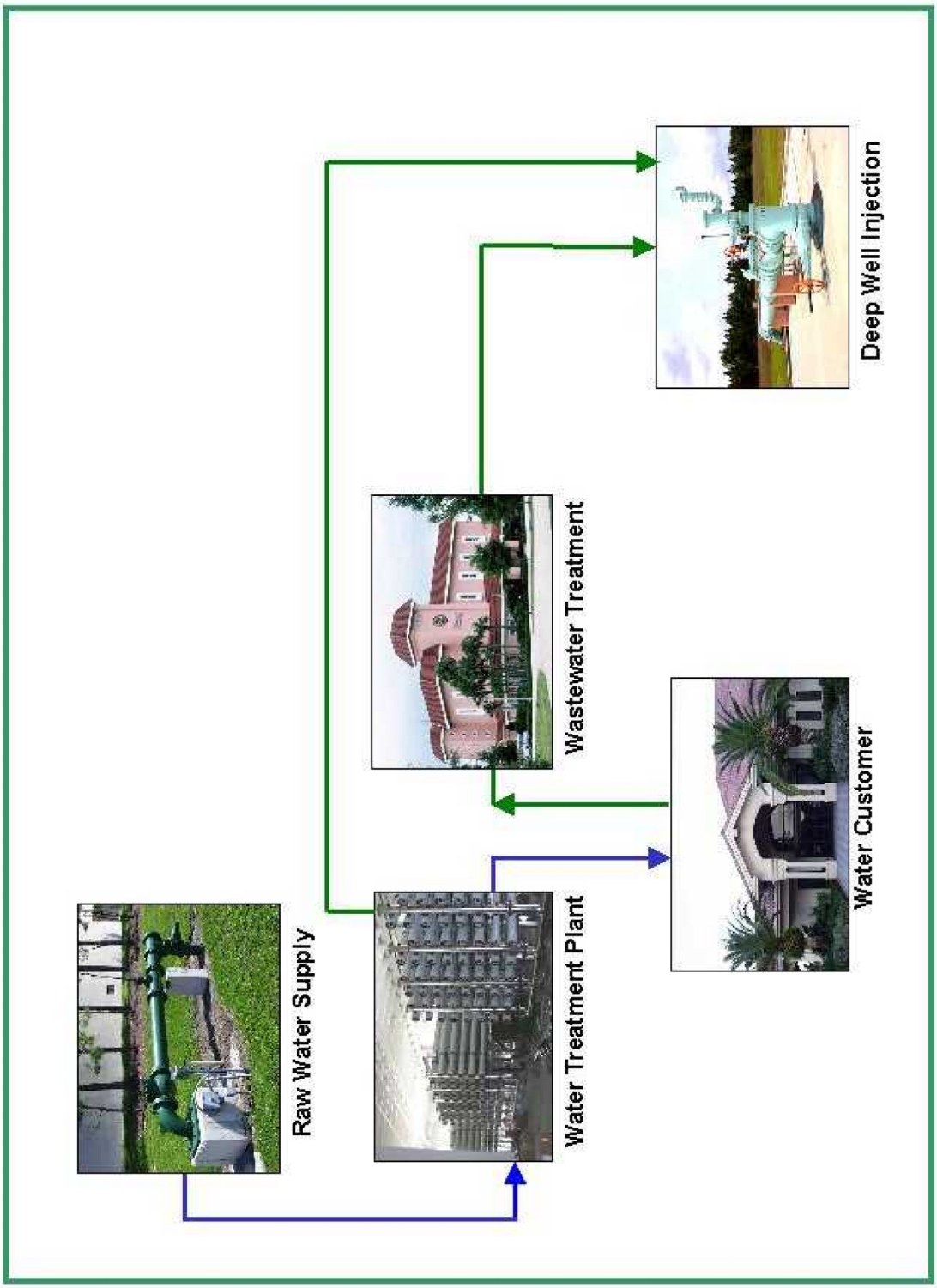


Figure 6-20
Historical Municipal Water Cycle

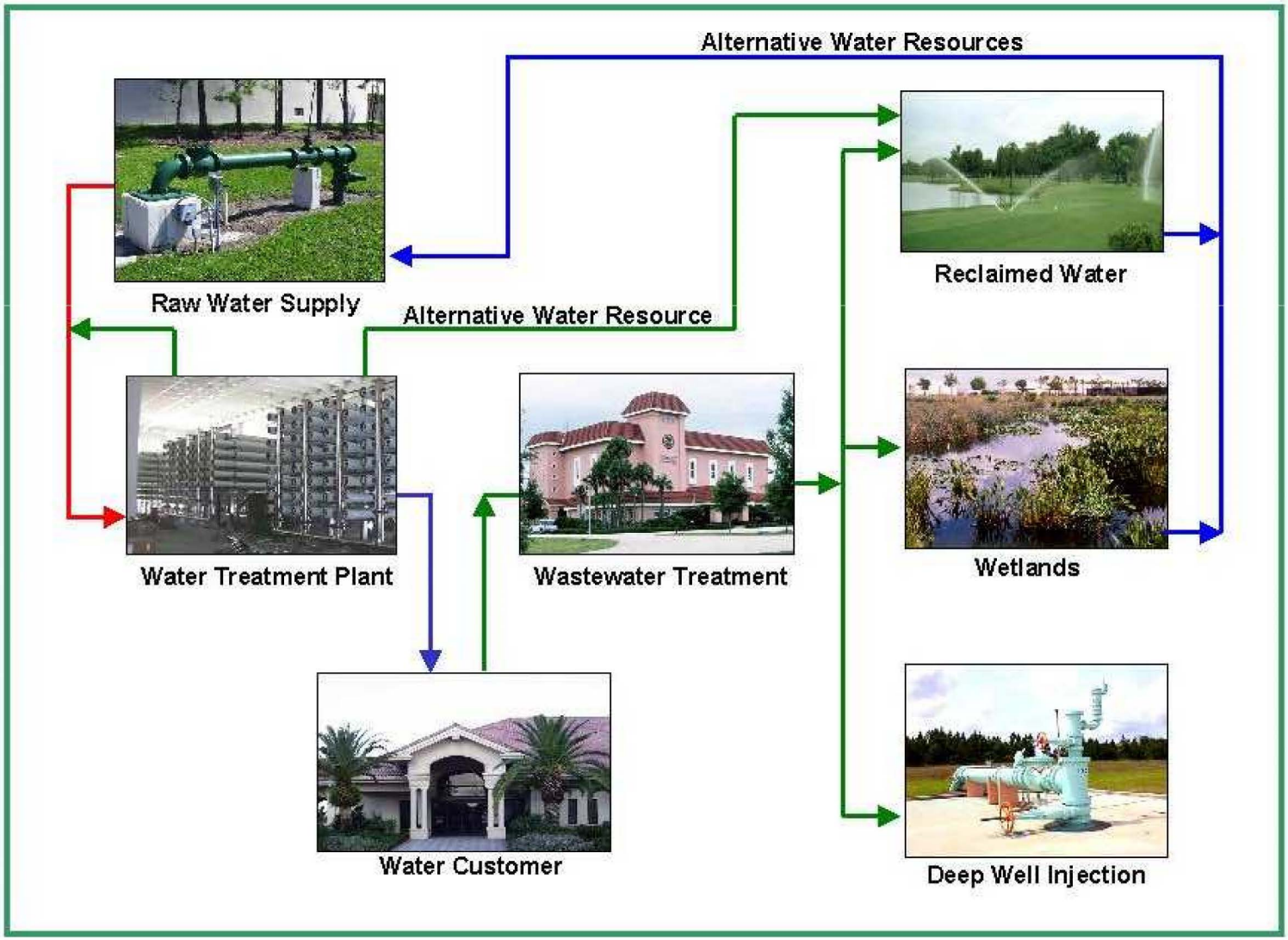


Figure 6-21
Municipal Water Cycle with Reuse Benefit

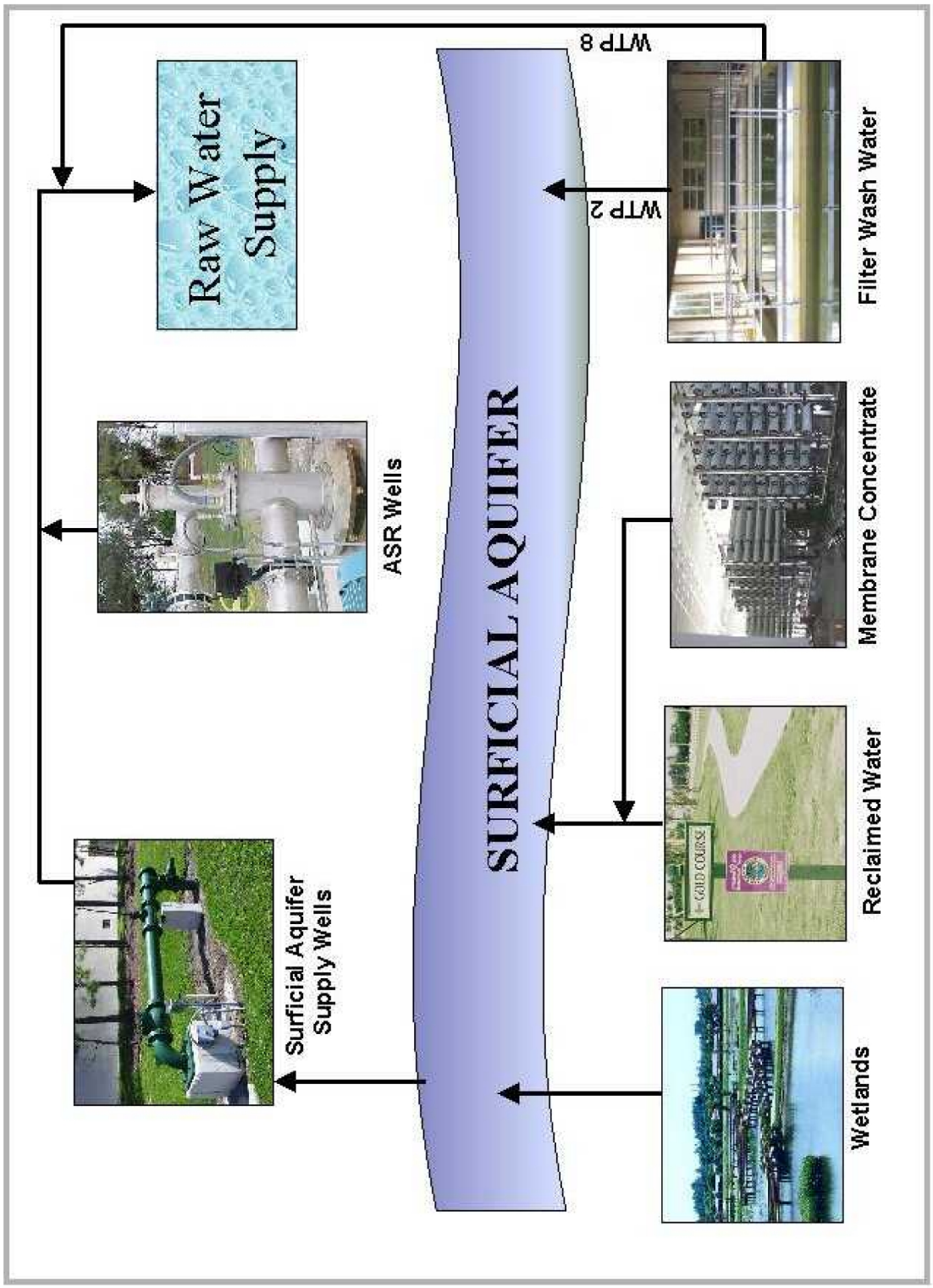


Figure 6-22
Alternative Water Resources Schematic

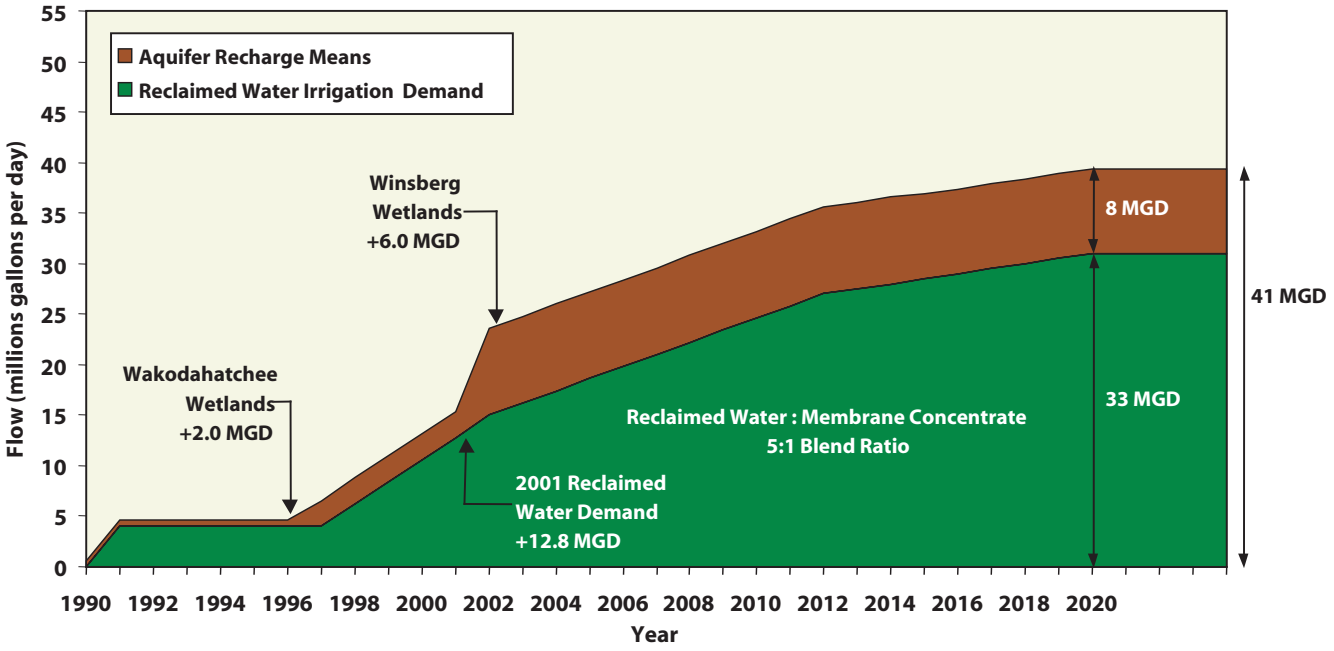


Figure 6-23
Average Daily Flow
Palm Beach County Alternative Water Resources

Under average daily flow conditions, aquifer recharge is achieved through reclaimed water irrigation, wetlands aquifer recharge, and filter wash water canal recharge. The bulk of the average daily alternative water resources usage is attributed to the consumer reclaimed water demand. The average daily alternative water resources usage will continue to increase until the irrigation demand matches the reclaimed water capacity of SRWRF and the availability of membrane concentrate for blending.

The extended drought in South Florida has served to promote reclaimed water education, public perception, and ultimately demand. Membrane concentrate from WTP 3 is blended with the reclaimed water at a ratio of 5:1. The volume of concentrate blended is absorbed into the consumer irrigation demand shown in **Figure 6-23**.

An increase in local aquifer recharge is expected under average daily flow conditions in the Year 2002 when the new Winsberg Wetlands become fully operational. After 2002, aquifer recharge is expected to steadily increase at a rate equal to the reclaimed water irrigation demand. The County's Alternative Water Resources Program presented in this document, indicate usage will continue to increase under average daily flow conditions through the Year 2024, as shown in **Figure 6-23**.

The net effect of the alternative water resources upon the County's local raw water demand is presented graphically in **Figure 6-24**. The raw water demand required to produce sufficient quantities of potable water for consumers is offset by the amount of aquifer recharge. As previously discussed, aquifer recharge reduces the net amount of water withdrawn from the Surficial Aquifer.

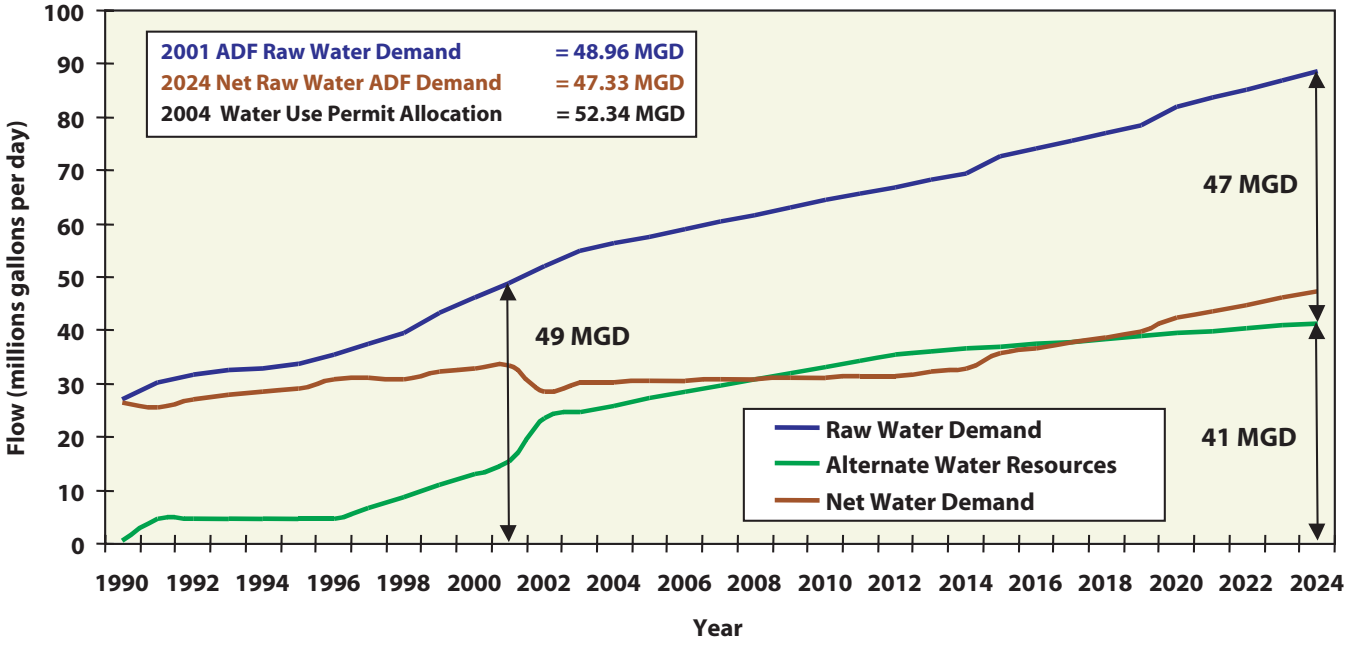


Figure 6-24
Average Daily Flow
Palm Beach County Net Raw Water Demand

The County's current SFWMD 2004 Water Use Permit (No. 50-000135) states system-wide allocation shall not exceed 19,104 million gallons per year under Limiting Condition No. 10. This is equivalent to approximately 52 mgd on an average daily flow (ADF) basis. The County is presently using an estimated 49 mgd of raw water and has a net raw water demand of 33 mgd. Although the 2024 raw water demand increases to 88 mgd, the County's Alternative Water Resources Program maintains the 2024 net raw water demand (47 mgd) below the current permitted raw water allocation (52 mgd). This indicates that the County will offset all increased raw water demand over the next 24 years. The difference between our raw water allocation and increased raw water demand will be offset by our Alternative Water Resources Program.

Net Raw Water Demand – Maximum Daily Flow

The impact of the Alternative Water Resources Program is more pronounced under maximum daily flow (MDF) conditions. As previously discussed, the County is in the process of implementing several alternative water resource projects. These projects are scheduled to be complete by the end of the Year 2006, at which time the use of the County's alternative water resources capacity will reach a plateau. After 2006, the alternative water resources are expected to provide a steady and reliable means of recharging the Surficial Aquifer. A summary of the County's alternative water resources on a maximum daily flow basis is shown in **Figure 6-25**.

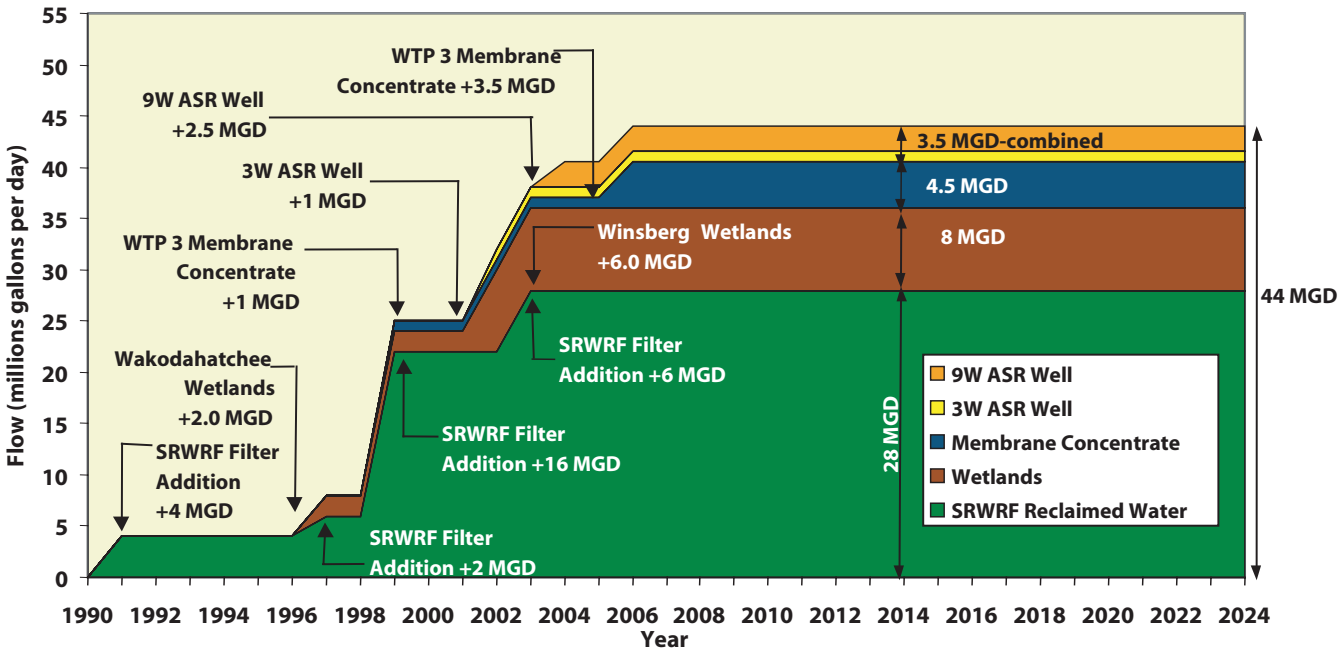


Figure 6-25
Maximum Daily Flow
Palm Beach County Alternative Water Resources

The primary projects contributing to the 2006 build-out include the following:

- 1999 – Membrane Concentrate Pipeline, SRWRF Expansion
- 2002 – 3W ASR Well, 9W ASR Well
- 2003 – SRWRF Expansion
- 2004 – Winsberg Farms Wetlands
- 2006 – Expansion of WTP 3, Increased Availability of Concentrate

ASR well capacity estimates are limited to 50% of their design capacities pending completion of operational testing.

The effect of the maximum daily use of the alternative water resources upon local raw water demand is shown graphically in **Figure 6-26**.

The County's current 2004 SFWMD Water Use Permit (No. 50-000135) states the system-wide maximum daily allocation shall not exceed 75.4 under Limiting Condition No. 10. PBCWUD's presently expected maximum daily flow (MDF) is 73 mgd and the net raw water demand is 48 mgd. The projected 2024 MDF raw water demand is expected to increase to 132 mgd. The Alternative Water Resources Program offsets 44 mgd of the 2024 raw water demand with some benefit from ASR. The County expects to use alternative water resource methodologies to offset the 12 mgd difference between the net raw water demand and maximum day raw water allocation by the year 2024.

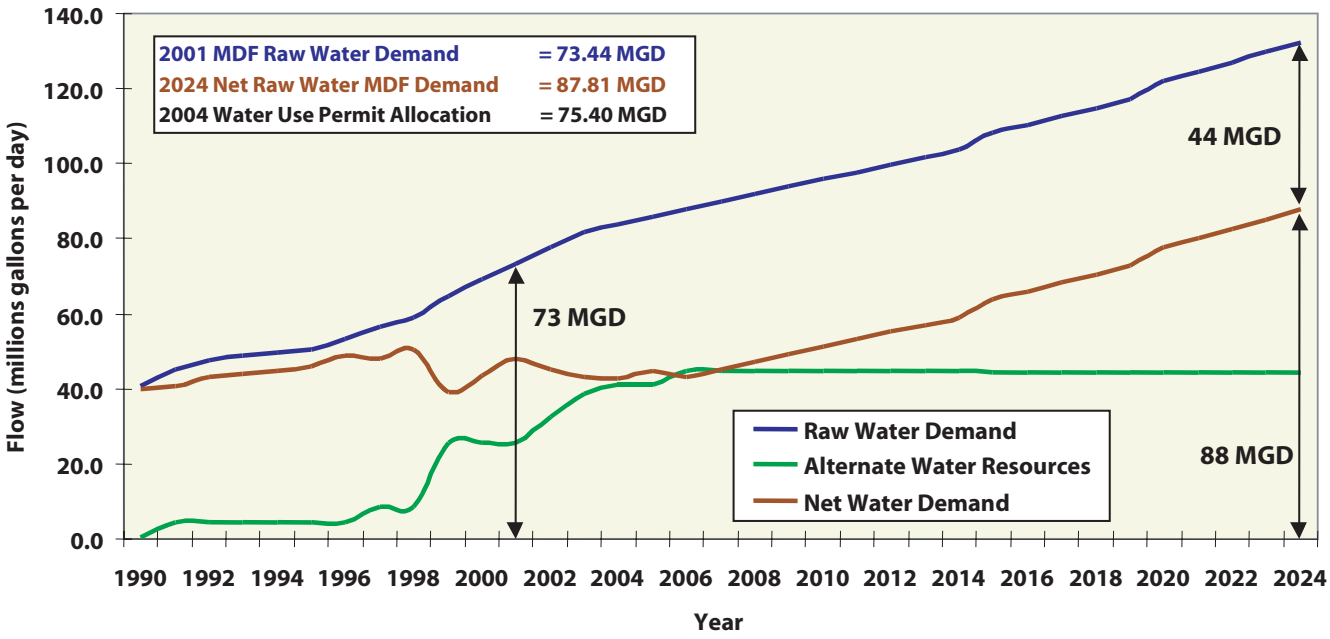


Figure 6-26
Maximum Daily Flow
Palm Beach County Net Raw Water Demand

CONCLUSION

The County has implemented an aggressive Alternative Water Resources Program to improve the environment, improve wellfield operating conditions, increase suburban green space, and extend the life of the Surficial Aquifer.

- **ASR Wells**: Aquifer storage and recovery technology provides the County with the technology to recover up to 8 mgd of stored fresh water to accommodate times of drought and max day raw water demand.

- **Reclaimed Water System**: The County currently operates the largest reclaimed water system in Southeast Florida with a capacity of 22 mgd. The system will be expanded to provide a total of 28 mgd for irrigation demand resulting in aquifer recharge. Additionally, the reclaimed water system has significantly reduced the County's reliance upon deep injection wells in that more than 73% of treated sewage is being converted to reclaimed water. Instead of being discharged down the deep injection well, the water is being land applied for reintroduction in to the Surficial Aquifer.

- **Wetlands**: The County has converted 56 acres of former percolation ponds into wetland and open water habitats for wildlife, waterfowl, and migratory birds. We are currently converting 200 acres of active row crops and a native plant nursery into a similar wetland facility. The wetlands provide treatment for a combined SRWRF effluent flow ranging from 8 mgd to 13 mgd. The wetlands serve to increase aquifer recharge and public awareness of water conservation.

- **Membrane Concentrate**: The County has constructed piping infrastructure to enable the process waste stream from WTP 3 to be directed to the SRWRF for blending into the reclaimed water system. This strategy reduces use of the deep injection wells and increases aquifer recharge.

The County's Alternative Water Resources Program reduces the 2020 net raw water demand below the current permitted allocation. This indicates that The County will not require increased raw water demand over the next 24 years. The difference between our raw water allocation and demand will be provided from our alternative water resources.

- **Average Day Flow:** The alternative water resources reduce the net raw water demand for the County by 15 mgd for average day flow conditions. This net demand reduction is expected to increase to 34 mgd by the Year 2011 and to 41 mgd by the Year 2024.

- **Maximum Day Flow:** The benefits of the County's Alternative Water Resources Program are more realized for times of drought and maximum day flow conditions. Net raw water demand is estimated to be 26 mgd for the Year 2001. The program build-out will occur in 2006 when a 44 mgd reduction of raw water demand will be provided.

8 Existing Wellfield Capital Improvements Plan

Current Wellfield Construction Projects

The County has a total of three (3) on-going capital improvements projects related to the four existing wellfields. Projects include modifications to existing piping and rehabilitation of existing water supply wells. A summary of these projects is provided in **Table 8-1**.

Rehabilitation Of Existing Wells

Rehabilitation efforts continue in WTP wellfields 2, 3, 8, and 9 under current construction projects WUD 98-66, WUD 00-136, and WUD 01-002. A summary of the County's existing wellfield rehabilitation projects follows.

Table 8-1
Existing Wellfield Capital Improvement Projects

WUD Project No.	Work Description	Project Status	Estimated Completion Date
WUD 00-136	WTP 2 Wellfield Improvements	Flow metering capability will be completed for some of the existing wells.	2003
WUD 00-136	WTP 3 Wellfield Improvements and Expansion	Flow metering capability and remote telemetry improvements will be completed for all wells. The well screens in the SRWRF wells (3W-15 through 3W-18) will be replaced. A total of ten new wells will be constructed to serve the expanded membrane softening plant (3W-11, 3W-12, 3W-20, 3W-21, 3W-23, 3W-25, 3W-26, 3W-27, 3W-28, and 3W-29).	2003
WUD 00-136	WTP 8 Wellfield Improvements and Expansion	Flow metering capability will be improved for some of the existing wells. All existing wells with vertical well pumps will be replaced with submersible well pumps. Two existing wells (8W-19 and 8W-20) will be abandoned. One new well (8W-16) will be constructed to replace the two abandoned wells.	2003
WUD 01-002	Well Rehabilitation: Well screen installation, well pump upgrade, electrical improvement and acidization of existing WTP 9 wells. Acidization of select WTP 3 wells.	Approximately ½ the existing open-hole WTP 9 wells have been screened. New pumps are being installed in these wells. Acidization is complete for the WTP 3 wells.	2002
WUD 01-035	New Piping: Construction of approx. 650 feet of new raw water piping to divert flow from wells 3W-8, 3W-9, and 3W-10 to the Lime Softening Plant.	As-built plan being prepared for submittal and approval by the PBC Health Department.	Completed
WUD 01-045	Hagan Ranch Road Utility Improvements: Conversion of 1.1 miles of existing 30-inch/ 36-inch raw water piping.	Construction is currently on-going. Work is being coordinated with WUD 00-136 WTP 3 wellfield improvements project for location of tie-ins for new production wells.	January 2003

2W Wellfield Rehabilitation

The System-Wide Wellfield Expansion project (WUD 00-136) will involve work at six wells serving WTP 2. Flow meters will be replaced for wells 2W-3, 2W-4, 2W-5, 2W-6, 2W-9, and 2W-12. Additional rehabilitation activities are not currently planned for the WTP 2 wellfield.

3W Wellfield Rehabilitation

The System-Wide Wellfield Expansion project (WUD 00-136) will involve work at each existing well in the WTP 3 wellfield. All wells will be equipped with new flow meters. Flow meters will be either magnetic flow meters or vertical propeller meters depending upon wellhead piping configuration. The flows from each well will be sent directly to WTP 3 via new hardwired cables or through the existing radio telemetry units (RTU). The radios presently in the RTU cabinets have become outdated and will be replaced with new units identical to the new WTP 9 wellfield radios provided under WUD 98-66.

The WTP 3 western wellfield located at the SRWRF tends to produce sufficient quantities of sand such that increased maintenance efforts are required to protect the WTP 3 membrane process equipment. The current WTP 3 wellfield rehabilitation effort is limited to acidization of all western wells (3W-13 through 3W-17). The acidization approach is intended to clean the well screens and develop some of the sand from each well. Under the System-Wide Wellfield Expansion project the existing 100-slot well screens in wells 3W-15 through 3W-18 will be replaced with screens more appropriately sized (approximately 30-slot) for the membrane plant pretreatment program.

Rehabilitation efforts are also underway for the WTP 3 eastern wellfield located on the WTP 3 site. In late 1999, an Aquifer Storage and Recovery (3W ASR) well was constructed at the site. Construction of a shallow monitoring well for the 3W ASR project utilized drilling mud (bentonite clay). Drilling mud is commonly used to keep well boreholes open during drilling operations. After completion of the 3W ASR monitor well, bentonite particles began to appear in water pumped from supply wells 3W-8, 3W-9, and 3W-10. These wells are located in the immediate vicinity of the ASR well. The County has constructed piping under capital Project No. WUD 01-035 to direct raw water from these three wells to the lime softening plant. Pumping these three wells to the lime plant allows them to be "further developed" to remove the bentonite from the raw water. This measure was required to protect the membrane softening plant and minimize maintenance associated with the membrane pretreatment program.

8W Wellfield Rehabilitation

The System-Wide Wellfield Expansion project (WUD 00-136) will involve work on several wells serving WTP 8. The existing vertical turbine pumps in wells 8W-1, 8W-2, 8W-3, 8W-10, 8W-11, and 8W-12 will be replaced with submersible well pumps. In addition to pump replacement, extensive wellhead modifications will be constructed for these six wells including new above-grade piping, check valve installation, flow meter installation, and instrumentation work. Flow meters will be constructed for the following wells: 8W-4, 8W-5, 8W-7, 8W-8, 8W-13, 8W-14, 8W-15, and 8W-21. The new meters will be a combination of magnetic flow meters and vertical propeller meters depending on wellhead configuration.

9W Wellfield Rehabilitation

The existing open-hole wells (9W-1R through 9W-15) at WTP 9 are being screened and gravel packed to minimize sand and silt transport to the new WTP 9 membrane facility under Project Numbers WUD 98-66, 00-136, 01-002. Historically, solids and sediment transport were not of concern because these materials settle into the lime sludge. Unlike lime processes, membranes are susceptible to plugging and fouling by solids and silt. The membrane softening processes offer the advantage of virus and bacteria removal. The quality of the permeate water and lifecycle of equipment are limited by the effectiveness of the Pretreatment Program. The WTP 9 Pretreatment Program begins with screening all open-hole wells. Additional pretreatment measures are taken at the plant site. Wells 9W-2

through 9W-15 will be equipped with a bubbler tube to accommodate water level measurement and monitor activities.

The System-Wide Wellfield Project (WUD 00-136) includes work associated with the nine wells located along the Hillsboro Canal (wells 9W-17 through 9W-25). The wellhead swing check valves for each well will be replaced with an automatic pump control valve. The control valve will serve as a check valve as well as a surge valve. A surge analyses was conducted on the raw water piping serving the Hillsboro Canal wells under project WUD 98-66. Various methods for mitigating potential surge waves were evaluated. It was determined that installing control valves at each wellhead would be the most reliable, long-term cost effective, and least maintenance option for addressing surge conditions in the new raw water line.

Wellfield Emergency Power Provisions

A complete assessment of emergency power provisions for the existing wells is provided in **Table 8-2**.

Wellfield Abandonment Program

The County has scheduled well abandonment programs for 2002 and 2010. In 2002, the seven production wells and four monitoring wells serving the decommissioned WTP 1 at the Palm Beach County Airport were abandoned under the System-Wide Wellfield Expansion Project (WUD 00-136).

Table 8-2
Existing Wellfield Emergency Power Provisions

Wellfield	Wells Hardwired to a Permanent Plant Generator	Wells Equipped with Portable Generator Plugs	Wells with No Emergency Power Provisions
WTP 2 Existing Wells	2W-1, 2W-2, 2W-3, 2W-4, 2W-5, 2W-7, 2W-9, 2W-10, 2W-11	2W-12, 2W-13, 2W-14, 2W-15	2W-6
WTP 3 Existing Wells	3W-1, 3W-2, 3W-8, 3W-9, 3W-10, 3W-17, 3W-18	3W-4, 3W-6, 3W-13, 3W-14, 3W-15, 3W-16	3W-3, 3W-5, 3W-7
WTP 8 Existing Wells	8W-1, 8W-2, 8W-3, 8W-8, 8W-10, 8W-11, 8W-12, 8W-13, 8W-14, 8W-15	8W-4, 8W-5, 8W-7	8W-21
WTP 9 Existing Wells	9W-1R, 9W-2, 9W-3, 9W-6, 9W-7	9W-8, 9W-9, 9W-10, 9W-11, 9W-12, 9W-13, 9W-14, 9W-15, 9W-17, 9W-18, 9W-19, 9W-20, 9W-21, 9W-22, 9W-23, 9W-24, 9W-25	None

Field activities at well 3W-17 resulted in the entire wellhead, pad, and casing to drop an estimated two inches. A video survey of the well was reviewed. It was determined that abandonment and replacement of the well will be the most cost effective solution. Therefore, the existing well will be abandoned and replaced with a new well 3W-17R located approximately 50 feet from the existing well under the System-Wide Wellfield Project (WUD 00-136).

Video logs of the wells at WTP 8 acquired from the Meadowbrook Utilities Acquisition (8W-19 and 8W-20) have been reviewed. The existing well screens are no longer attached to the casing. Therefore, these two wells are scheduled for abandonment under the System-Wide Wellfield Expansion Project (WUD 00-136).

In 2002-2003, the three existing wells at the Century Village WTP 7 (8W-28, 8W-29, and 8W-30) site will be abandoned when the plant is decommissioned under the System-Wide Wellfield Expansion Project (WUD 00-136). A summary of the planned wellfield abandonment program is provided in **Table 8-3**.

Table 8-3
Wellfield Abandonment Program

Well No.	Year Abandonment Planned	Planned Well Site Location	Well Site Easement ORB Reference	Design Capacity (gpm)
8W-19	2003	WTP 8 – Meadowbrook	ORB 3224, Pg 1406, 1370	1,000
8W-20	2003	WTP 8 – Meadowbrook	ORB 3224, Pg 1406, 1370	1,000
8W-28	2002	WTP 7 – Century Village	ORB 6938, Pg 472	700
8W-29	2002	WTP 7 – Century Village	ORB 6938, Pg 469	700
8W-30	2002	WTP 7 – Century Village	ORB 6938, Pg 472	700
8W-35	2002	WTP 1 – PBIA	ORB 575, Pg 363	750
8W-36	2002	WTP 1 – PBIA	ORB 575, Pg 363	750
8W-37	2002	WTP 1 – PBIA	ORB 575, Pg 363	500
8W-38	2002	WTP 1 – PBIA	ORB 575, Pg 363	1,000
8W-39	2002	WTP 1 – PBIA	ORB 575, Pg 363	800
8W-40	2002	WTP 1 – PBIA	ORB 575, Pg 363	1,000
8W-41	2002	WTP 1 - PBIA	ORB 575, Pg 363	900
Reduction in Raw Water Capacity with 2002-2003 Abandonment Program				11 mgd